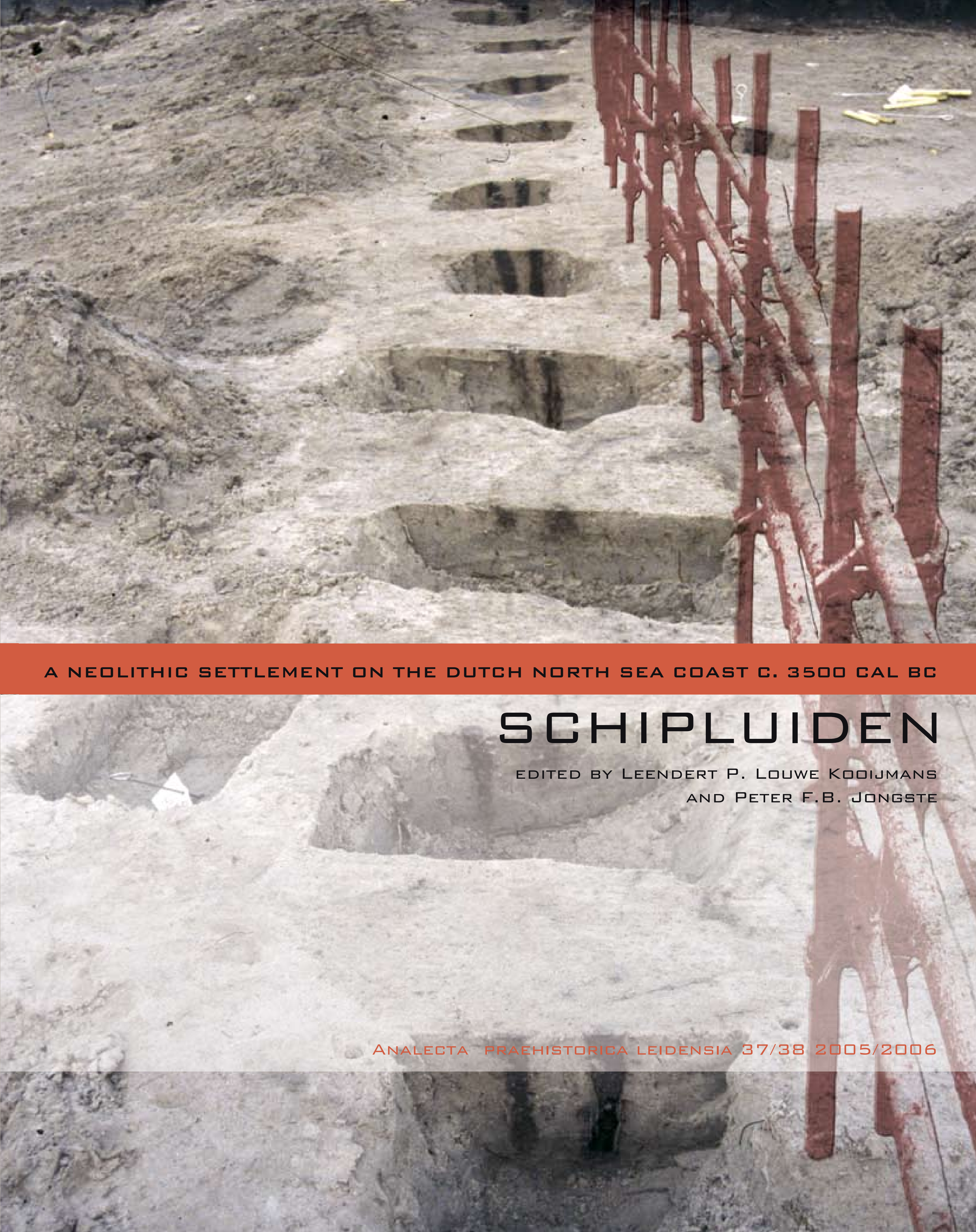

A NEOLITHIC SETTLEMENT ON THE DUTCH NORTH SEA COAST C. 3500 CAL BC

SCHIPLUIDEN

EDITED BY LEENDERT P. LOUWE KOOIJMANS
AND PETER F.B. JONGSTE

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Preface

During the development of a new, large wastewater treatment plant for The Hague and environs (AHR), the *Hoogheemraadschap* (Polder Board) of the Delfland region in 2000 formed an archaeological project group whose responsibility was to promote the interests of archaeological values in the planning area in accordance with present-day standards. At the time no-one suspected that concealed beneath the surface of the building plot was one of the most informative Neolithic settlement sites in the Netherlands. It is thanks to the project group's vision that the site could be excavated according to high research standards prior to the building work. Because a site of such an age and quality was entirely in line with the research programme of the Faculty of Archaeology of the University of Leiden, a strategic alliance was soon formed. A team of the best researchers was composed, which, according to the 'design and construct' principle, first formulated the research design and subsequently carried out parts of the research itself. Archol BV, which had previously successfully completed two comparable complex projects along the route of the new Betuwe railway line, was made responsible for the project's management. Fully aware of the great value of the archaeological remains that were inevitably to be disturbed, the Delfland *Hoogheemraadschap* agreed to finance the relatively costly excavation. This led to a unique private-public cooperation project. The publication that now lies before you presents the results of this project. The research team's aim was to show how successful such a form of cooperation can be, and to demonstrate the added value of a strategic alliance between on the one hand professional, 'commercial archaeology' according to the currently required documentary quality standards and, on the other, in-depth analysis and knowledge of academic archaeology.

The Neolithic settlement of Schipluiden-Noordhoorn owes its importance to a combination of factors.

In the first place, the site dates from an interesting period – a period in which the native population gradually switched from a way of life based on hunting, fishing and gathering to one based on arable and stock farming. The hunters slowly evolved into farmers. Schipluiden is a good reference point, showing us what stage the development of an agricultural society had reached 1500 years after farming had been introduced in the Netherlands.

Secondly, in this particular period, the site's environment – the coastal area and in particular the Delfland region – underwent a fairly drastic change. Within a relatively short space of time the mud flats behind an open coastline that had characterised this area for many centuries evolved into a vast freshwater swamp sheltered from the sea by a belt of coastal barriers bearing low dunes. The Schipluiden site presents a detailed impression of how people lived there under those specific conditions, and at the same time raises the question as to what extent the resulting picture of a community can more in general be used as a model for, or be seen as representative of, societies in those days.

In the third place, the site itself is interesting, too, due to its situation in an area in which, under the influence of the constant rise in sea level, sediments were laid down in a relatively stable environment. In the centuries after the period of occupation, expanding peat sealed in the entire site, preserving its remains and preventing contamination with younger finds. The fact that the deposition of artefacts extended into the wet swamps surrounding the settlement means that the site is of great informative value. It is precisely these wet peripheral zones that make all the difference – it is in these zones that artefacts and refuse of perishable materials have survived, and those remains provide a very detailed picture of the occupants' material culture and subsistence system and the site's natural environment. The natural stratification in this zone moreover enables us to divide the period of occupation into phases, and thus study the occupation and the landscape through time. It was mainly the landscape that changed drastically, and not the occupants' way of life. The phased chronology also provides us with a basis for making statements about the structure of the settlement.

Of course all that glitters is not gold. The settlement itself lay on a dry dune, on which virtually no organic matter whatsoever has survived, and it was used for such a long time that it is almost impossible for us to identify any patterns in the jumble of features. Some 3000 years after the occupation period the dune narrowly escaped complete destruction by a large-scale marine ingression. Only its tip was affected; the greater part of the dune and the old settlement site were fortunately spared.

Of great importance for our interpretations was that we were able to excavate and record not quite the entire site, but nevertheless a very large part of it according to the present state of the art. Uncertain hypotheses concerning parts that could not be excavated were thus restricted to a minimum, and we were able to set up a quantitative model of the local group. A complete site and a detailed associated database are the best any excavation team can hope for. Thanks to previous excavations of other settlements of the same regional community we were finally able to obtain an understanding of prehistoric society that goes beyond that of this local group.

The editors

PART I

INTRODUCTION

1 Discovery and working method

Peter Jongste
Leendert Louwe Kooijmans

The Middle Neolithic Schipluiden site was discovered during a systematic coring prospection of a building ground where a new wastewater treatment plant was scheduled. The site was assessed on the basis of additional borings and a small trial excavation. As the site could not be saved, an excavation strategy was developed by a project team. The excavation was executed by a research team coordinated by Archol B.V. The unforeseen wealth and wide extension of features and finds necessitated some adjustments to the excavation programme. The research goals of full coverage of the site and recording of all finds were met within the available time and the budget generously provided by the Water Board of Delfland.

1.1 Background of the investigation

1.1.1 Cause

The immediate cause of the discovery and excavation of the Neolithic settlement at Schipluiden was the construction of a new wastewater treatment plant by the *Hoogheemraadschap* (Water Board) of the Delfland region in the Harnaschpolder, in the northernmost part of the municipality of Midden-Delfland. The plant was to measure around 25 ha and comprise effluent pipelines with a total length of 30 km (figs. 1.1-2).

An 'AHR Project Group' (AHR stands for *Afvalwater-zuivering Haagse Regio* = Wastewater Treatment in the Region of The Hague) responsible for the archaeological supervision of the work was formed via a covenant between the *Hoogheemraadschap*, the municipal archaeological services involved, the provincial authorities of Zuid-Holland and the University of Amsterdam (Koot 2000). The Project Group's tasks were to inventory and survey the sites concerned, take protective measures and optionally execute or organise the execution of excavations. When the project was commissioned, the area was, on the basis of the known archaeology of the region, assumed to contain sites from the Roman period and the Middle Ages, but the possibility of research into Neolithic occupation remains was not considered (Koot 2000, 6 and 9). The report of the archaeological inventorying of early 2001 states that it was still not clear whether the research area was expected to contain dunes with Neolithic sites, and explicitly recommends deep exploration of the soil by means of deep borings (Bult *et al*. 2002, 52). The reason for this was that four settlements of the Hazendonk group had been found elsewhere in this region: Rijswijk (Koot 1994), Wateringen 4 (Raemaekers *et al*. 1997), Wateringse Veld (Oude Rengerink 1996a, b) and Ypenburg (Koot/Ten Have 2001).

1.1.2 Discovery

During boring trials (to a depth of -6.50 m NAP) carried out in the context of an Additional Archaeological Inventory, *RAAP Archeologisch Adviesbureau B.V.* discovered a buried sandy ridge with a width of around 50 m in the northernmost part of the building site. This was later found to be a low dune whose top lay at around -3.40 m NAP (Deunhouwer 2001).[1] The dune was explored further via 24 standard borings (Ø 4 cm) and two wide-diameter borings (Ø 12 cm). Most of the samples from the top of the body of sand were found to contain charcoal, and nine also contained fragments of pottery, flint and/or bone and – a sample obtained in one of the wide-diameter borings – even two carbonised emmer grains. With hindsight, these modest finds represented a

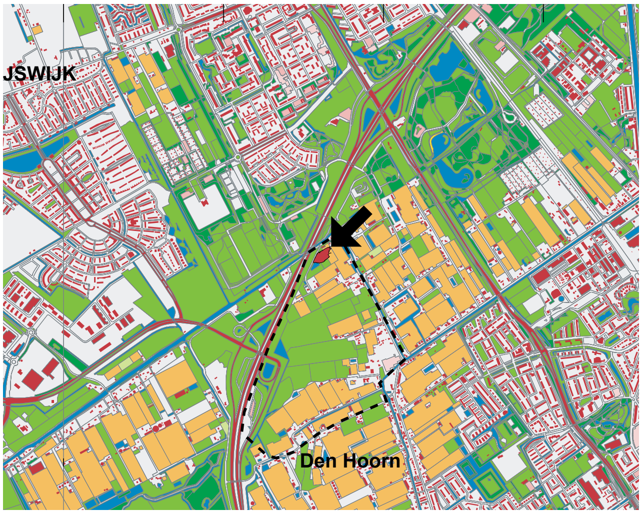

Figure 1.1 The wastewater treatment plant and the Neolithic site. Orange: greenhouse farming.

Figure 1.2 Aerial photographs taken on July 16 2003, half way through the excavation, showing the site surrounded by built-up areas and greenhouses and cut off by the A4 motorway. Detail showing excavation trenches.

refuse area at the foot of the dune. As only part of the site was accessible – the rest was still occupied by greenhouses – the site's dimensions could not be determined. It was however possible to establish a detailed stratigraphy for the period in which the dune was under the influence of the rising groundwater covered with peat and layers of clay. The top of the dune was found to have suffered erosion in later times (Iron Age).

At the time of its discovery the site was referred to as 'Schipluiden-Harnaschpolder' in view of its location in a remote corner of the municipality of Schipluiden, although the site actually lies much closer to the village of Den Hoorn and the large town of Delft. We decided not to change this designation to avoid confusion, even though Schipluiden was later incorporated in the larger municipality of Midden-Delfland.

1.1.3 Additional Archaeological Research

An Additional Archaeological Research assignment yielded more insight into the nature and quality of the site (Deunhouwer 2002). This additional research comprised 26 manual and 46 mechanical wide-diameter (Ø 10 cm) borings intended to obtain samples of an adequate volume. A test pit measuring 4×4 m was dug on top of the dune. The great depth of the site precluded the digging of a long trial trench. The results of this additional research in many respects confirmed those of the first exploration. Although the site was still not accessible in its entirety, the settlement appeared to have covered the whole dune, whose area was estimated to have been 0.75 ha. Find densities were still not known, but the archaeological remains appeared to be concentrated primarily on the dune slopes and in the aquatic deposits overlying the sand. Features were observable in the test pit, and a few remains were found. Among the botanical remains were carbonised sloe stones, while the zoological evidence included fish remains. The depth of the remains and characteristics of the pottery suggested that they predated (by a short time) the Vlaardingen group. This was confirmed by the outcome of thirteen AMS ^{14}C dates obtained for charcoal from the residues of the boring samples and samples from the test pit, including a carbonised sloe stone. They span a time range of 3900-3350 cal BC (2σ). This period coincides with that of the Hazendonk group, with minor overlaps with the preceding Swifterbant culture and the subsequent Vlaardingen group.[2] Unfortunately five stratigraphically consecutive samples from one boring at the southern edge of the dune revealed no development from old to young.

1.1.4 Assessment and advice

On the basis of the quality of the biological remains and the site's preservation in a calm depositional environment, the site was assessed as being of high value. As the fact that the plans for the wastewater treatment plant had already been approved meant that the site was destined to disappear, it was decided to excavate it.

1.2 Research questions

Following the report of the exploratory research, the AHR Archaeological Project Group formed a team that would be responsible for planning the excavation. The team was composed so as to comprise expertise relating to the period concerned, the categories of finds that were expected to come to light and the specific (wetland) research conditions. It was clear from the start that the members of this team would also be charged with the excavation's supervision on account of the limited availability of the required expertise in the Netherlands. The team formulated the research questions and made the excavation plan (Louwe Kooijmans *et al*. 2002).

The core questions of the research were: how did people live in the coastal area in the early Neolithic, to what extent may they be classed as 'fully Neolithic', and what place did the Schipluiden community occupy in the neolithisation process of the Lower Rhine area? Additional questions concerned the reconstruction of the former landscape, dating and phasing, cultural characteristics, subsistence and the settlement's function. Aspects of particular interest with respect to the latter issue were the size and composition of the group who lived here, its degree of mobility and seasonality. All questions were to be tackled with due attention for the unmistakable environmental changes that took place in the period of occupation, and the extent to which they may have affected the site's use.

The ways in which the analyses of the individual categories of remains and samples were hoped to help yield answers to these questions are indicated in a cross-table (fig. 1.3).

1.3 Excavation design

1.3.1 References

The excavation design was of course primarily based on the evidence obtained in the surveying of the site itself. In addition, the site Wateringen 4, which was much smaller but highly comparable in environmental and chronological terms, had shown what kind of macroscopic information the fine find fractions obtained in the borings could reveal. The possibility that two sites that were assumed to be so very comparable would actually prove to differ substantially in terms of the duration of occupation was however never considered. In a more general, methodical respect, the two excavations at Hardinxveld (Louwe Kooijmans 2001a, b), though differing from Schipluiden in environmental and chronological terms, also proved to be important references. But although these references were conscientiously used, the

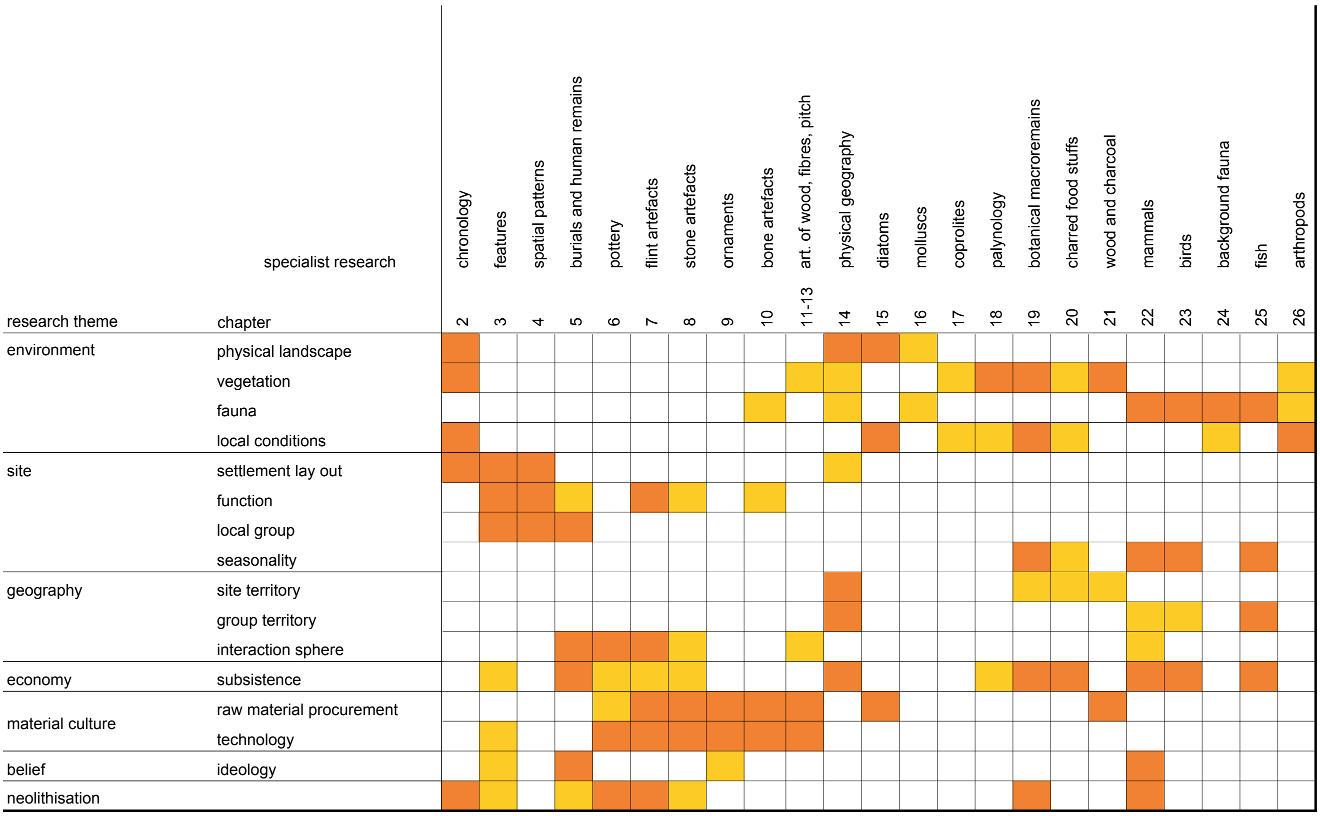

Figure 1.3 Specialist research versus research themes.

site was found to differ considerably from what had been expected. This was largely attributable to underestimation of the indications provided by the aquatic deposits at the edge of the settlement site in the preliminary investigation.[3]

1.3.2 The design

The design was based on complete excavation of the whole site, as this site afforded the possibility of mapping an entire settlement, with the exception of only a small part in the north, which had previously been disturbed by the construction of a motorway. Partial excavation was undesirable on account of the possibility of spatial differentiation of the site and the unpredictability of the occurrence of unusual features such as burials and house plans. The area to be excavated was calculated to measure 5500 m^2.

The design was formulated according to the same quality criteria as employed in comparable excavations, notably those of Wateringen 4, as a synchronous frame of reference in the same region, and Hardinxveld-De Bruin and Hardinxveld-Polderweg for the overall excavation procedure. These criteria conform to the standards of the Faculty of Archaeology of Leiden University and the KNA.[4]

Two important, but contradictory requirements were good stratigraphical control over the finds and an adequate spatial overview of the cleared surfaces to enable configurations of features to be identified in the field already. The solution chosen primarily entailed the digging of 6-m-wide parallel trenches perpendicular to the average longitudinal axis of the dune (fig. 1.4). This meant that, for every find, a vertical section would be available within 3 m. Secondly, in collecting the finds, the established stratigraphy was to be followed where possible, and each layer was to be excavated via spits with a thickness of at most 10 cm. The 6 m chosen for the width of the trenches was assumed to be sufficient for identifying house plans of the kind known from the period concerned (see section 3.8.5). It was moreover a good practical dimension for manual excavation.

A metre grid was assumed to be adequate for the resolution of the envisaged spatial patterns in the distribution of the finds (fig. 1.5). So, with 10-cm-thick spits, this meant that finds would be collected in units of 1 × 1 × 0.1 m. By way of comparison: the metre grid initially prescribed in the design for the late Mesolithic site of Hardinxveld was later reduced to segments of 50 × 50 cm. At the Bronze Age settlements that came to light along the course of the scheduled Betuwe railway line units of 2 × 2 × 0.1 m were used (Jongste/Van Wijngaarden 2002).

Total find recovery of all archaeological find categories of >2 cm was taken as the standard, with a view to both the information they would yield and the distribution patterns that were to be drawn. On account of the envisaged fragility of the pottery and bones and the possibility of use-wear traces and residues on stone, flint and bone implements, it was decided that the find-containing deposits would be excavated by hand, instead of being sieved. In view of the size of the site and the limiting value of 2 cm, this could be done by shovel. Trowels would be used only for concentrations of fragile finds.

In order to check the manual collection and obtain a sample of class 4-20 mm of all the find categories, it was decided to rinse the soil from one-metre strips from each trench through a 4-mm sieve. The primary aim of this sieving was to recover small fragments of flint, beads of various materials, small faunal remains (of fish) and large botanical macro-remains (fruit stones and pips and nuts).

An archaeo-ecological sampling programme was set up for zoological and botanical remains smaller than 4 mm. Samples of 10 litres were to be taken from the sections of the trenches all over the site in 6 × 6 m grids. They were to be assessed during the excavation and on the basis of the results of those assessments 60 samples would be selected for botanical and zoological assessment and analysis. Features were also to be sampled. A 5-litres portion of each 10-litres sample was to be sieved through mesh widths of 2 and 1 mm for the zoological research and the other 5-litres portion through mesh widths of 2, 1 and 0.5 mm for botanical research. A 0.5 litre portion was each time to be sieved to obtain a fine fraction of 0.25 mm.

For the other specialisms (diatoms, molluscs, arthropods, ^{14}C dating) the specialists themselves were to take samples at what they considered the most suitable points, or where necessary samples would be taken in consultation with the relevant specialists.

In order to place the settlement in its former landscape, its immediate surroundings within a radius of one kilometre were to be covered in a geological survey as there would be a major discrepancy between the detailed information obtained at the excavated site and the palaeogeographical information available on the region. The specially surveyed microregion would of course have to be incorporated in the broader palaeogeographical context.

The fieldwork was assumed to take at least 15 weeks, from April until Augustus of 2003. However, the civil-engineering preparatory work began to overrun its schedule and that put pressure on the excavation's schedule, which was partly dependent on the availability of students in the summer months. In the end the fieldwork was started in June and completed in September, within the allotted time.

1.3.3 Deviations from the design

Any excavation, however meticulously prepared and planned, will be affected by unforeseen discoveries, and things were no different in the case of the investigation of Schipluiden-Harnaschpolder. The greatest surprise at this site was its size. Although it had indeed been envisaged that the entire dune had been occupied, neither the information obtained in the surveying nor that of Wateringen 4 had given cause to assume that the refuse deposits would extend far into the surrounding sediments. In addition, the number of finds and the density of features exceeded the initial expectations by a factor of eight to ten. This alone already shows that the research led to a fundamentally new understanding of the

municipality	Schipluiden
region	Harnaschpolder
site code	AHR 39
ROB registration number	4257
coordinates	see figure 1.3
execution	ARCHOL BV in cooperation with the Faculty of Archaeology (Leiden University), Groningen Institute of Archaeology, BIAX Consult, Archeobone
preparatory work	weeks 20-22
excavation work	weeks 23-37 (2.6.2003 until 12.9.2003)
post-excavation work	weeks 38-39
duration of the excavation	15 weeks
number of student days	2615, from 126 (=25 studs) to 238 (=47 studs) per week, on average 35 students from Leiden and Ghent
duration of analyses and writing of the report	17 months

Table 1.1 Administrative details of the excavation.

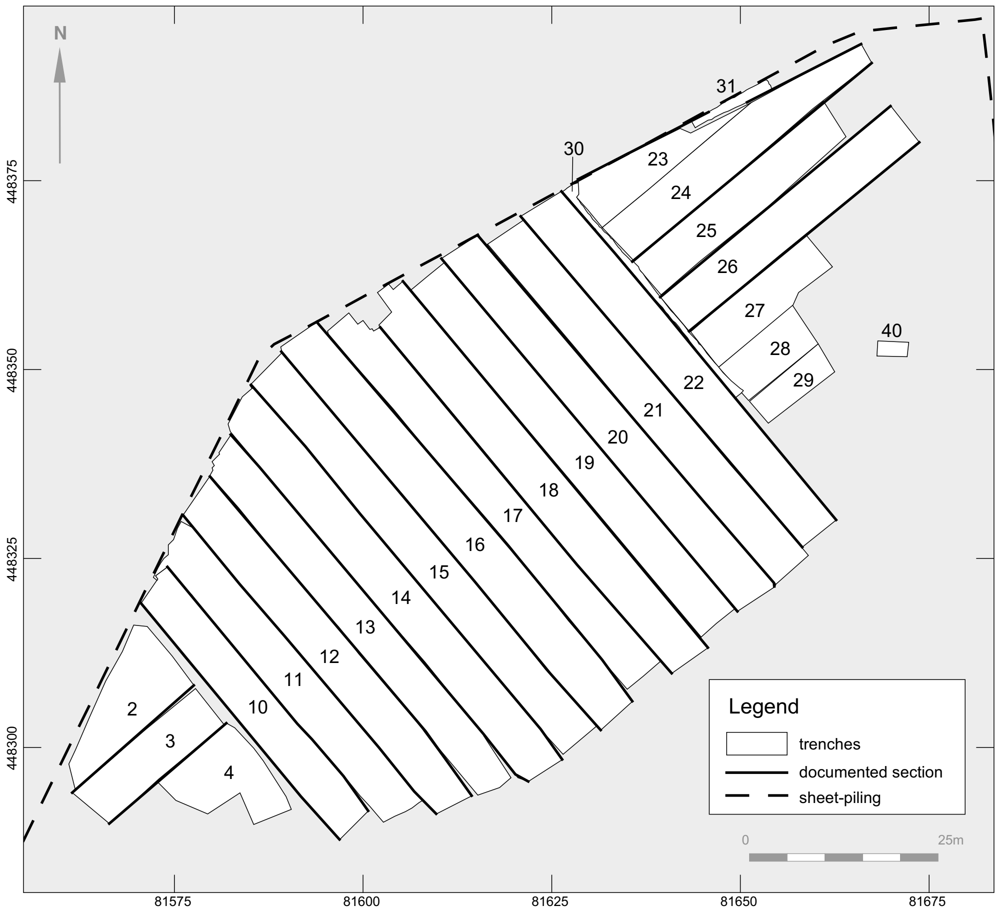

Figure 1.4 Layout of the excavation trenches and sections.

period concerned, in which there were evidently not only small settlements, but also much larger ones that were used over longer periods of time.

Another unexpected aspect was the wealth of organic remains, in particular wooden artefacts, which had survived because activities were carried out far from the site in the surrounding swamps.

What were the causes of this underestimation? In the first place a too rigid focus on Wateringen 4 as a reference, based on the assumption that sites of a comparable age in an identical environmental setting in the same region would be bound to correspond in other respects, too. A second cause was the limited possibility of interpreting the features observed in the test pit and the find indications obtained in the borings. In retrospect, one or more small trial trenches, or even better a single long trial trench, covering the two long slopes of the dune, would have proved very elucidating. Another factor, finally, were the limited possibilities of exploring the northern part of the site.

Fortunately, the organisation made it possible to respond to the new situation on time during the excavation. The capacity for sectioning features and the drawing work was expanded, as was that for the processing of the finds. By way of compensation the 4-mm sieving programme was restricted 50%, because various samples, especially those from the aquatic deposits, were difficult to sieve. During the fieldwork it had been found that manual digging already yielded a sufficient degree of accuracy. Sieving the soil from the units 1/12 instead of 1/6 nevertheless yielded an adequate sample of the fine fraction (4-20 mm).

After some manual trials it was decided to use a digging machine to collect finds from the clay Unit 19S (phase 1), for reasons of efficiency.

Due to the delay in the civil-engineering preparatory work the fieldwork had to start at a time when only the southwestern part of the site had been cleared. Unfortunately, very little came of the original plan to start with two more representative trenches (12 and 18). Instead, trenches 10 and 14 were dug first. The greater part of the southwestern end of the dune (trenches 2 and 4) moreover had to be excavated with priority, more quickly and without find recovery in view of the risk of the nearby motorway subsiding due to the

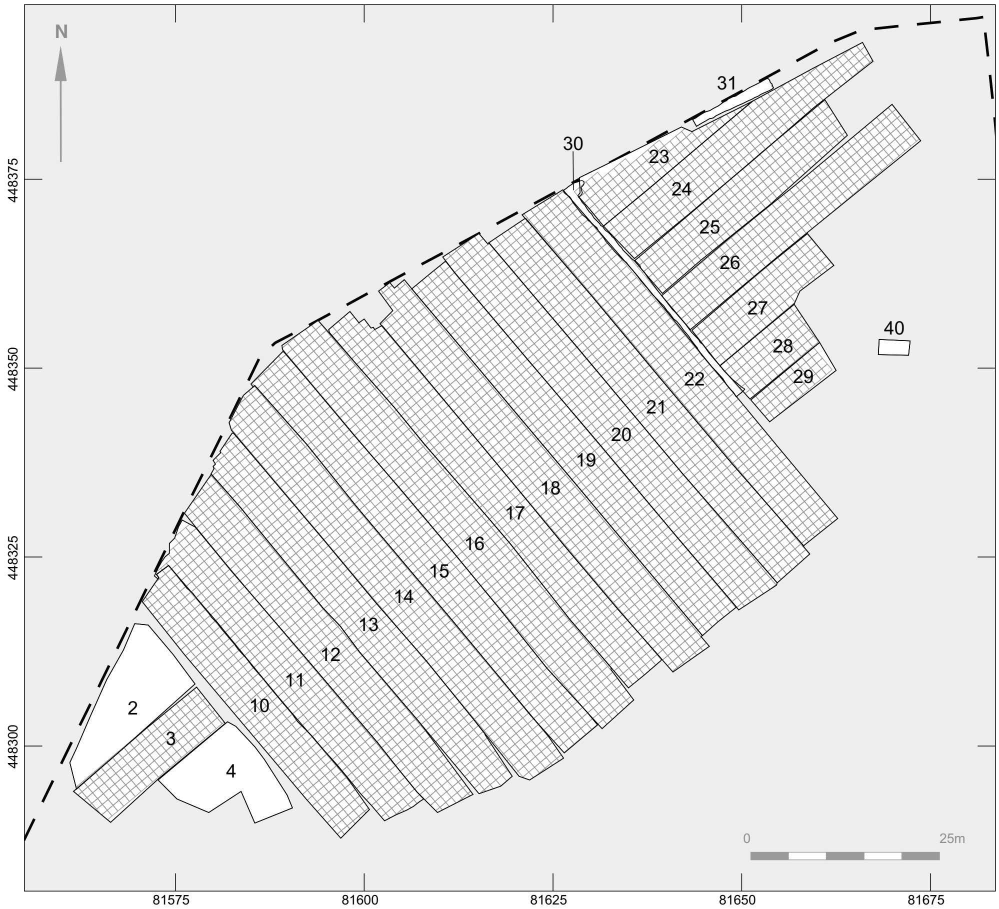

Figure 1.5 Layout of excavated segments.

well points dug for drainage. The features were however completely recorded.

Finally, the layout of the trenches at the northeastern end was adapted to the local relief of the dune to ensure better stratigraphical control.

1.4 Execution

1.4.1 Organisation

Responsibility for the execution of the excavation was granted to ARCHOL B.V. in Leiden on the basis of its capability, proven in previous projects (Hardinxveld), of conducting such large-scale, detailed wetland excavations on a contract basis. The contracts for the ceramic, botanical and zoological research were granted to the Groningen Institute of Archaeology, BIAX Consult in Zaandam and Achaeobone in Leeuwarden, respectively. Among the partners with which ARCHOL cooperated were the In Terris agency in Amsterdam (automation), Smits Antropological Bureau in Amsterdam (human remains), the Zoological Museum of the University of Amsterdam (arthropods) and the TNO Institute for Applied Geosciences (NITG) in Utrecht (diatoms). ARCHOL's systematic cooperation with the Faculty of Archaeology of the University of Leiden guaranteed the availability of the required expertise and internal quality control. By using students of archaeology – on average 35 a week – the large required working capacity could be met under relatively favourable conditions. The standard excavation team comprised eighteen persons (see Appendix 1.1). In addition, ten specialists were regularly involved in sampling procedures in the field. For the internal communication, a Schipluiden Bulletin presenting the results of the previous week's work was distributed every week.

1.4.2. Automation (database, cartography and photographs)

The great wealth of finds and features involved extensive recording work. In view of the wet, dirty working conditions in the field it was decided to use primarily analogue forms and field drawings for the field records. Height measurements (obtained with the aid of an infrared theodolite or Total Station) and the field photos (taken with a digital camera) were directly digitally processed. The find cards

were all barcoded to avoid the risk of errors in reading the unique identifications in the find processing.

All the field forms and field drawings were checked during the fieldwork and digitised or otherwise computerised. A database program was developed in an Access environment for the digital processing of the excavation data. The employed digital forms were based on the obligatory specifications formulated for this research by the principal. Besides options for entering and changing data, the program also comprised extensive control queries, which made it possible to quickly detect omissions and errors. The field drawings were digitised in AutoCAD and further processed into Mapinfo and Surfer files for further spatial analyses.

The finds were also processed simultaneously with the fieldwork. A specially developed VisualBasic split module made it possible to automatically record the number of finds in each category and their total weight. Also digitised were the production of new find cards, including the recorded find context, and the box administration.

The material specialists used their own digital records, developed in consultation with the AHR Project Group, in processing the various categories of finds. The system of unique find numbers that was used by everyone meant that the described finds and samples could always be coupled to the field records.

The relational integrity of the various tables, each covering a specific part of the workflow and administration, was regularly checked in strict, comprehensive inspections throughout the duration of the research. This ultimately resulted in an integral digital set of records.

Figure 1.6 Sieving installation in sea container and the artificial decantation basin of the closed-water circulation system.

1.4.3 Facilities

The Delfland *Hoogheemraadschap* made a house lying a short distance from the site available as an excavation base and for the automatic processing of the data. A shed was available for the processing of the finds (washing, drying, sorting and storage) and the sieving of the ecological samples. The sieving installation that had been developed for the Hardinxveld excavations (Louwe Kooijmans 2001a, b) was used for the 4-mm sieving procedure. The installation was placed in a sea container next to the site (fig. 1.6). A closed circuit with a basin for collecting and reusing the rinsing water was created for the sieve's water supply.

1.4.4. Layout of the site

The ground level of the site of the scheduled wastewater treatment plant – and hence the excavation site – was -1 m NAP. The site was along its northwestern side limited by the A4 motorway. The fact that work would have to be done at depths ranging from -3 to -5 m meant that the site would have to be drained by well points. To this end, steel sheet piling was driven into the ground along the motorway. A slope was assumed to suffice on the other side of the site. Phase 2 of the site preparations comprised the archaeologically supervised mechanical removal of the archaeologically sterile clastic covering layers (Unit 0) to approximately 30 cm above the highest find level. Next, the trenches were marked out. They were alternately excavated, so that a good general survey of the site's dimensions and the distributions of finds and features would be obtained halfway through the excavation already (fig. 1.7).

1.4.5 Standard procedure

Field procedure

During the fieldwork, due consideration was paid to the contours of the old landscape. The find layers were followed as they sloped downwards and were "peeled away" down to the levels at which features became visible. The features were then plotted. The standard procedure followed in each excavation trench was as follows. First the remnants of the covering layers were mechanically removed, after which the metre grid for the segments in the find layer (level A) was installed. Next, the find layers were excavated by manual shovelling in collection units of 1 × 1 × 0.1 m down to the first level at which features became visible, which was still characterised by anthropogenic soil (level B) (fig. 1.8). The height of each segment in the find layer was determined.

The height of level B was determined along three rows in each trench (along the edges and across the centre). Then excavation was continued mechanically to approximately 10 cm beneath level B, to a level at which features could still be clearly identified (level C, fig. 1.9). This level was mapped (scale 1:50, fig. 1.10). The heights of the levels were deter-mined (see level B), and each individual feature was three-dimensionally measured. All features were sectioned, the small ones (postholes) first, and the larger ones (pits) last.

As the excavation of Wateringen 4 had shown that not all features were visible at this depth, the excavation was in each trench continued to approximately 30 cm beneath level C, to level D.[5] This led to the discovery of a modest number of new features, among which were some hearth pits.

Finally the two long sections of the first series of trenches were drawn. Palaeoecological grid samples were taken from the sections, to ensure optimum stratigraphical control.

Ecological sieving programme

10-litres samples were taken from the fills of pits, wells and sections. They were all (N=300) assessed by the specialists concerned during the fieldwork. Of the 300 samples, 128 were subjected to zoological analysis. A selection of sixty samples with good research potential, obtained from different parts of the site and representing the different phases and the distinguished contexts (layers, pit fills), were botanically analysed. See chapters 18-25 for further details.

A few pit fills with extremely favourable preservation conditions were sampled for arthropod research (see chapter 26). Diatom samples were taken from the aquatic stratification and from the odd pit fill (see chapter 15).

1.4.6 Post-excavation work

The specialists responsible for analysing the various find categories were confronted with quantities that were five to ten times the amounts envisaged. This meant that the specifications that had been set up for the selections of the various categories that were to be analysed were actually superseded. For reasons of scientific desirability, available research capacity, time and costs, new lower limits were therefore defined for the different find categories. The new limit chosen for pottery was 10 grams, that for flint and stone was 2 cm. In the case of bone it was felt to be undesirable to employ such an absolute dimensional criterion, in view of the risk of it affecting the scores of smaller species. The criterion chosen for this category was therefore quick and unambiguous determinability. This led to the exclusion of fragments that could not be identified with any greater precision than 'large, medium-sized or small mammal (LM, MM, SM)'. As a good spatial and quantitative picture of the total quantity of finds could be obtained via other routes (chapter 4), the new strategy did not imply a loss of information. The same objectives could be realised with a little extra effort, and the much better quality of the finds implied the prospect of a far more satisfying final result.

In managerial terms it could be said that the merit of the employed 'design and construct' concept was proved, because a more rigid organisational set-up would have either

Figure 1.7 General view of the site from the south, half way through the excavation.

Figure 1.8 The excavation of the 1 m^2 segments in 10-cm spits and following the natural stratigraphy.

Figure 1.9 Removal of approx. 10 cm of soil between segments and level C (*cf.* fig. 3.1) by a machine equipped with a shovel specially designed for archaeological excavation.

Figure 1.10 Recording of features, indicated by white labels, at level C.

involved alarmingly higher costs or necessitated restrictions in the excavation, which would have led to a qualitatively poorer final result.

One of the results of the cooperation between ARCHOL and the Leiden Faculty of Archaeology was that limits were on many occasions for scientific reasons exceeded in favour of the project. This was for example the case in the intrasite spatial analysis (chapter 4), the analyses of flint (chapter 7) and stone artefacts (chapter 8) and the coprolites analysis (chapter 17), but also in the preparation of the overall publication.

Some of the finds recovered in this excavation will be incorporated in the reference collections of the individual experts – *i.e.* finds that will be of use for future scientific research on account of their informational value.

Some of the wooden objects have been preserved by means of freeze-drying by the preservation and restoration laboratory of Archeoplan (Delft).

The entire set of records (analogue and digital), the categorised finds, the preserved and restored objects and all the reports written in the course of the research were on conclusion of the project filed in the depot of the provincial authorities of Zuid-Holland, where they can be consulted for further research.

1.4.7 The report

It was decided to divide the report into three main sections.

Two chapters were first to outline the site's chronological and spatial context, respectively, both independently of environmental and cultural-material factors. The spatial analysis was moreover to contain a fundamental assessment of the representativeness of the collected archaeological finds in relation to the employed recovery method. These chapters were to be followed by the reports of the specialist analyses, each based on its own research questions.

The second section, 'Man and materials', was to present the results of all the analyses of the artefacts and the burials, including those of the skeletal research. And the third section, 'Subsistence and environment', was to focus on the results of the geoscientific and biological research.

A final chapter was to synthesise the two sections, and to place the know-how and insights obtained in the research in the broader context of the early occupation of the Dutch and the development of early farming communities in the Lower Rhine area.

notes

1 In the excavation, the highest point was found to lie at -3.0 m, outside the explored area.

2 A remarkable number (four) of these dates (4040-3640 cal BC, 2 sigma) entirely predate the ^{14}C dates obtained for the samples taken in the excavation, while two others only just overlap in the two-sigma range (3900-3540). Three of these samples were charcoal from the test pit, the three others were charcoal from different depths in the stratifications on the western and southeastern sides.

3 The archaeological indicators (small pieces of charcoal, bone, flint and pottery) from borings are not representative of the rich archaeological remains of larger dimensions.

4 KNA = Dutch Archaeology Quality Standard (http://www.archinsp.nl/publicaties/KNAUK.pdf).

5 The field codes of these levels were 1-11 (A), 50 (B), 70 (C), 90 (D).

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Appendix

1.1 The project staff.

Design team

C.W. Koot	leader of the AHR Archaeology Project Group
Dr A.L. van Gijn	Faculty of Archaeology, Leiden University
Dr L.I. Kooistra	BIAX Consult
Prof. dr L.P. Louwe Kooijmans	Faculty of Archaeology, Leiden University
Dr J.A. Mol	Faculty of Archaeology, Leiden University
Prof. dr D.C.M. Raemaekers	Groningen Institute of Archaeology
Dr J.T. Zeiler	Archeobone

Excavation team

Prof. dr L.P. Louwe Kooijmans	Faculty of Archaeology, Leiden University	scientific supervision
Dr P.F.B. Jongste	Archol BV	project leader
T.D. Hamburg	Archol BV	excavation leader
M.M. van den Bel	Archol BV	assistant excavation leader
S. Knippenberg	Archol BV	assistant excavation leader
Dr J.A. Mol	Faculty of Archaeology, Leiden University	physical geography
E. de Graaff	Archol BV	physical geography field assistant
M. Wansleeben	Faculty of Archaeology, Leiden University	automation design and supervision
M. Kappers	In Terris	automation
E. Smits	Smits Antropologisch Bureau	physical anthropology
R. van Beek	Archol BV	field technician
M. Hemminga	Archol BV	draughtsman
Y. Taverne	Archol BV	draughtsman, field technician
R. de Leeuwe	Archol BV	land surveyor
L. Bruning	Archol BV	find processing
D. Eijsermans	Archol BV	assistant find processor

Student assistants

P. van den Bos	student assistant
A. van Hilst	student assistant
M. Pruijssen	student assistant
R. Timmermans	student assistant

ARCHOL B.V.

C. Leeflang	director
S.M. van Roode	member of office staff

Other specialists involved in the project

Prof. dr D.C.M. Raemaekers	Groningen Institute of Archaeology	pottery
M. Rooke	Groningen Institute of Archaeology	pottery
Dr L.I. Kooistra	BIAX Consult	wood
Dr L. Kubiak-Martens	BIAX Consult	botanical macroremains
Dr A.L. van Gijn	Faculty of Archaeology, Leiden University	artefacts of stone, flint and bone
Prof. dr J. Boon	FOM Institute AMOLF	chemical analysis
Prof. dr C.C. Bakels	Faculty of Archaeology, Leiden University	pollen analysis
Dr J.T. Zeiler	Archaeobone	archaeozoological remains
Dr H. de Wolf	Netherlands Institute for Applied Geosciences	diatoms
T. Hakbijl	Zoological Museum, University of Amsterdam	insects
W. Kuijper	Faculty of Archaeology, Leiden University	molluscs
Dr D.C. Brinkhuizen	Stichting Monument & Materiaal	fish remains
C. Vermeeren	BIAX Consult	coprolites
M. van Waijjen	BIAX Consult	coprolites

Figure 1.11 The excavation team. Front row from left to right: Caroline Leeflang, Liesbeth Smits, Eveline de Graaff, Leendert Louwe Kooijmans, Raf Timmermans, Roos de Leeuwe, Anne van Hilst, Sigrid van Roode, Maurits Pruijssen, Peter van den Bos. Rear row: Danny Eijsermans, Tom Hamburg, Sebastiaan Knippenberg, Michiel Kappers, Peter Jongste, Lauren Bruning, Yvonne Taverne, Minja Hemminga, Martijn van den Bel, Roy van Beek, Milco Wansleeben, Joanne Mol.

Figure 1.12 The final weeks' student field team celebrating the excavation of 'the last square'.

2 Stratigraphy and chronology of the site

Joanne Mol
Leendert Louwe Kooijmans
Tom Hamburg

The Holocene stratigraphic sequence around the site was determined by the rise in sea level. This sequence is the key to assessing the dates and duration of the occupation period. On the basis of the stratigraphy, the settlement history can be subdivided into four phases. This subdivision gave us an opportunity to identify any changes that may have taken place in the life of this local group of people.

The absolute dates of the settlement were established by means of radiocarbon dates relating to the stratigraphy. Regrettably, wiggles in the calibration curve hampered the analysis. Nevertheless, the outcome is consistent with external geological, ecological and archaeological evidence.

2.1 Introduction

The Middle Neolithic site Schipluiden lies on top of a small dune (approx. 0.5 ha) oriented NE-SW. It was formed in the dynamic environment of a large estuary. Clay sedimentation and peat formation continued around the dune during the period of prehistoric occupation, which resulted in a succession of sediments in which archaeological remains were embedded in primary positions (figs. 2.1 and 2.2).

The stratigraphy was studied and recorded during the excavation by means of a series of parallel sections, spaced 6 m apart at right angles to the dune axis, created by the first series of excavation trenches. The layout of the trenches at

Figure 2.1 North section of trench 20 showing the deposits covering the southeastern slope of the dune.

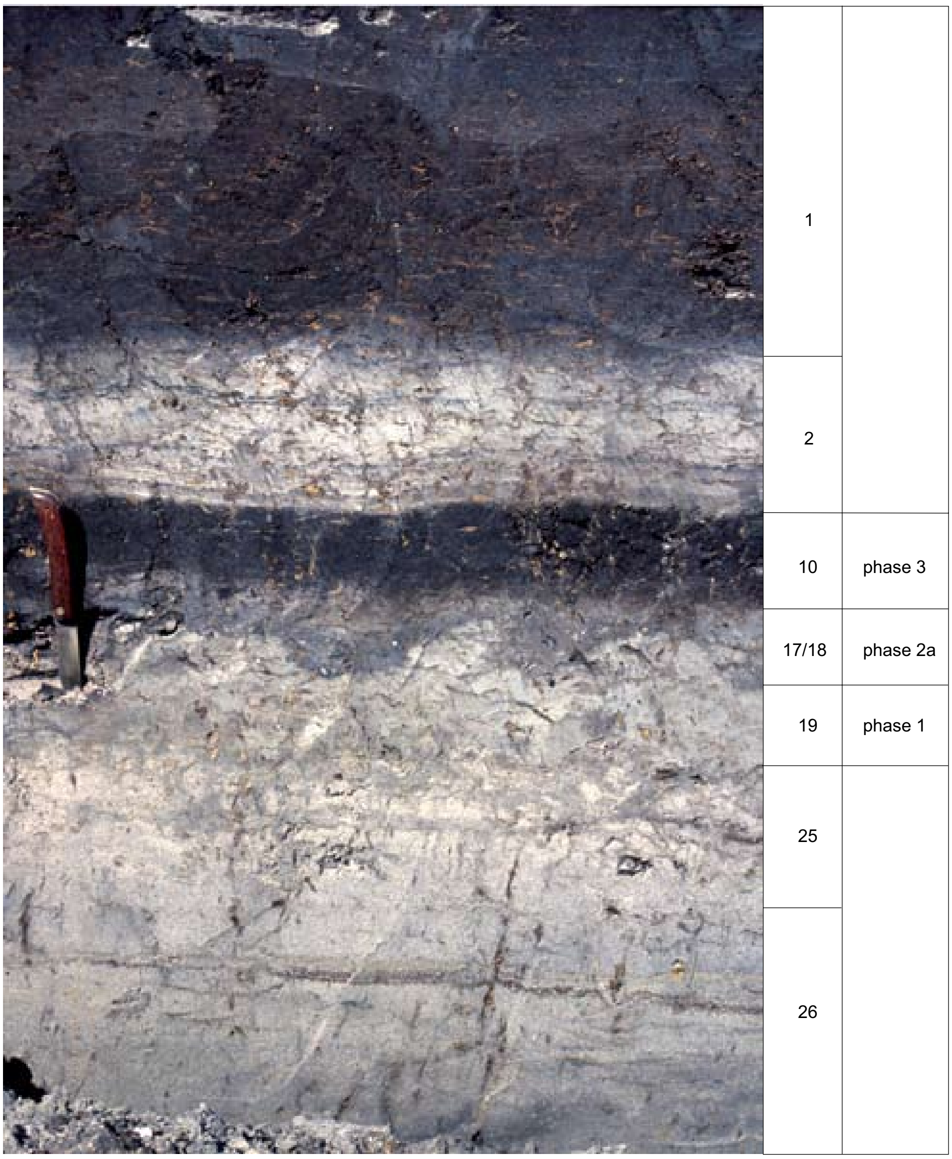


Figure 2.2 Detail of the section shown in figure 2.1 beyond the limit of the colluvium of Units 15/16.

the SW and NE ends was adjusted to create sections more or less at right angles to the contour lines of the dune there, too.

A series of lithostratigraphical units was distinguished, each with its specific sedimentary characteristics and stratigraphical position. Initially, the deposits of the four dune sides were coded in separate series. After the stratigraphical sequence on each side had been distinguished, the units were correlated on the basis of their absolute heights and stratigraphical positions.[1] The stratigraphy basically appeared to be uniform around the dune, but in some periods the dynamics of the depositional environment caused dissimilarities in deposition between the different sides of the dune (figs. 2.3 and 2.4). This was especially the case during the period of occupation.

Remains from the overall period of occupation were embedded as a mixed assemblage in the 'occupation layer' and in colluvial deposits on the top of the dune and on its slopes. The majority of the archaeological finds were however found embedded in a primary position in the aquatic deposits on the northwestern slope and especially on the long southeastern side. On the basis of this natural stratigraphy three phases were distinguished in the overall period of the site's occupation. This phasing could however not be applied to the majority of the finds recovered outside this stratigraphy, nor to the majority of the features observed in the dune sand.

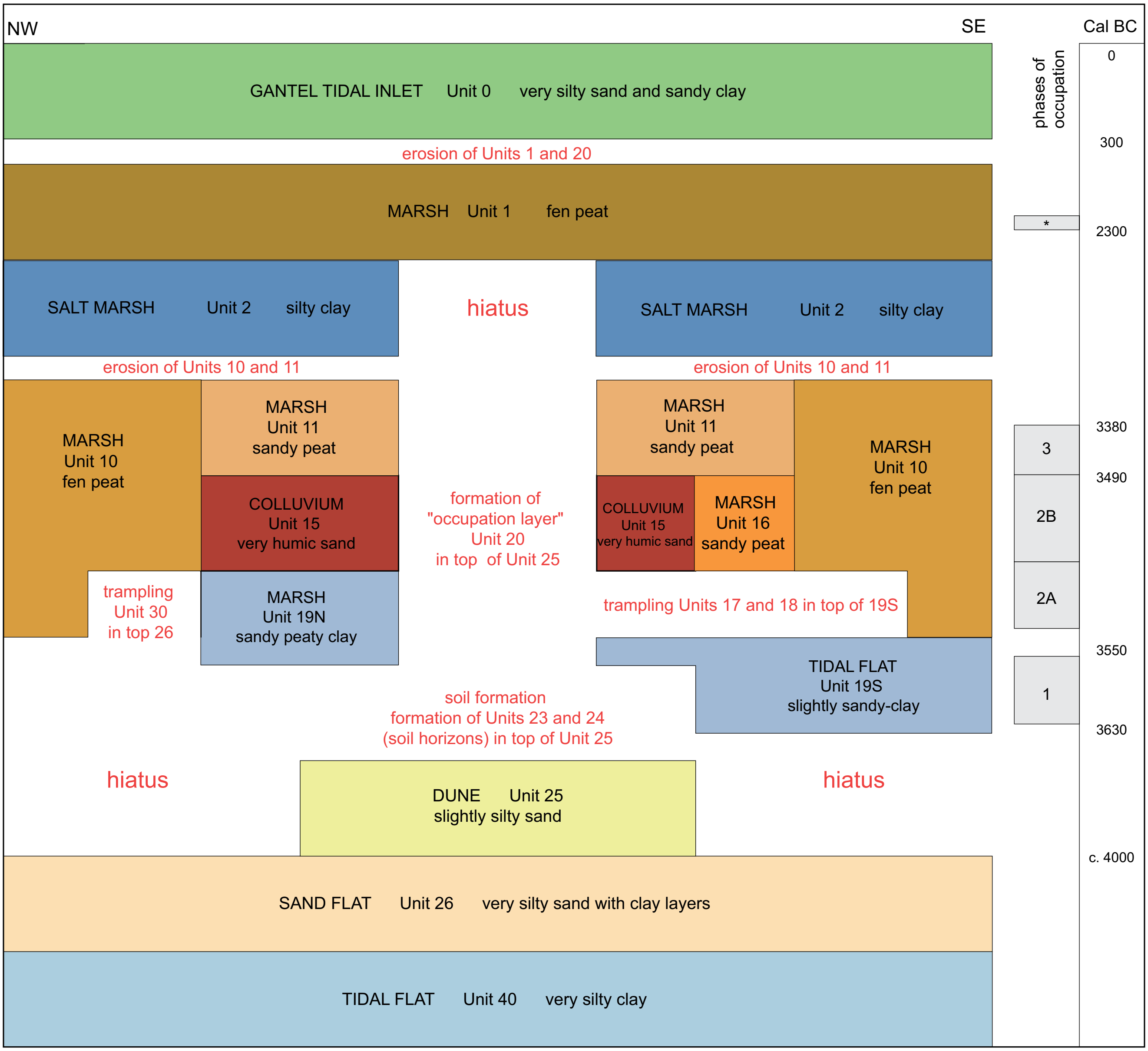


Figure 2.3 Schipluiden-Harnaschpolder. Chronostratigraphical diagram of the lithological units. Units at the same height in the diagram were deposited synchronously. The thickness of the blocks refers to the period in which the unit was deposited and provides no indication of the sedimentation rate or the actual thickness of the deposits.

2.2 STRATIGRAPHY[2]

The identified stratigraphical units are listed in table 2.1 and shown in a series of sections in figure 2.4. The depositional sequence can be divided into three main stages:

- Stage A: deposition prior to the period of occupation
- Stage B: deposition during occupation
- Stage C: deposition after the period of occupation

2.2.1 *Stage A: deposition prior to the period of occupation* (fig. 2.7a)

Stage A comprises the basal part of the sequence, Units 40, 26 and 25 (table 2.1). The entire sequence shows a gradual change from a wet to a dry environment. The units were deposited before the actual period of occupation and evidently afforded an attractive environment for Neolithic settlement and exploitation.

Unit	texture	maximum thickness (m)	synchronous with	material from occupation phase*	interpretation
0	alternation of thin very silty sand and sandy clay layers	4	–	–	tidal inlet
1	fen peat	0.15	–	4	marsh
2	silty clay with peat fragments	0.4	–	–	tidal flat
10	fen peat	0.1	11	3	marsh
11	sandy peat	0.1	10	3	marsh with colluvium input
20	very humic sand with charcoal	0.15	15 and 16	1, 2	'occupation layer' and colluvium
15	very humic sand with charcoal	0.15	16 and 20	2b (1, 2a)	colluvium
16	sandy peat with charcoal	0.15	15 and 20	2b (1, 2a)	colluvium
17	very humic silty clay	0.1	18	2a	trampling horizon
18	sandy clay, ripened	0.1	17	2a	trampling horizon
19S	silty clay with some shells	0.5	19N and 30	1	tidal flat
19N	very humic silty clay	0.1	19S and 30	1, 2	local marsh conditions
30	well-sorted clayey sand (105-150 μm)	0.1	19N and 19S	1, 2	trampling horizon in 26
23	well-sorted, slightly silty sand (105-150 μm)	0.3	–	–	eluviation horizon of soil in 25
24	well-sorted, slightly silty sand (105-150 μm)	0.2	–	–	humus illuviation horizon of soil in 25
25	well-sorted, slightly silty sand (105-150 μm)	1.5	–	–	dune
26	well-sorted very silty sand (105-150 μm) with thin silty clay layers	1.1	–	–	tidal sand flat
40	silty clay, with a soft consistency and in situ shells	> 0.4	–	–	tidal flat

* phases in brackets: material in secondary position

Table 2.1 Lithostratigraphical units of the Schipluiden site and its immediate surroundings in chronological order (youngest at the top). Several units were simultaneously deposited in different places; this is indicated in the fourth column.

Unit 40 consists of soft silty clay mixed with shells from marine and brackish environments (chapter 14). It is completely covered by Unit 26, consisting of silty sand containing thin layers of clay. Deposition of Unit 26 reached a maximum level of -4.5 m on the NW side and a slightly higher level beneath the later dune. On the SE side the top of this unit will have been eroded.

This unit is partly overlain by Unit 25, a 1.5-m-high sand rise in the middle part of the section, to be interpreted as a low dune. It represents the subsoil of the settlement. A podzolic soil developed in its top, containing a clear eluviation horizon (Subunit 23) and a humus illuviation horizon (Subunit 24, fig. 2.5). The A_1 and A_2 horizons suffered a good deal of erosion due to colluviation and the formation of the 'occupation layer'. The profile was however preserved at the western end of the dune. Unit 40 was found to contain shells of tidal species preserved *in situ*. The molluscs were evidently buried too rapidly to be able to escape. Their presence points to a brackish to salt tidal environment (chapter 16). This means that this poorly ripened clay was deposited in a back-barrier environment and represents a 'lower tidal flat' that was exposed to the atmosphere for short periods only.

The occurrence of layers of clay in Unit 26 and its diatom flora point to aquatic deposition under (tidal) conditions similar to those under which the underlying unit was laid down (chapter 14). This means that Unit 26 must also have been deposited in a back-barrier environment, and is to be regarded as a sand flat in a beach plain (chapter 14).

Unit 25 on top of this sand flat has no indications of running water: it contains no layers of clay or any shells and the podzolic soil (Subunits 23, 24) in the top part of this unit shows no gley features. Since these (sub)units developed during a continuously rising sea level it is highly unlikely that this unit is water-lain; such a deposit would never have lain at the surface for the length of time required for the formation of a podzolic soil. The unit most likely represents a low dune, blown on top of the sand flat. Such a sedimentary unit lay well above the water level and allowed sufficient time for soil development. It is this dune that apparently attracted the Neolithic people.

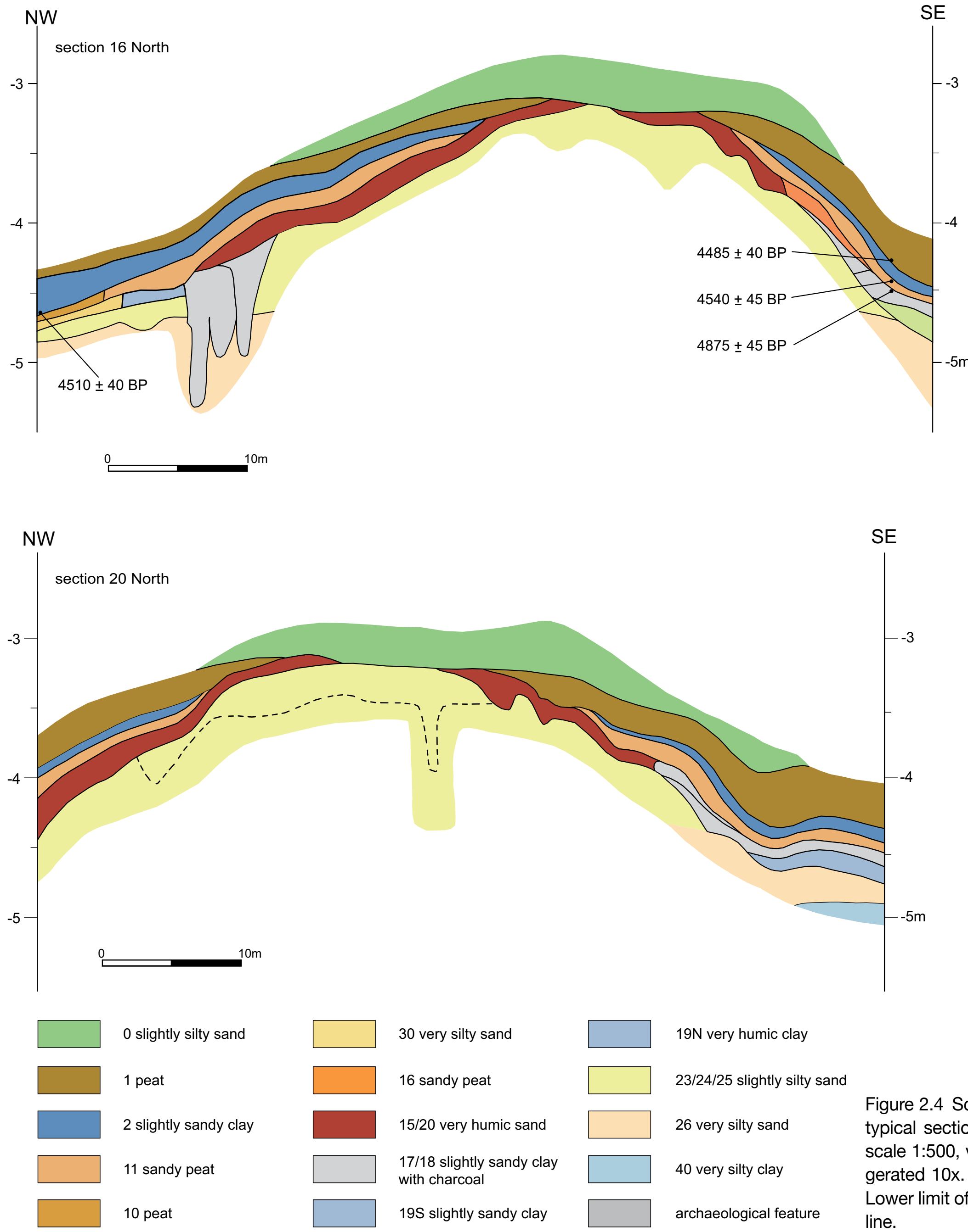


Figure 2.4 Schipluiden-Harnaschpolder. Two typical sections through the site. Horizontal scale 1:500, vertical scale 1:50, height exaggerated 10x. Smoothed after field drawings. Lower limit of podzol indicated with a dashed line.

2.2.2 *Stage B: deposition during occupation*

The main focus of this research was the part of the sedimentary sequence that formed during the period of human occupation (stage B). It is represented by Units 30 to 10 (in stratigraphical order; see table 2.1), which gradually covered the older layers. The environment during this stage showed the widest variety of facies and land-scape changes. During this period the landscape changed from an open, tide-dominated area to a closed, densely overgrown reed marsh, with a progressively declining estuarine influence (chapter 14). The top of Unit 26 will consequently not have been flooded on a regular basis. This condition – together with the

Figure 2.5 Podzolic soil in the north section of trench 10 showing B_h and A_2. The turf horizon and part of A_2 were transformed into occupation layer Unit 20.

presence of the low dune – will have made the site and its surroundings suitable for occupation.

Occupation phase 1 (fig. 2.7b)
The beginning of the sedimentary sequence is complicated as a result of facies variations on the different sides of the dune. The topography and the dynamics of the environment were apparently such that the sedimentary conditions differed on a micro-scale, resulting in three Units that were formed synchronously (19S, 19E and 19N).

Clay sedimentation started in the lowest parts and was concentrated on the southeastern side of the dune, preceded by some erosion of Unit 26 in those parts. There, 0.5 m of clay (Unit 19S) was deposited. It contained the lowermost stratified artefacts found, but only in its basal part, its top 25 cm being archaeologically sterile. These remains represent the first occupation phase (phase 1). This clay was deposited in a tidal environment similar to that in which Unit 40 was laid down. Its clay was slightly more consistent than that of Unit 40, and must therefore have been exposed to the atmosphere more frequently. It was probably deposited in a morphologically slightly higher position than Unit 40, and can be regarded as a ‘higher tidal flat’ that was frequently exposed during low tide. The archaeological finds recovered from its basal part were deposited during its active stage, while clay sedimentation still occurred.

A maximum sedimentation level of approx. -4.0 m. on the southern dune slope was reached at the end of the formation of 19S. During the next occupation phase, this top part became Unit 18 as a result of the subsequent human activities.

Deposition of this clay was discontinuous in terms of both space and time. At the northeastern end of the dune the clay is here and there interrupted by layers of well-sorted sand (Units 13 and 14) representing a phase in which some aeolian deposition took place on top of the tidal flat (Unit 19E; fig. 2.6), after which clay deposition continued (Unit 18).

On the northwestern side different conditions prevailed in the time span between the formation of Units 26 and 10/11. In a restricted zone next to the dune some 10 cm of very humic clay was deposited (Unit 19N). The maximum level of sedimentation of this deposit was difficult to establish in the sections due to the many wells in this area, which disturbed the stratigraphy. Its regular occurrence up to a level of -4.2 m was however recorded in the matrix variable of the find registration and in the sections over the water pits. This implies a close parallel to the end of Unit 19 on the southeastern slope. There is a similar parallel in the stratigraphic relation to the oldest fence (section 3.8.2).

The special local conditions that led to the formation of this humic deposit may have been caused by groundwater seeping from the dune body, but the digging of the unlined

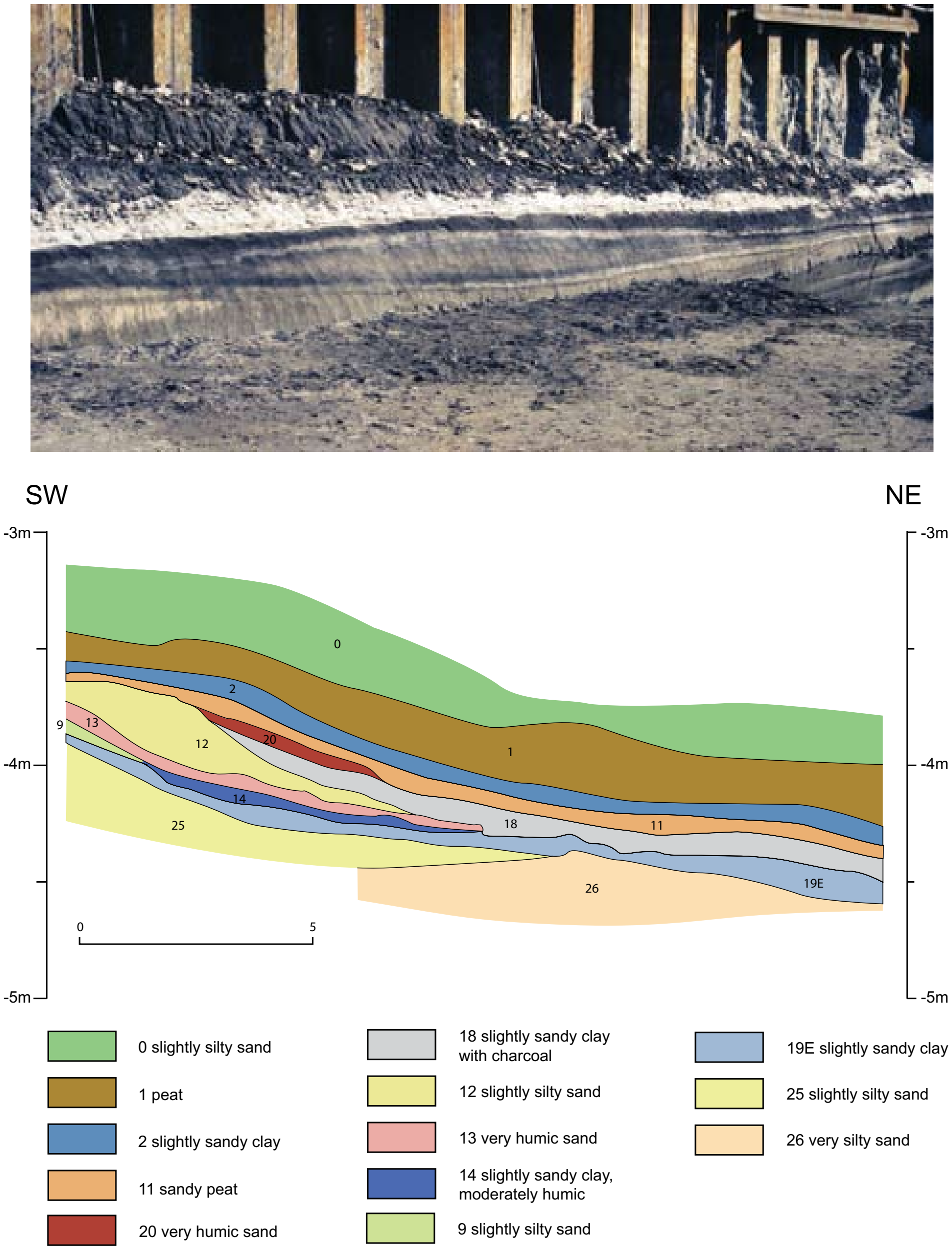


Figure 2.6 North section of trench 24 on the NE side of the dune showing a very confined dune deposit (Unit 12), which was formed during sedimentation of Unit 19.

wells or water pits (section 3.4.2) and the resulting heaps of sand may also have played a part.

It is more than likely that Unit 19N is separated from the underlying Unit 26 and the covering Units 15/16 and 10/11 by hiatuses, but their time spans are difficult to make out.

The underlying sand flat outside deposit 19N meanwhile remained subaerially exposed and was trampled on in this period, leading to the creation of Subunit 30.

It is quite plausible, finally, but difficult to ascertain, that the formation of the 'occupation layer' in the top of the dune sand started as early as this phase at the settlement site.

Occupation phase 2 (figs. 2.7c, d).
The top 5-10 cm of Unit 19S differed considerably from the underlying part and was classified as Unit 18. Its colour was (very) dark grey, its lower boundary irregular and its structure heterogeneous. It graded further uphill into a very

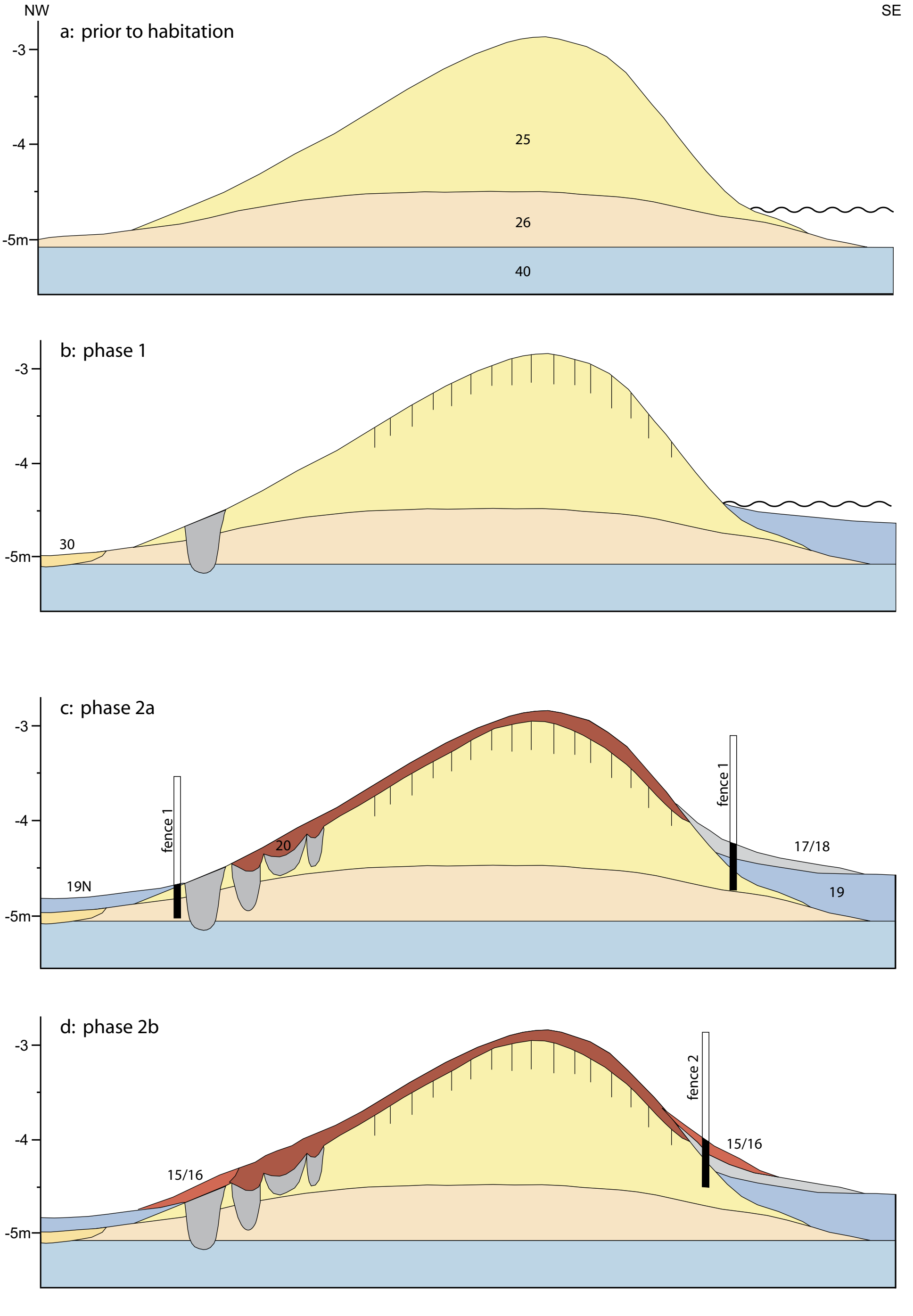

NW
SE
a: prior to habitation
-3
-4
-5m
25
26
40
b: phase 1
-3
-4
-5m
30
c: phase 2a
-3
-4
-5m
fence 1
20
19N
fence 1
17/18
19
d: phase 2b
-3
-4
-5m
fence 2
15/16
15/16

Figure 2.7

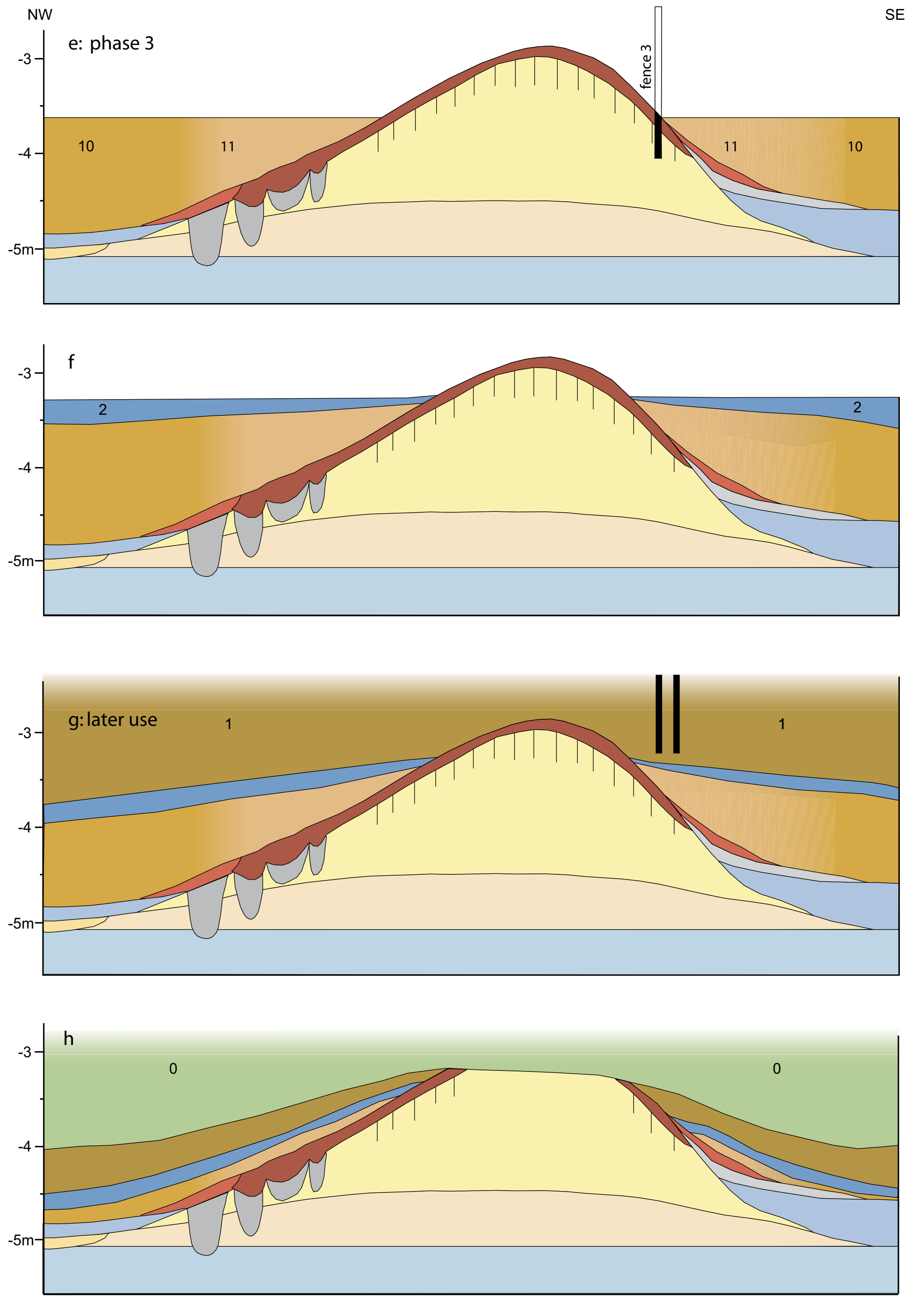


Figure 2.7 Schipluiden-Harnaschpolder, schematic representation of landscape development before, during and after the period of occupation. Only the newly formed units have been numbered. Soil formation indicated by shading.

humic clay, which was classified as Unit 17 (fig. 2.7c). Unit 18 was apparently exposed subaerially for a prolonged period, resulting in ripening and the possibility of people walking on it and trampling its top. So it is essentially part of 19S in a sedimentological respect and was only separately classified because of the later anthropogenic transformation. This means that the archaeological finds are all younger than the actual period of clay deposition. These finds, representing the onset of occupation phase 2 (phase 2a), were separated from those of phase 1 by approx. 25 cm of sterile clay (19S).

This distinction of two individual occupation phases separated by a (short) hiatus was observable in Units 19 and 18 all along the southeastern edge of the site. We consider a short-term interruption in occupation the most plausible explanation for this widespread hiatus in archaeological deposition.

Deposition of clay continued in the northeast, too, resulting in a clay cover on top of the very confined aeolian deposit (Unit 12) up to a height of -3.8 m. The top of this clay layer was also trampled, and was classified as Unit 18. A 4-6 m-wide and approx. 35-m-long zone with evidence of deeper and more intensive trampling extended all along this edge of the dune.

It should be emphasized that the northwestern side of the dune experienced limited or no deposition during occupation phase 1 and the onset of phase 2(a), as this has consequences for the phasing of the artefacts found in layers 19N and 30. Remains contained in these units may date from either occupation phase 1 or phase 2, having ended up in their present position due to trampling of these thin (10 cm!) units after their formation.

After the deposition of the clay (19 and 18) around the dune, the land became fully covered by vegetation. Peat formation started in the lower parts of the landscape away from the dune and made the dune an isolated elevation within a large marsh dominated by reed. The top of the dune sand and the podzolic soil were transformed into an 'occupation layer' (Unit 20) – a very dark and very humic unit containing artefacts – as a result of trampling in the settlement in combination with colluviation on the dune slopes (fig. 2.7d). This colluvial deposit extended several metres as Unit 15 into the surrounding aquatic deposits, where it was intercalated between the top of the preceding clays (Units 17, 18 and 19N) and the peat cover (Units 10 and 11). Part of Unit 15 was peaty and in that case classified as Unit 16.

The humic appearance and dark colour of Units 15 and 20 are only partly due to the presence of plant remains. These units also contain considerable quantities of charcoal dust, as was observed in the samples taken for the study of botanical macro-remains and arthropod identifications. Their formation will have been the result of the removal of the vegetation from the dune surface combined with trampling, wind erosion and slope wash, affecting the distribution and preservation of the archaeological remains.

The archaeological remains recovered from the colluvium (Units 15 and 16) primarily represent the continuation of occupation phase 2 (phase 2b), possibly contaminated with secondarily deposited older remains deriving from the dune surface. The remains from Unit 20 consequently represent both phases 1 and 2, and – in its central part – phase 3, too.

Occupation phase 3 (figs. 2.7e)
After this colluviation phase, peat growth continued. The slopes of the dune gradually became covered by sandy peat containing artefacts (Unit 11) and peat without sand and fewer artefacts further away from the dune (Unit 10). In view of their dimensions and their occurrence in a peaty matrix, it may be assumed that the larger finds contained in this deposit were in a primary position and as such represent a separate (last) occupation phase 3. All archaeological remains (pottery, flint, bones) selected for analysis on the basis of minimum dimensions are considered to have been in a primary position.

The sand contained in Unit 11 is probably attributable to a combination of aeolian action and colluviation, triggered by the human disturbance of the vegetation on top of that (small) part of the dune top that was not yet completely covered. The wider landscape around the dune during this last phase of the human occupation was characterised by peat growth only.

It was not easy to establish the boundaries between the various more or less sandy peat deposits in the field and during the excavation work. This holds especially for Units 15/16 and 20, which gradually merge laterally and could be distinguished only on the basis of the absence/presence of clay 18 in the section. This had some consequences for distinguishing archaeological remains from phases 2(b) and 3 where Unit 11 was involved (see also below).[3]

2.2.3 *Stage C: sedimentation after the period of occupation* (figs. 2.7f-h)

The sequence is completed by three deposits (Units 2, 1 and 0 respectively), which concealed and preserved the archaeological site (stage C).

The dune was abandoned some time before the surrounding peat became flooded and a thin layer of clay (Unit 2) was deposited at a level of approx. -3.50 m, as indicated by the uncompacted maximum sedimentation level on the slopes of the dune, 50 cm below its tip (fig. 2.7f). No finds were recovered from this clay. Its deposition was preceded by an erosion phase, which is clearly visible in the southeast, where reworked peat from the underlying deposits is contained in the clay. The clay probably developed in a marshy environment, possibly a salt marsh. In the absence of shells, the pollen and diatom data in this case yield conclusive the salinity of the environment (chapters 15, 18).

After the deposition of this clay, a reed swamp developed, resulting in a layer of peat (Unit 1) dominated by reed remains. This peat concealed the dune by overgrowing it completely; it must ultimately have covered it by several metres.

The peat of Unit 1 covered not only the clay of Unit 2, but also the sandy peat of Unit 11, where it extended beyond the clay, and the occupation layer 20 on the dune's top.

Distinguishing Units 11 (phase 3) and 1 above the -3.5 m contour line was sometimes very difficult. In the first place, it should be borne in mind that the two peat layers merged into a single thin seam in this zone. In some sections and trenches a peat unit – containing artefacts and therefore classified as 'Unit 11' – was recorded all over the dune, except in the eroded zone at the top. Such a peat cover does however not seem to be in agreement with the fact that the dune was occupied. In view of the water levels it is moreover incomprehensible that Unit 11 should have been formed much higher than the clay of Unit 2 that was deposited during subsequent inundation. Most probably there was some confusion in the field – in the interpretation of the sections as well as the collection of finds – concerning a transitional horizon between Unit 20 and the peat cover Unit 1 (see below), which will have looked very similar. It was decided to regard -3.4 m as the upper limit of Unit 11 and to consider all (sandy) peat deposits containing archaeological finds above this level as belonging to the peaty top of Unit 20.

It should be noted that the upper part of Unit 20 will have been influenced by rooting and other forms of bioturbation, especially in the stage of the first peat overgrowth, and that a transitional horizon will have formed that will easily have been misinterpreted as an extension of Unit 11.

A concentration of wooden posts was found embedded in the preserved base of Unit 1 in one trench (22) on the eastern side of the dune, implying that activities took place at the site in the final phase of the Neolithic, long after the dune had completely disappeared (fig. 2.7g; section 3.8.7). The position of the dune in the subsoil may however have been visible in the vegetation.

The Gantel system (fig. 2.7h)
The greater part of the peat of Unit 1 was eroded at a relatively early stage and replaced by the thick clastic Unit 0. The highest parts of the dune, including the occupation layer 20 at the top, were also eroded, resulting in an erosion base at -3.2 m (figs. 2.8-9). Unit 0 consisted of horizontally bedded sand and clay intercalations with dense concentrations of molluscs that extended all the way up to the present surface. It was up to 4 m thick in this part, as recorded in borings in the immediate surroundings of the excavation trench. The greater part of this deposit was removed by machines in the preparation of the excavation site, but its base could be studied in the trench sections. Unit 0 is clearly an aquatic sediment deposited by either fresh or saline water. Molluscs and diatoms in this case point to a saline to brackish environment with occasional fresh influxes (chapters 15 and 16). The deposit is to be associated with the former river Gantel, a large tidal system that brought in salt water from the Meuse estuary near Naaldwijk and drained the region in early historic times (chapter 14, Van Staalduinen 1979).

The deposits of the Gantel system in this area have been dated pre-Roman on the basis of Roman settlement remains found overlying them in the western part of the excavated area. External dating evidence points to an Iron Age date (Van Staalduinen 1979). At the base of the sediments enigmatic N-S oriented parallel linear features were observed in the excavated layers on top of the dune (fig. 2.10). They were up to 10 m long and up to 20 cm wide and clearly visible in the dark soil of the partially eroded Unit 20. The features must be regarded as subaquatic, in view of the facies of Unit 0, and seem to have been created by fairly firm, heavy objects scratching the floor of the (tidal) gulley, presumably at low tide water levels. The objects in question may have been ships, trawl nets or tree trunks. The sharp outlines, straightness and parallel orientation are more indicative of an anthropogenic than a natural cause. Heavy ships and massive trawl nets are however not what one would expect in the Iron Age.

2.3 Absolute chronology

2.3.1 Restrictions

A series of radiocarbon samples was used to estimate the duration of the period of occupation. The radiocarbon samples were obtained from stratigraphically indisputable units and miscellaneous materials. A major problem, however, are several pronounced wiggles in the calibration curve coinciding with the period of occupation (fig. 2.11). Between 5000 BP and 4500 BP the curve shows a series of peaks and associated troughs, which are reflected in the calibrated radiocarbon dates. The related dating problems were partly solved by the additional stratigraphical information.

A second problem concerns the samples of human bone and crusts of charred food on pottery, which were both affected by a reservoir effect.

2.3.2 The radiocarbon dates

All radiocarbon dates obtained during the project, including those from the prospection phase, are given in table 2.2. The dates were calibrated using the OxCal program, version 3.9 (Bronk Ramsey 2001, fig. 2.11, updated with the latest dataset *IntCal04* (Reimer *et al.* 2004).

Figure 2.8 South section of trench 18 showing the erosion of the top of the dune by the Gantel system (Unit 0).

Figure. 2.9 Detail of the section of figure 2.8 showing an irregularity at the base of the Gantel deposits and their finely bedded structure.

Figure 2.10 Trench 17, level C, showing irregular and straight linear features at the base of Unit 0, in the top part of the dune.

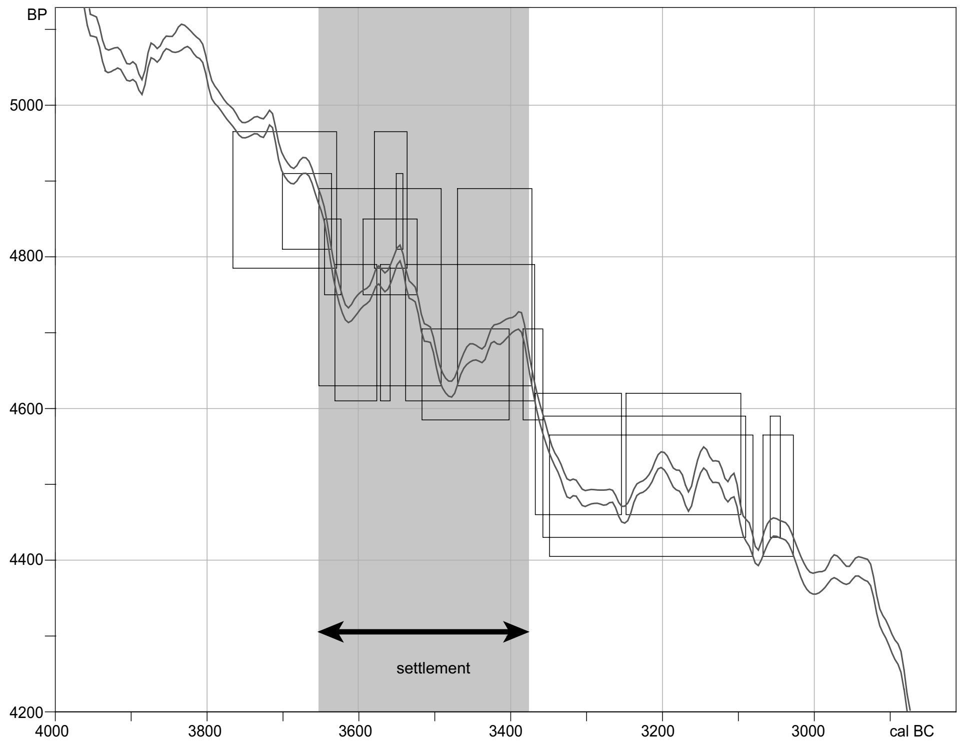


Figure 2.11 Calibrated radiocarbon dates obtained for the terrestrial samples (phase 4 excluded) plotted on the IntCal98 calibration curve. The individually calibrated radiocarbon dates are indicated as rectangles. The dates show a cluster between 3650 and 3380 cal BC. Calibrated with the aid of OxCal v.3.9 (Bronk Ramsey (1995, 2001).

The radiocarbon dates obtained in the prospection, shown separately in figure 2.12, were all obtained from charcoal, which usually gives reliable age determinations. Some of the dates are from a series of samples in a stratigraphical order (*e.g.* boring 41), but they show no clear trends. Regrettably, the dates cannot be linked to any of the occupation phases, but grouped together, they represent a time span of *c*. 3800-3400 cal BC, which we may assume includes the period of occupation.

The remaining dates were all obtained for samples from lithostratigraphical units, which could be linked to one of the occupation phases. Several types of samples were submitted and dated:

– samples of terrestrial plant macro-remains from the top or base of a lithostratigraphic unit, which provide the chrono-stratigraphical framework from a geological perspective;
– samples of archaeological artefacts of various materials that were indisputably associated with the individual occupation phases. They provide dates for the actual period of occupation;
– samples from the graves.

All the samples were grouped in stratigraphical order, so they should have shown a consistent pattern after calibration. Regrettably they do not. The dates obtained for the charred food remains found encrusted on pottery and those for the graves are completely out of phase with those obtained for charcoal, wood and seeds. The two sets of dates were therefore analysed separately.

The samples of terrestrial botanical sources (wood, charcoal, seeds), which are usually considered the most reliable age indicators, were analysed first. Phase 1 was dated on the basis of three samples of wood showing cut marks, implying that they most probably dated from the actual period of occupation. Phase 2 was dated on the basis of seven samples, two of which consisted of charred cereals and five came from wooden fence posts (chapter 4). Phase 3 could not be dated on the basis of a comparable series of samples; only one sample was available, from a post from the last fence. Two samples of uncharred seeds obtained from the top of Unit 10 yielded a *terminus ante quem* for that phase. The estimated duration of phase 3 will consequently be too long. The post cluster in Unit 1 was dated by two of the pointed posts, which characterised this later reuse of the site.

The following step was a sequence analysis based on the stratigraphy (Bronk Ramsey 2001). Such an analysis allows assumptions regarding relative age differences to be included in a chronology. The analysis usually results in a narrowing of the 2σ-range, since older samples cannot overlap with younger ones and vice versa. The resulting calibrated distributions are usually more confined than the initial values, and show a clear pattern from old to young. Figure 2.13 shows the result of the

sample code	material	context	phase	lab code	date	$\partial^{13}C$	$\delta^{15}N$
Samples from prospection							
NSH-1	charcoal	boring 41 sample 1 (top)	–	AA-50074	4745 ± 50	-26.2	
NSH-2	charcoal	boring 41 sample 2	–	AA-50075	4950 ± 50	-25.8	
NSH-3	charcoal	boring 41 sample 3	–	AA-50076	4770 ± 60	-25.7	
NSH-4	charcoal	boring 41 sample 4	–	AA-50077	4715 ± 50	-26.7	
NSH-5	charcoal	boring 41 sample 6 (base)	–	AA-50078	4875 ± 55	-26.6	
NSH-6	charcoal	boring 72 sample 1 (top)	–	AA-50079	5105 ± 55	-26.0	
NSH-7	charcoal	boring 72 sample 6 (base)	–	AA-50080	4755 ± 60	-26.8	
NSH-8	charcoal	boring 27 sample 2 (top)	–	AA-50081	4790 ± 50	-23.7	
NSH-9	charcoal	boring 27 sample 3 (base)	–	AA-50082	4955 ± 50	-22.9	
NSH-10	charcoal	test trench sample 1	–	AA-50083	4680 ± 50	-23.9	
NSH-11	charred seeds	test trench sample 2	–	AA-50084	4900 ± 60	-25.0	
NSH-12	charcoal	test trench feature 101	–	AA-50085	4930 ± 50	-23.7	
NSH-13	charcoal	test trench feature 112	–	AA-50086	4890 ± 55	-28.0	
Samples from excavation							
no. 1338	wooden post	base Unit 1	phase 4	GrN-28864	3720 ± 20	-28.30	
no. 1855	wooden post	base Unit 1	phase 4	GrN-28865	3790 ± 20	-28.13	
no. 4838	charcoal	base Unit 1	t.a.q. Unit 10	GrA-24372	4485 ± 40	-24.04	
no. 4850	seeds	top Unit 10	t.a.q. phase 3	GrA-24373	4510 ± 40	-24.35	
no. 4839	seeds	top Unit 10	t.a.q. phase 3	GrA-24334	4540 ± 45	-26.34	
no. 2061	wooden post	fence, third phase	phase3	GrN-28860	4700 ± 45	-27.86	
no. 7506	charred remains on pot	Unit 10	phase 3	GrA-26361	4900 ± 35	-26.00	
no. 7927	charred remains on pot	Unit 10	phase 3	GrA-26362	4985 ± 40	-26.50	
grave 3	human bone	grave 3	phase 3	GrA-26670	5055 ± 40	-21.52	12.79
id.*	id.	id.	id.	GrA-28037	5010 ± 40	-21.56	
grave 2	human bone	grave 2	phase 2	GrA-26653	5055 ± 40	-18.81	15.55
grave 4	human bone	grave 4	phase 2	GrA-26671	4650 ± 40	-20.50	10.07
id.*	id.	id.	id.	GrA-28150	5120 ± 45	-19.34	
grave 6	human bone	grave 6	phase 2	GrA-26737	5070 ± 40	-21.05	16.36
grave 1 ind.1	human bone	grave 1 ind.1	phase 2	GrA-26650	5005 ± 40	-18.67	15.77
grave 1 ind.2	human bone	grave 1 ind.2	phase 2	GrA-26652	5080 ± 40	-19.02	15.95
no. 5160	wooden post	fence, first phase	phase 2	GrN-28862	4740 ± 25	-29.64	
no. 6006	wooden post	fence, first phase	phase 2	GrN-28863	4800 ± 25	-28.51	
no. 6006	wooden post (fine frac.)	fence, first phase	phase 2	GrN-28884	4760 ± 65	-28.91	
no. 4603	wooden post	fence, first phase	phase 2	GrN-28861	4860 ± 25	-28.96	
no. 8683	worked wood	Unit 17	phase 2	GrN-28962	4645 ± 30	-28.98	
no. 4847	charred wheat	Unit 18	phase 2a	GrA-24335	4875 ± 45	-25.92	
no. 340	charred wheat	Unit 18	phase 2a	GrA-26892	5250 ± 35	-24.38	
no. 8630	charred remains on pot	Unit 18	phase 2a	GrA-26363	5055 ± 40	-21.50	
grave 5	human bone	grave 5	phase 1 / 2a	GrA-26672	5170 ± 40	-18.50	
no. 8006	worked wood	Unit 19	phase 1	GrN-28963	4710 ± 35	-22.57	
no. 9509	worked wood	Unit 19	phase 1	GrN-28965	4720 ± 35	-23.90	
no. 9507	worked wood	Unit 19	phase 1	GrN-28964	4745 ± 35	-27.13	
no. 5431	charred remains on pot	Unit 19	phase 1	GrA-26359	5205 ± 40	-26.80	

* redated samples

Table 2.2 Radiocarbon dates obtained for Schipluiden-Harnaschpolder

applied procedure. The prior distribution is still visible, showing which part of it was used for the age determination.

It should be emphasised that some restrictions may limit the value of such an analysis. For instance, a stratigraphically incorrectly interpreted sample or unit will result in an incorrect age estimation of an entire sequence. Another dating problem concerns the possibility of old remains having become incorporated in younger layers. Samples

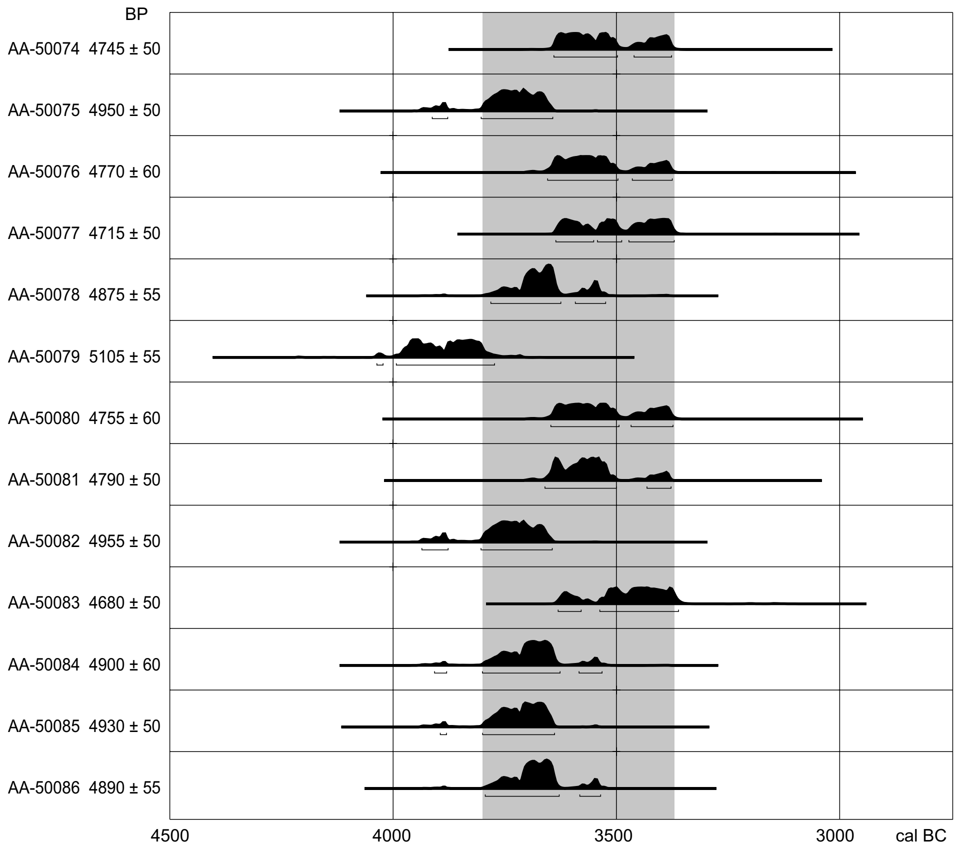


Figure 2.12 Calibrated radiocarbon dates obtained during the prospection of Schipluiden-Harnaschpolder. Although the dates cannot be put in stratigraphical order, lumping reveals the period in which the site was occupied (indicated in grey). Calibrated with the aid of OxCal v.3.9 (Bronk Ramsey 1995, 2001).

taken from such layers will of course yield a too wide chronological range for those layers. Errors in a stratigraphical sequence are usually revealed by a low agreement value for all the samples. The agreement value should be at least 60% (shown at the top of the diagram). The reliability of the individual samples is indicated by the percentage behind each sample, which should also be at least 60%.

Although the botanical samples were expected to provide a reliable chronology, there are some stratigraphical inconsistencies. The three wood samples from phase 1 (samples 8006, 9507, 9509) are younger than the majority of the samples from phase 2. Especially the two samples of charred cereal from phase 2 (samples 340, 4847) yielded earlier dates. Such results are statistically unreliable (lower than 60%).

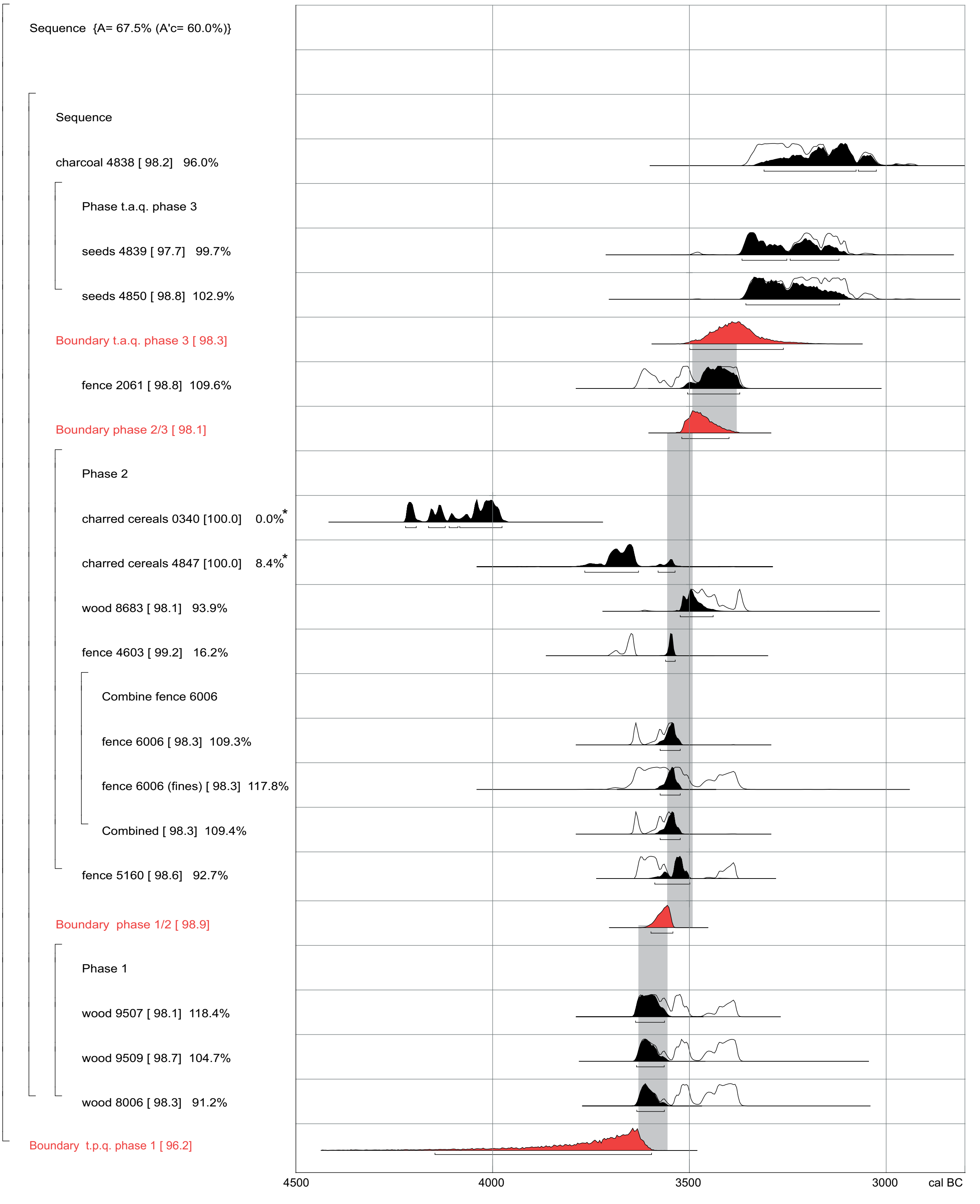
The results obtained for both sets of samples seem to constitute reliable evidence for human occupation, but they do not agree with each other: either the wood dates from a later phase or the cereals from an earlier phase. The wood came from Unit 19, from beneath an archaeologically barren layer of clay that was mechanically excavated. So this wood cannot date from a later phase. The consistency of the three samples moreover suggests that the estimation is reliable. The charred cereal grains were obtained from Unit 18, the trampling zone at the top of the clay. Although they were found in a clay context, which could imply reworking, they were also considered to be reliable age indicators on account of the fact that the cereal was charred. As can be seen in figure 2.13, sample 340 is nevertheless completely out of range with the other dates. Sample 4847 can be assigned to phase 2 due to its lower age limit, but this results in an agreement value that is too low. These two samples were therefore not used for the establishment of the chronology.

After rejection of these samples, figure 2.13 clearly shows a decreasing age from old to young.

On the basis of this analysis, the following boundaries were derived using the mode of the curves and an error based on the width of the curve (curves indicated in red in fig. 2.13):

3630 ± 25 BC for the beginning of phase 1
3550 ± 20 BC for the beginning of phase 2
3490 ± 25 BC for the beginning of phase 3
3380 ± 35 BC for the end of phase 3

These dates indicate a chronological sequence of *c*. 3630-3380 cal BC for phases 1 to 3, with 3380 being a *terminus ante quem*. This agrees well with the ages inferred from the prospection samples.


Sequence {A= 67.5% (A'c= 60.0%)}
Sequence
charcoal 4838 [98.2] 96.0%
Phase t.a.q. phase 3
seeds 4839 [97.7] 99.7%
seeds 4850 [98.8] 102.9%
Boundary t.a.q. phase 3 [98.3]
fence 2061 [98.8] 109.6%
Boundary phase 2/3 [98.1]
Phase 2
charred cereals 0340 [100.0] 0.0%*
charred cereals 4847 [100.0] 8.4%*
wood 8683 [98.1] 93.9%
fence 4603 [99.2] 16.2%
Combine fence 6006
fence 6006 [98.3] 109.3%
fence 6006 (fines) [98.3] 117.8%
Combined [98.3] 109.4%
fence 5160 [98.6] 92.7%
Boundary phase 1/2 [98.9]
Phase 1
wood 9507 [98.1] 118.4%
wood 9509 [98.7] 104.7%
wood 8006 [98.3] 91.2%
Boundary t.p.q. phase 1 [96.2]
4500
4000
3500
3000
cal BC

The following age constraints based on radiocarbon dates were consequently derived for each individual phase:
phase 1 3630 – 3550 cal BC
phase 2 3550 – 3490 cal BC
phase 3 3490 – 3380 cal BC at the latest

2.3.2 ^{14}C reservoir effect

The dates obtained for the graves and charred food remains are given in figure 2.14. The period of occupation based on these dates clearly predates the time span inferred from the prospection samples and the samples of wood and seeds. The human bones and food residues yielded a time span from *c*. 4050 until 3650 cal BC for the period of occupation. There is a difference of approximately 300 calibrated years with respect to the dates yielded by the terrestrial botanical samples. This suggests a ^{14}C reservoir effect.

This phenomenon is well known from earlier studies in the Dutch coastal plain, and was on those occasions attributed to a fish diet on account of the high $\delta^{13}C$ values (Mol/Louwe Kooijmans 2001, Mol 2003). The $\delta^{13}C$ values obtained for Schipluiden are also high, as are the δ^{15} N values (table 2.2). These values are indeed indicative of a high-protein diet, comprising substantial quantities of fish, and point to a ^{14}C reservoir effect with associated age offsets (*cf*. Bonsall *et al*. 1997).

The relationship between the dates obtained for the food residues and the human bones is consistent (fig. 2.14), suggesting a ^{14}C reservoir effect for the food residue samples, too. The $\delta^{13}C$ values of these samples are rather low in comparison with those of the human bones. Their $\delta^{15}N$ values were not measured (table 2.2). These values are however similar to those obtained in a study in Denmark, in which both recent freshwater fishes and prehistoric food residues containing remains of freshwater fish were measured (Fischer/Heinemeier 2003). The $\delta^{13}C$ samples showed a reservoir effect of 300 ^{14}C years, which was attributed to a diet of freshwater fish. Earlier studies (Lanting/Van der Plicht 1998; Cook *et al*. (2001) similarly showed that not only a marine diet, but also a diet of freshwater fish can lead to ^{14}C reservoir effects of up to 500 ^{14}C years. As a result of this fish diet, figure 2.14 does not represent the correct period of occupation. Correction of this reservoir-effect is in principle possible; purely marine diets can be corrected with ^{13}C-values and purely fresh-water diets with ^{15}N-values (Arneborg *et al*. 1999; Cook *et al*. 2001). However, the reservoir-effect in our dataset cannot be quantified because of the assumed mixed diet.

2.3.3 External evidence

The absolute chronology is confirmed by other evidence, such as the style of the pottery and the development of the landscape. All the pottery belongs to the Hazendonk group (chapter 6). No representatives were found of the predecessor of this style – Swifterbant pottery, which was in use until *c*. 3800 cal BC. Neither were any remains found of Vlaardingen pottery, which was produced from *c*. 3400 cal BC onwards. The pottery tradition consequently points to an occupation period in the interval of 3800-3400 cal BC. This agrees well with our findings based on radiocarbon dating, including the end of phase 3, which was dated to 3380 cal BC at the latest.

The dune bearing the occupation site was formed some time after *c*. 4000 cal BC, by which time coastal erosion had ceased and coastal progradation and associated dune formation had only just started (chapter 14). This also agrees with the date of *c*. 3630 cal BC for the beginning of the occupation period.

It was decided to compare the levels established in the excavation with the curve representing the relative rise in mean sea level (Van de Plassche 1982) in order to double-check the dates and estimate the water regime, more specifically the tidal range. The estimated age of the tidal deposits underlying the dune at a level of -4.5 m is *c*. 4000 cal BC or slightly younger. According to the MSL graph, the mean sea level must then have been around -5 m, implying a tidal amplitude of about 0.5 m, or a little more if we allow for some compaction. These can be considered very accurate fits.

2.4 Occupation phases: conclusions

Phase 1 may actually have begun a little earlier than the 3630 cal BC suggested by the prospection dates. A slightly earlier date would still be in agreement with the dates of the pottery and the development of the dune. But the fact that the artefacts from phases 1 and 2 almost all have more or

◀Figure 2.13 Sequence analysis of the terrestrial samples from Schipluiden-Harnaschpolder (wood, charcoal. cereals and terrestrial seeds) performed with the aid of the OxCal v. 3.9 program (Bronk Ramsey 1995, 2001). All dates are in stratigraphical order (oldest at the top). Individual ages within each phase have been lumped in cases in which their relative positions were unknown (shown by brackets). The combination of stratigraphical position and calibrated time range results in narrowing of the 2σ range. The original distribution is shown by a line.

Value A (top left) gives the agreement index of the total sequence (in this case 67.5%), which should be at least 60%. The percentages behind each individual date show the extent to which the final distribution overlaps with the original. Values >100% indicate that only the very highest parts of the distribution overlap. Two dates were rejected on statistical grounds (indicated by *) because the agreement index was initially too low in the case of these samples.

The time windows resulting for each individual phase are indicated in grey.

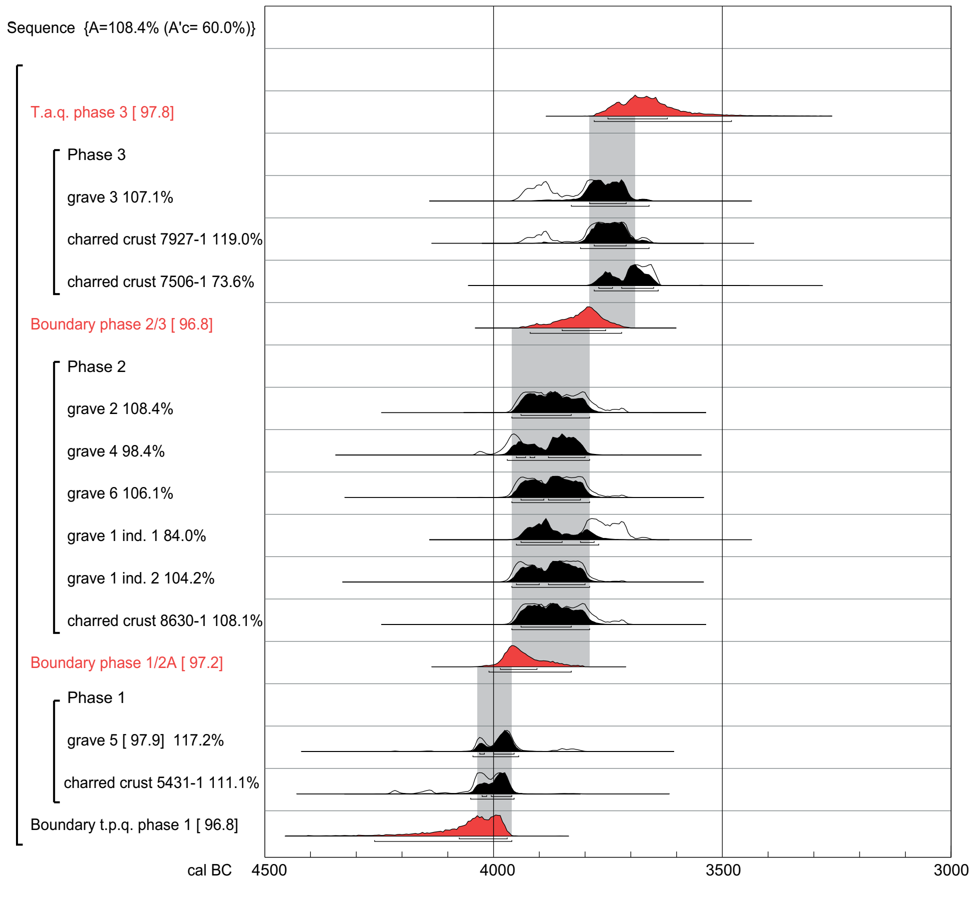


Figure 2.14 Sequence analysis of the samples of the graves and charred food remains (from pottery) from Schipluiden-Harnaschpolder. The analysis was performed with the aid of OxCal v. 3.9 (Bronk Ramsey 1995, 2001). A clear age difference of at least 300 calibrated years is visible with respect to the results obtained in the analysis of the terrestrial samples (figure 2.13); this is the result of a reservoir effect. Results of redating were used for graves 2 and 4 (*cf.* table 2.2).

less the same dates suggests a short time span rather than a long one. For this reason the date of the beginning of the occupation period was left unchanged at 3630 cal BC.

As for the end of the occupation period, there is good agreement between the calculated value of 3380 ± 30 cal BC and external evidence for the end of the Hazendonk group (*c*. 3400 cal BC). It should however be noted that the latter date should be regarded as a *terminus ante quem*, implying that phase 3 probably lasted shorter than the proposed 90 years. These factors make it difficult to estimate the overall duration of the period of occupation. It is estimated to have been between 2 and 3 centuries. During this 200-300 years' time span the dune was gradually covered by deposits and the area available for occupation became smaller and smaller.

Figure 2.15 shows the extent of the dune during each occupation phase.

Occupation phase 1 (3630-3550 Cal BC)

The dune was occupied for the first time during the initial formation of clay 19S. Remains were left on the dune surface (embedded in 20) and on the northwestern side (later embedded in 19N, trampled into 30) and were dumped in the water along the southeastern side (embedded in the base of 19S) up to a height of -4.5 m.

Only in 19S did remains from this occupation phase become covered and protected against contamination with later remains. Unit 20 certainly and Unit 19N most probably contain mixed assemblages from this and the subsequent phase.

Occupation phase 2 (3550-3490 cal BC)

The second phase most probably started after a short hiatus, which could not be dated due to its very short time span. Remains were again left on the dune surface and were later trampled into 20. On the southeastern side remains were also trampled into the previously formed clay 18/17 and were possibly left on/in the very humic silty clay of 19N on the northwestern side at a height of -4.0 m. The dune had by this time already shrunk considerably, to between -4.0 and -3.8 m.

Continued intensive use of the site resulted in partial colluviation of 20, with extensions 15/16 into the aquatic stratigraphy. So the remains from 20 and 19N are essentially

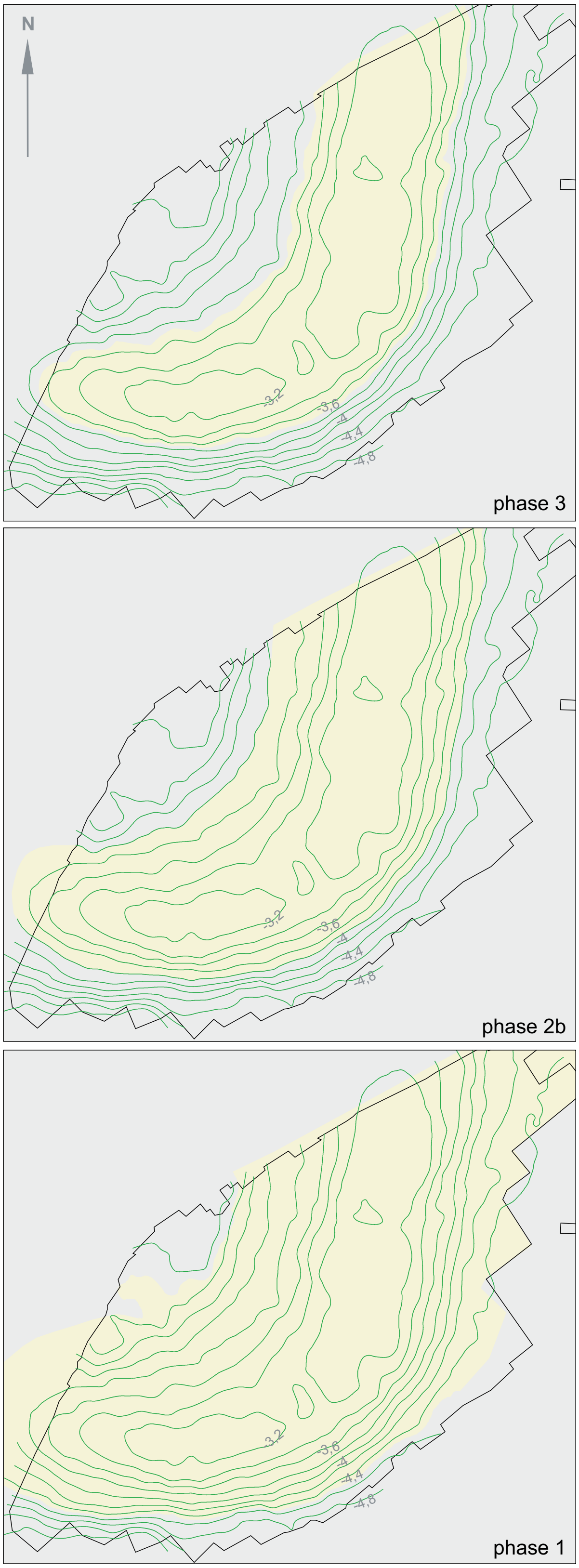


Figure 2.15 Phases of submergence of the dune based on the uncompacted maximum sedimentation levels of the clastic deposits. The contour lines represent the height of the underlying dune and sand flat.

mixed assemblages from phases 1 and 2, and the smaller fraction from 15/16 must also be considered a mixture. The larger artefacts from this colluvium may be regarded as primary deposits from phase 2. This phase is however exclusively represented only in clay Unit 18/17, where it is separated from earlier and later remains by sediments.

The remains from Unit 18 may be regarded as representing an early stage of phase 2 (2a), those from Units 15/16 a later stage (2b).

Occupation phase 3 (3490-3380 cal BC)
The inhabitable part of the dune will have shrunk considerably by the time of phase 3, not so much in length, but especially in width. Occupation will have been restricted to the highest parts of the dune (above -3.7 m), which are precisely the parts that were eroded by the Gantel system. Most of the remains from phase 3 will have vanished due to erosion, but the deposits at the level at which features became visible seem to have been untouched. It is assumed that the assemblage of Unit 20 contains very little or no admixed remains from phase 3 as the greater part of the slopes of the dune were already covered by peat 10/11 at this time. Phase 3 is attested exclusively by remains embedded in peat layer 10/11.

Later use (2300-2050 cal BC)
The dune itself had disappeared a few centuries later, but its position may still have been visible in the vegetation. Wooden posts embedded in layers 1/2 testify to human activity.

notes

1 The field codes are composed of two parts: a prefix (20, 40, 60, 80) for each of the four sides of the dune (NW, SE, NE and NW, resp.) and a suffix for each layer. The layer codes were chosen as uniformly as possible for each series. Only a few units had to be recoded to obtain a uniform site stratigraphy: Unit 2017 was recoded as 19N (= North) and Units 4019, 6019 and 8019 as 19S (= South).

2 All heights refer to the local Dutch ordnance datum (NAP), which roughly coincides with the mean sea level.

3 This was demonstrated by the results of the physical anthropological analysis. Two human diaphyses with very similar characteristics, most probably deriving from the same individual, were found about. 80 m apart: No. 8808 in the NW of trench 13,

Unit 10, No. 5525 on the other side of the dune in trench 26, Unit 16. The latter may very well have been incorrectly coded as the stratigraphy was locally rather diffuse.

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3 Features

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Many thousands of features reflect the long-term, intensive use of the entire dune and its immediate surroundings. Clusters of postholes represent the sites of former huts or yards. A large number of temporary wells testify to the occupants' struggle to secure fresh water supplies after floods. Hearth pits show that a Mesolithic tradition lived on for a long time in this area. Fences, which will have enclosed the entire dune, are seen to represent a collective effort intended to keep cattle out, but also to give structure to the site and to isolate the domestic domain from its surroundings. Remains of a small hut probably postdate the permanent settlement.

3.1 Introduction

All over the dune and in part of the adjacent clay deposits (Units 19/18) a large number of features came to light – more than ten times the expected number. The initial expectations were based on the evidence of the Wateringen 4 site, which appears to have been a single-house site that was occupied for only a short time. The difference in the distribution and density of the features implies that the dune at Schipluiden was used for much longer and far more intensively. The numbers of postholes and pit fills seem large, but viewed in relation to the assumed length of occupation (around 2.5 centuries) they are not that excessive: on average 15 postholes and one pit per year.

The features came to light at the base of the various find-containing layers: beneath Unit 20 in the dune sand (Unit 25), further northwest beneath Unit 19N, in Unit 26, and to the southeast beneath clay Unit 18, in clay Unit 19.

In comparison with evidence in the Pleistocene sandy areas, the features have survived extremely well, thanks to the fact that they were covered with aquatic deposits relatively soon after the site was abandoned. Only the top 30 cm of the features had been destroyed by bioturbation, trampling and colluviation. The measured depths consequently had to be increased by around 30 cm to obtain the original depths. Shallow features with depths of <30 cm have disappeared. So the posts of postholes with recorded depths of 5-60 cm will originally have been dug 35-90 cm into the soil. The exceptionally good wetland conditions, which had preserved even the ends of several wooden posts, were to be found only in the peripheral zone of the dune.

Not only the depths, but also the other dimensions of the features as specified in the drawn and digital records relate to the first cleaned level (C, fig. 3.1). This means that many features, in particular pits, are smaller in diameter than they originally were at the former surface.

Although the top of the dune, including the find layer, had disappeared due to erosion at the base of the Gantel system (Unit 0), this level C lay precisely at the base of the eroded stratum at the highest points. Comparison of the excavation plan with the erosion zones shows that the patterns of features were not affected by the erosion: for example, dense clusters of postholes are observable in the erosion zones, too. So the map may be regarded as homogeneous and representative.

3.2 Recording the evidence (figs. 3.2-3, after p. 54)

Levels A and B

After the find layers had been excavated, height measurements were taken at the base of those layers in every excavation trench in a 2 × 2 m grid. So on the dune this level (B) lay at the base of Unit 20, at the top of the dune sand (25). To the northwest it lay beneath the -4.70 m contour line at the top of Unit 26, beneath the humic sandy clay of 19N or the trampling horizon 30, to the southeast it lay at the top of Unit 19S, at the base of the clay Unit 18. The shape of the

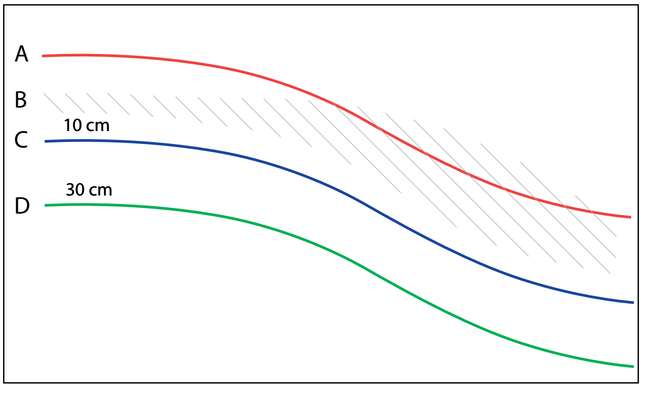

Figure 3.1 Position of excavation levels A-D in relation to the stratigraphy. Hatched: sediments containing artefacts.

dune and of the former ground surface above the -4.50 m contour line in phase 2 (level A) was accurately reconstructed by raising this level by 20 cm, the average thickness of the excavated layer. To the southeast, this is the surface of the adjacent gulley deposits that was later deformed by subsidence (18 plus 19S). The features that came to light already during the shovelling of the culture layers, in particular postholes of the fences were recorded and the small features were sectioned. At this depth the level (B) was however still badly disturbed by bioturbation and only few features could be made out.

Levels C and D [1]

In order to make the features (better) visible, a second level – level C – was exposed about 10 cm deeper down (fig. 3.4). Height measurements were recorded in this area in a 2 × 2 m grid, too. The features observed at this level were recorded in area plans in a scale of 1:50 and were subsequently sectioned – first the small features, then the pits and wells. Some of the large pit features were excavated not by hand, but under close scrutiny with the aid of a digging machine. This was necessitated by time pressure, and was justifiable on the basis of the small numbers of finds they contained. All sections were drawn and some were also photographed. A database was created in which the following data were recorded per feature: centre coordinate, height of the level, diameter, depth, fill. This information proved very useful in the later analyses, especially those of the postholes.

After all evidence at the first level had been recorded, excavation was according to the research design continued, again with the aid of the digging machine, down to a third level (D), 30 cm below the previous one, *i.e.* at a depth of 60 cm beneath the original ground surface. This was done because the research at Wateringen 4 (Raemaekers *et al.* 1997) had shown that some features were not visible at higher levels. This procedure led to the discovery of a number of hearth pits and assured us that we had not missed any important features (house plans, burials).

Figure 3.4 Excavation level C in trench 16 showing postholes and other features.

	N=	sum
small features		
stake holes	475	
stakes and stake holes of fences	293	
post moulds	3086	
postholes	180	
postholes with postmoulds	82	
post holes with posts	4	
total		*4120*
large features		
pits	275	
wells	148	
deposition pit	1	
hearth pits	56	
graves	6	
ditches, foundation trench	3	
total		*489*
total anthropogenic features		*4609*

Table 3.1 Quantitative survey of all features.

Finally, Unit 19S was in every excavation pit excavated by mechanical scraping to collect the finds embedded in it (phase 1). No features were observed at the base of this deposit.

The excavation trenches all extended far beyond the distribution of the features, but the find scatter was found to extend beyond the excavation pits in a southeasterly direction.

The field drawings of large features that crossed the boundaries of excavation trenches did inevitably not join up in the site map. The limits were adjusted as accurately as possible in the final map. The fills of large depressions that covered more than a single pit were not included in the excavation plan.

3.3 Classification And phasing

3.3.1 Classification (table 3.1)

In total, 7584 features were recorded. They were classified in the field on the basis of their shape (in horizontal and vertical section), their dimensions (diameter, depth) and characteristics of the fill (colour, stratigraphy). Classifications were generally based on a combination of characteristics rather than on distinguishing criteria. The employed criteria can however be described.

A large number of features (N=2975) were interpreted as natural disturbances caused by root action and burrowing.

These were mainly small features, with diameters of 5-15 cm, which were at this level often indistinguishable from stake holes and postholes. Their main characteristics are irregular outlines and a heterogeneous fill. Many large features were likewise attributed to natural causes, notably the fills of natural depressions in the dune. Those features are characterised by a shallow depth combined with irregular outlines in cross-section.

The remaining features (N=4609) were interpreted as man-made on the basis of their regular cross-sections and outlines in the exposed area, sharp limits and homogeneous fills. They vary tremendously in dimensions, from a few centimetres to more than three metres in diameter and from almost zero to two metres below level C. In spite of these widely varying dimensions, no classes could be distinguished exclusively on the basis of diameter-depth ratios. From the smallest and shallowest to the largest, the features represented a continuous range. For the benefit of the later analysis, the individual features were in the field grouped into a number of categories on the basis of their dimensions, shape and characteristics of the fill:

- large features: 'ordinary' pits and wells,
- large features with a special function: burials, hearth pits and a deposition pit,
- ditches and trenches, including a wall-foundation trench,
- small features: postholes.

Classifying the features rarely involved problems: all features with diameters >50 cm were assigned to the first categories and all features <20 cm were classified in the last group. Only the distinctions between pits and postholes later proved to have been somewhat arbitrary. These categories were found to overlap at diameters of 20-50 cm (*cf.* fig. 3.5).

3.3.2 Phasing

Only a very small number of the individual features could be assigned to the stratigraphically distinguished phases. This was due primarily to the small number of finds encountered in the fills and the absence of undisputed typochronological markers, and secondarily to the small number of intersections and their positions within the body of the dune, outside the stratigraphy. There were three variables allowing some degree of phasing, coupled to depth zones:

- the development of the dark occupation layer and the incorporation of soil from this layer in the fills of features,
- stratigraphic positions beneath covering layers,
- altitudes on the dune slope.

It should moreover be borne in mind that the stratigraphically distinguished phases vary substantially in length, and

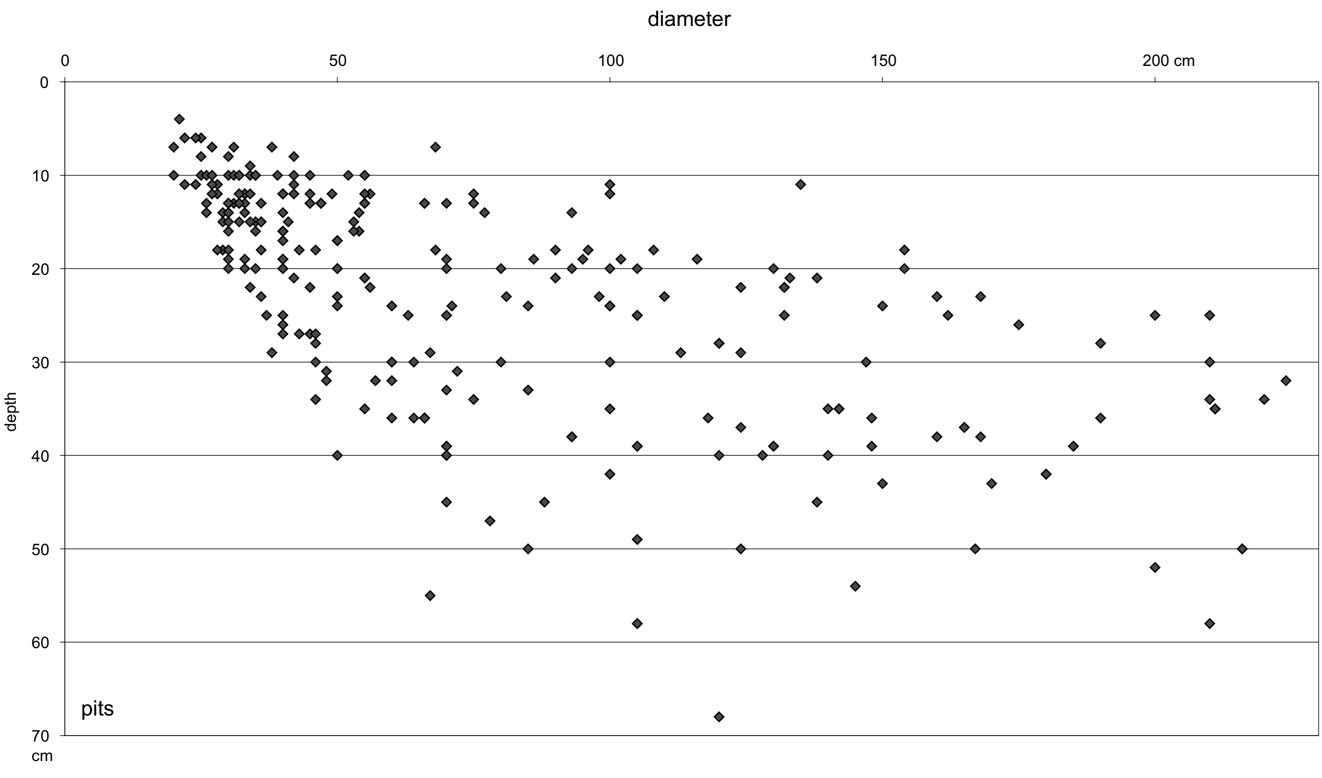

Figure 3.5 Pits, diameter versus depth.

that environmental conditions also varied considerably, in particular between phases 1-2b on the one hand and phase 3 on the other (see chapter 2). These differences may well have led to a different use of the site.

3.4 LARGE FEATURES: PITS

The 423 large features can be divided into two groups on the basis of the nature of their fills:
- 'ordinary' pits
- wells

With the odd exception, the pits of both categories yielded exceptionally few finds. This could imply that they became filled fairly quickly and that their surroundings were kept relatively clean.

3.4.1 'Ordinary' pits

Classed as 'ordinary pits' (N=275) were in the first place all features with diameters of more than 50 cm and an unstratified, homogeneous light to dark grey sandy fill. The largest diameter measured is 230 cm. These pits were dug down into the top part of the dune sand (Unit 25), were not deeper than 70 cm and their diameters were always greater than their depths (fig. 3.5).

Relatively shallow features (with diameters >1.5 × their depths) with cross-sections of 20-50 cm, which were in the field, classified as 'ordinary' pits, show some overlap in their ranges with the postholes and post moulds. The pits in question were on the basis of non-metric indicators somewhat arbitrarily classified as either a pit or a posthole. From an analytical viewpoint these features are however to be regarded as a single group, and indeterminate in functional terms. In the post configuration research (section 3.8) the features of the entire group were regarded as (probable) postholes/post moulds.

The pits were regularly distributed across the crown and the northwestern slope of the dune and very little can be said about them. They contained very few finds, neither primary finds at the base nor secondary finds in the fill. This implies that the settlement site was fairly clean. Why these pits were dug is not clear.

3.4.2 Wells

Characteristics

'Watering places' or 'wells' (N=148)[2] were dug down to the top of the tidal deposits (Unit 26) underlying the dune, and some even down into Unit 40. Most of the wells were found to contain a bipartite fill: a primary fill with a microstratification of clean sand mixed with washed-in anthropogenic soil in varying degrees. The secondary fill was an extension of the surrounding occupation layer (Unit 20 or Unit 19N) and bore a close resemblance to that of the ordinary pit fills. The primary fill seems to have been formed within a short space of time (a few months or perhaps even weeks) due to the caving in of the edges of the pits, which originally had steep sides. On the whole, the wells do not seem to have been stabilised or maintained. Once the primary fill had formed, a wide, fairly shallow depression remained, which became filled at a much slower rate. In some cases the remnants of wells lying side by side were found to have merged into large shallow depressions. This was for example observed in trench 16, feature 15, and trench 2, feature 12.

Functional interpretation

Similar pits have been encountered at other contemporary settlements in this region, notably at Rijswijk, Wateringen 4 and Ypenburg (Koot 1994; Raemakers *et al*. 1997; Koot, H./ B. van der Have 2001). At these sites the pits were interpreted as the features of temporary sources of freshwater in the then prevailing brackish to saline tidal environment. These interpretations were based on the assumption that in the case of such an isolated dune, precipitation will within a short time have led to the formation of a bubble of freshwater floating on the saline groundwater in the subsoil. The 'wells' in question were all dug down to beneath the former groundwater level, and in such positions relative to the body of the dune as to suggest that such underground supplies of freshwater – assuming they indeed existed – would have been tapped (fig. 3.6). Quite recently, some interesting observations on such freshwater seepage have been published. Small pits dug 'at the foot of the dunes were found to yield pleasantly cool potable water'. True streams have risen in the large Velsen Dunes (Van Deursen 2001). And digging operations on the seaward side of of the dunes of the provinces of Noord- and Zuid-Holland have also yielded evidence of seepage. It is assumed that the water in question derives from a 50-cm-thick layer of freshwater that

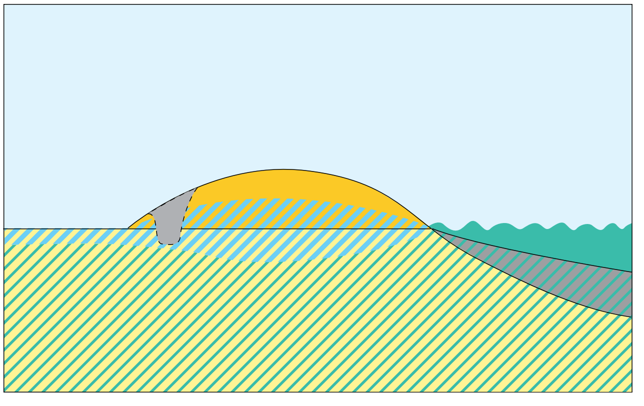

Figure 3.6 Schematic representation of an unlined well that tapped fresh water from the natural reservoir in a dune. Green: salt water, blue: fresh water.

slowly flows to the sea beneath the beach (Knip 2004). This is a matter demanding further research.

The pits were not maintained, they contained hardly any refuse and they were largely filled up in a natural manner fairly shortly after they had been dug. In only one case (feature 2-12, one of the pits of the complex to be discussed below) had an effort been made to stabilise a well by placing three approximately 1-m-long planks vertically against the walls. But these efforts were in vain: at least one of the planks (a tangentially split part of an alder *(Alnus)* collapsed inwards (fig. 3.7). Another possibility is that there was usually a sufficient supply of freshwater, but that that supply was incidentally threatened, notably when the sea forced its way inland during storms and/or spring tides. After a flood, such pits will have constituted a quick solution for bridging the time to the recovery of the former situation.

Description
The features that were identified as wells are pits with diameters of 40 to 370 cm at level C. Their depths relative to this level vary from 30 cm to 2 m, so their original depths will have been 60-230 cm (fig. 3.8). The majority of the recorded diameters relate to the collapsed structures, and are consequently systematically too large. In 65 cases the original diameter could be determined at the base of the well, where the deepest part had been dug into the stable, clayey sediment (Unit 40). These parts were cylindrically shaped and had diameters of between 30 and 240 cm. That stability may well have been the very reason why these wells were dug down so deep into this layer:

Figure 3.7 Section of feature 2-12, a well reinforced with vertically inserted split wood; measuring staff with 20-cm divisions.

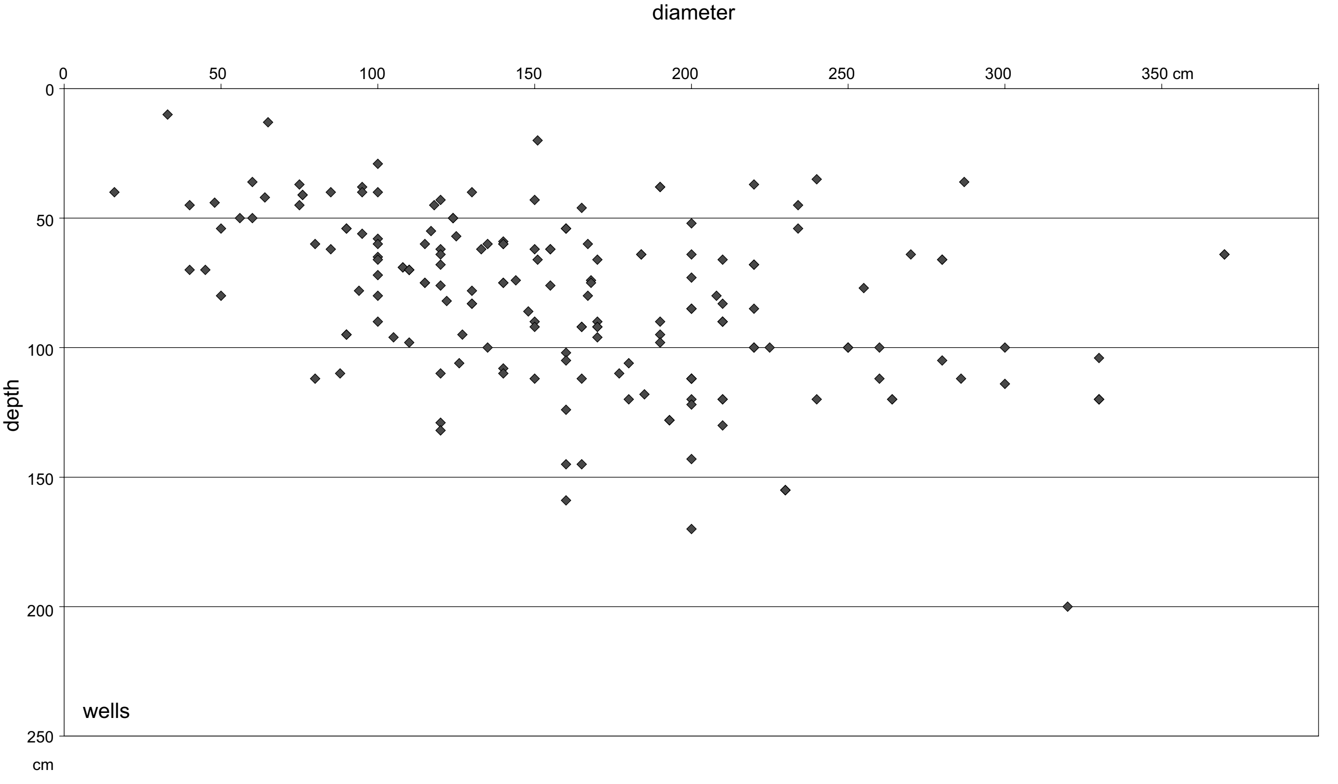

Figure 3.8 Wells, diameter versus depth.

this part did not collapse, allowing a supply of freshwater to seep from Unit 25 and optionally Unit 26.

Remarkable is the great variation in dimensions. Some of the wells have an exceptionally small diameter, of less than 80 cm in ten cases. They are not relics of larger pits, but primary steep, deep pits with small diameters. They were found randomly distributed between the wells on the northwest side. From time to time there were evidently situations when a small supply of freshwater sufficed. Does this reflect a measure that was occasionally taken exclusively for human use or does it mean that the group of people who lived at this site varied in size? This intriguing observation is hard to explain.

At the other end of the spectrum are complexes of large pits whose fills were found to merge to such an extent that we assume that the wells succeeded one another. One of the complexes in question comprised the aforementioned well that was reinforced with planks. Otherwise very few intersections were observed. We may assume that the depressions marking the sites of former wells remained visible for quite some time, and that people avoided digging in their unstable fills. Only one of the features (14-19) is assumed to represent a wide well, in which the water could be reached via a specially dug entrance.

Most of the 'wells' were found lying close together in a large group at the foot of the northwestern side of the dune. Viewed from the former waterfront on the southeastern side, that will have been the sheltered side and, certainly in the earlier occupation phases, the most obvious location for a well. A much smaller number were dug in other parts of the dune and on its southeastern slope.

Besides the pits themselves, the heaps of sand dug from them will have remained visible for quite some time. On the northwestern side of the dune they will have hampered drainage and will – along with the water seeping from the dune – have led to marshy conditions in those parts, enabling the formation of Unit 19N (see also chapter 2). Higher up the dune the excavated sand will have acted as a source of colluvial deposits.

Dates

The wells can be generally dated to a particular phase on the basis of the nature of their fills and/or the presence of a dated overlying stratum.

All the wells of the large group found on the northwestern side had a very clean primary fill. Beneath the -4.0 m contour line they were covered by Unit 19N. Only two pits contained no secondary fill. This was taken to indicate an early date (phase 1), prior to the formation of this stratum. In all the other cases 19N constituted a secondary fill, implying a broader time span, comprising phases 1 and 2a.

The wells found higher up the dune slope could be differentiated exclusively on the basis of their fills. We assume that the darker 'occupation layer' (Unit 20) was formed in the course of the period of occupation. This assumption implies that wells from the beginning of the occupation period will have a relatively clean fill whereas late wells will contain large amounts of soil washed into the pit or subsided from the surrounding occupation layer (figs. 3.9-10). We also assumed that the youngest pits would contain evidence of a higher groundwater level and expanding peat growth (Units 10 and 11). This led to the following classification criteria:

phases 1/2a:	light primary fill and no secondary fill	N = 60
phase 2a:	light primary fill and dark secondary fill	N = 43
phase 2b:	slightly contaminated primary fill and darker secondary fill	N = 22
phase 3:	primary fill occasionally, and secondary fill always dark and peaty	N = 5
phase 2/3:	intermediary between phases 2 and 3	N = 5
not phased:		N = 13

So the great majority of the wells were dug in phases 1 and 2a, and in that time almost exclusively on the north-western side of the dune (fig. 3.2). It is not clear how intensive this activity was in phase 1 because the beginning of the formation of Unit 19N cannot be accurately related to the standard stratification. By some point in time, however, wells had been dug all over a strip measuring 12x60 m. Only a few wells were dug in the higher part of the dune. Most of the wells date from the first half of the occupation period, which is understandable as that was the time when marine influence was strongest and the supply of freshwater will have been under threat more often than in later times, when the saline conditions will have been replaced by freshwater conditions.

A few dozen more wells were dug in phase 2b, but they were created more over the entire dune, in particular around the western end. The criteria for classifying wells as the youngest dug were evidence of a higher groundwater level and expanding peat growth (Units 11 and 10). All the wells except those from phase 1 were assumed to contain a dark secondary fill.

Only a few wells were dug in phase 3, finally, and all near the top of the dune, above the -3.4 m contour line, which then roughly marked the boundary between the dune and the surrounding peat (Units 10/11).

Figure 3.9 Feature 12-314, section showing a microstratigraphy of dark soil and sand. Arthropod and diatom samples taken from the base and half-way up the fill were analysed.

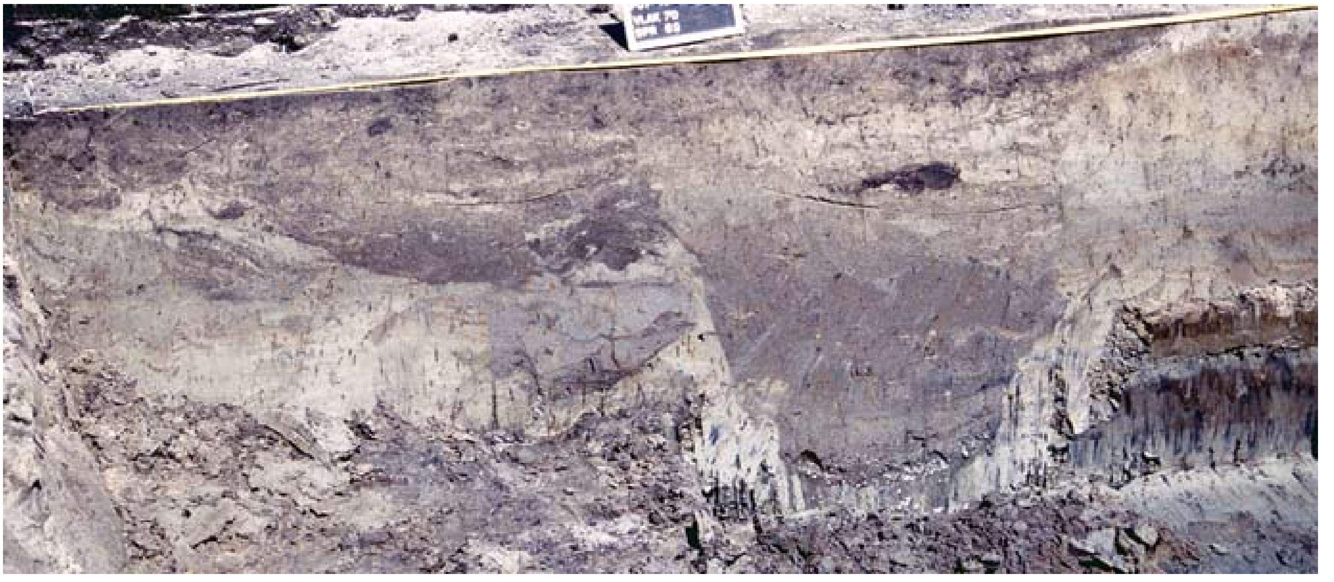

Figure 3.10 Feature 18-63, two intersecting wells.

No wells were encountered in the northeastern part of the dune, to the northeast of trench 21. Did this part of the site have a different function, or was it used only in phase 3, when there seems to have no longer been any need for wells?

Comparison of the number of large wells (diameters of >80 cm, N=138) dug in phases 1 and 2a with the assumed duration of occupation (less than a century?) leads to the conclusion that the wells were dug at an average of around one a year. On the assumption that the site was permanently occupied, this frequency would seem to be based on a highly acceptable risk of one disaster a year. If the site is assumed to have been occupied on a seasonal basis, the wells could represent annually dug fixed sources of drinking water. An argument against the latter option is that such a well would have become brackish in the event of a saltwater flood, and would no longer have served its intended purpose.

3.5 Large features with a special function

The shape, fill and/or contents of three categories of large features indicate that they represent pits that were indisputably dug for a specific purpose or function:

- hearth pits
- burial pits
- a deposition pit

3.5.1 Hearth pits

Description

Hearth pits (N=55) are features with diameters of between 25 and 120 cm (fig. 3.11). They have a bowl-shaped section and a fill with a high charcoal content. Three hearth pits were not identified as such until further soil had been removed beneath level C because the pale top parts of their fills did not stand out very clearly from the surrounding light-coloured dune sand at the higher level. The pits' (partly reconstructed) depths relative to level C were 10-55 cm, which means that they were dug to depths of 40-85 cm relative to the original ground surface.

Two subtypes of hearth pits can be distinguished on the basis of the pits' fills:

- pits with a thick layer of charcoal at the base of the pit covered by pale (bleached) sand (N=45; figs. 3.12-13).
- pits with a homogeneous light to dark grey fill containing regularly distributed large quantities of charcoal (N=10).

Figure 3.12 Hearth pit, feature 2-99.

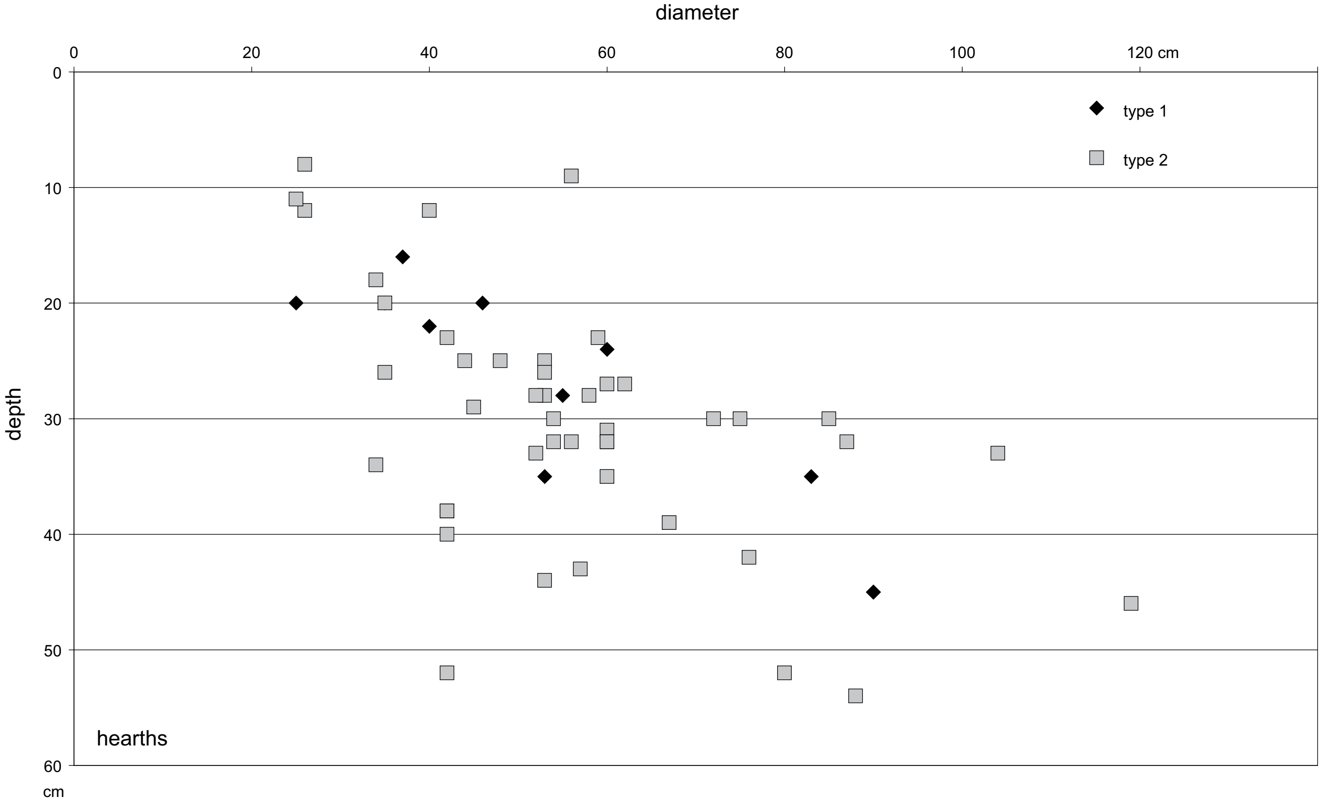

Figure 3.11 Hearth pits, diameter versus depth.

The two types were interpreted as hearth pits on the basis of the abundant quantities of charcoal found in them. The fact that the soil around the hearth pits had not been discoloured by the heat of the fire suggests that the fires were not particularly hot and did not burn for very long.

The hearth pits were found all over the dune, from the southwesternmost to the northeasternmost part, but there was a pronounced concentration, comprising half of the total number, at the middle of the northwestern slope. The hearth pits all lay above the -3.80 m contour line of the former surface, so in the high part of the dune.

Dates

In the areas of the 'occupation layer' (Unit 20) and the colluvium (Units 15/16) these pits came to light beneath these strata, which means that they must date from the first half of the occupation period (phases 1 and 2). One hearth pit in the northwesternmost part of trench 18 certainly dates from phase 1, judging from its low stratigraphic position. Ten pits found at the top of the dune may date from phase 3.

Such hearth pits are well known from all phases of the Mesolithic. They are usually encountered in small numbers in isolated positions, but at two sites several hundred were found close together. One of those sites is NP3 in the southeast of the province of Groningen, which lay on an exceptionally long (1.5 km) but only 40-m-wide coversand

Figure 3.13 Hearth pit, feature 18-107.

ridge. There, 600 small pits with fills with a high charcoal content were found within an excavated area of 6 ha. Many of the pits, which had extremely uniform dimensions, were clustered in small groups. They were round or oval, with diameters of 40-60 cm, in a few exceptional cases 80 cm, and depths of 40-50 cm. A large number of ^{14}C dates obtained for these pits place them in the Middle Mesolithic, 7600-6500 cal BC. The pits were found not within, but adjacent to the associated flint scatters that are assumed to represent domestic areas (Groenendijk 1987, in press). From this same period (7400-7100 cal BC) date twelve hearth pits that came to light on the buried coversand ridge of Verrebroek 'Dok' in Antwerp's docks (Crombé *et al.* 2003). Many dozens of such pits were found on coversand ridges in Amersfoort-Noord (Vathorst). Some of them were hearth pits, with diameters of 80-250 cm, *i.e.* significantly larger than the aforementioned ones. Associated microliths, charcoal identifications (coniferous wood) and two ^{14}C dates (8680 ± 50 and 7180 ± 90 BP) place the pits in the Mesolithic. A third ^{14}C date (5190 ± 120 BP) however shows that such pits continued to be dug until the end of the 5th millennium cal BC (Van der Roest 1998/1999).

The second site where many hundreds of hearth pits came to light is Mariënberg-De Schaapskooi, which lies on a coversand ridge along the river Vecht in the province of Overijssel. These pits were slightly larger, with diameters of 0.5-1 m and depths of 5-40 cm relative to the exposed surface. Their original depths are estimated to have been at most 65 cm. Their dates cover a wider span, from 7500 to 5000 cal BC, *i.e.* late Boreal and Atlantic (Verlinde/Newell in press).

A total of 111 'deep hearth pits' were found at the occupation site of 'Hoge Vaart'. They have all been dated to the local phase 2, 6400-6100 BP, around 5300-5000 cal BC, at the end of the Mesolithic (Peeters/Hogestijn 2001, 36, 131). They were deeper than 15 cm. Three types of pits were distinguished, the first corresponding to the Schipluiden type 1, the other two to Schipluiden type 2:

- pits with a thick layer of large lumps of charcoal at the base,
- pits with small lumps of charcoal mixed throughout the entire fill,
- pits with diffusely distributed fine charcoal particles.

Experiments have shown that hot fires, with temperatures of up to 900ºC, could very well be created in such pits. The small pits in particular will have retained the heat for several hours. This suggests a variety of functions: roasting seeds and nuts, heating cooking stones, smoking meat or fish and drying foodstuffs or utilitarian objects such as animal skins (Groenendijk/Smit 1990).

^{14}C dates show that such 'typically Mesolithic' hearth pits were used in the Neolithic, too (Groenendijk 1987, 97), but their occurrence at Schipluiden is indeed an eye-opener reflecting the continuity of this custom.[3] The pits' clustered distribution adjacent to domestic areas and their dimensions are comparable with those of the Mesolithic examples.

3.5.2 Burial pits

Description (table 3.2)

Six burials, including a double grave, were found in the western part of the dune. They will be discussed in detail in chapter 5. The following discussion will be restricted to contextual aspects of these finds.

The burials were visible in the excavated area as dark grey pit fills with outlines ranging from oval to subrectangular, with the exception of burial 4, which was not observable in the form of a pit. This was a partially disturbed shallow grave in the occupation layer, which did not extend into the underlying light-coloured deposits. These features were identified as burials only when they were found to contain articulated human skeletons.

Four of the burials lay close together, spaced 2-4 m apart, in a small cemetery at the western end of the dune. The other two were found in isolated positions, one at the top of the dune and the other at the foot of the southeastern slope.

More burials were searched for in the excavation, especially in the areas between and around the graves, but no others came to light. This and the fact that the recorded burials were clearly visible suggest that the total number of deceased who received such a formal burial was quite small in relation to the size of the settlement.

Dates

The cemetery can be dated to (the end of) phase 2 on the basis of intersections. Burial 6 was dug into the secondary fills of some pits that have been dated to phases 1/2a. Burial 4 was embedded in the occupation layer (Unit 20). Burials 1 and 2 were both filled with the same dark sand of the occupation layer in that area. The burials, in particular 4 and 6, moreover lay so far down the slope of the dune as to make dates in phase 3 unlikely, for by the time of phase 3 those locations lay in the peripheral zone of the swamp surrounding the site. What is however remarkable is that these burials lay in the westernmost corner of the (reconstructed) enclosed area.

Burial 5 was intersected by a well that has been dated to phase 2, which implies a date in phase 1 or the early part of phase 2. The burial's position on the dune slope moreover makes a date in phase 3 unlikely.

Burial 3 lay at the top of the dune, so it could in principle date from any of the occupation phases. The pit was dug into the fill of a well that has been dated to phase 2. The occurrence of large lumps of peat in this fill implies that the expanding peat (Unit 10/11) had by this time already reached this area.

grave no.	orientation	form	length	width	depth	surface	base	fill	phase
1	S-N	rectangular	186	112	52	-3.6	-4.4	dark sand (20)	2
2	W-E	oval	115	55	32	-3.4	-4.0	dark sand (20)	2
3	W-E	oval	85	56	56	-3.3	-4.1	heterogeneous, peat lumps	3
4	N-S	–	–	–	–	-3.8	-4.0	in Unit 20	2
5	W-E	round-oval	85	67	65	-3.7	-4.6	light sand	1-2a
6	SW-NE	rectangular	63	43	40	-4.0	-4.7	peaty sand (19N)	2a

Table 3.2 Burials, basic data.

This leads to a date in phase 3. This assumption is supported by the fact that a location at the highest point of the dune was chosen for this burial.

The burials yielded no grave goods that could have been of further help in dating the pits.

The ^{14}C dates suffer from a considerable reservoir effect and are of no use for phasing individual graves.

Conclusion

At different times in the history of the site's occupation deceased were buried on the dune. In each case a peripheral location was chosen for the burial: at the western end of the dune, at the edge of the settlement site and at the former foot of the dune, at the edge of the surrounding swamp. In phase 1 a child of around 8 years of age was buried on the southeastern side (burial 5). In phase 2 a small cemetery was created in the westernmost corner of the enclosed area, in which four adult men and a small child (burial 6) were buried. And in phase 3, finally, an adult man (burial 3) was buried at the western end of the dune, which had by then shrunk considerably (*cf* chapter 5).

3.5.3 Deposition pit

One fairly small pit with steep sides (12-48, find no. 6086) at the northwesternmost edge of the settlement site was conspicuous not so much on account of its shape, but because of its contents. The pit had a diameter of 66 cm and extended to a depth of 36 cm beneath the exposed features area. In those respects it was very much the same as the smallest wells. This pit however had a homogeneous fill which belonged to Unit 19N in its entirety. An exceptional aspect of the fill is that it contained a large number of animal bones. There was no anatomical relation between the bones, which were randomly mixed, but they did appear to have been deposited in a single act. The bones are the remains of three head of cattle and the skull of a dog, killed by a blow. The exceptional concentration and composition of the assemblage suggest an intentional deposition on a special occasion (see section 22.3.7). No bones were found at the base of the fill, which must mean that this part of the fill had already been formed by the time the bones were deposited here, which must hence have been some time after the pit had been dug. This part of the fill did contain a large number of uncarbonised sloes *(Prunus spinosa),* some of which had under the exceptionally good preservation conditions survived with identifiable flesh. The fact that these remains are exclusively remains of fruits, and that other sloe remains or other botanical macro-remains were absent, is an argument in favour of deliberate deposition and against natural causes, such as fruit falling from a sloe tree that happened to grow there.

The pit was dug at the edge of the swamp at a time when Unit 19N was in full development. This implies a date in phase 2a.

It is assumed that the pit's contents is not the outcome of random accumulation, but indeed reflects deliberate deposition, in several phases: first a batch of sloes and later the remains of several animals. We do not know what the purpose of the depositions was, but it may have been in some way associated with the cemetery in the pit's immediate vicinity, which has indeed likewise been dated to phase 2. We may assume that this part of the site had a spiritual meaning for the occupants.

3.6 Ditches and trenches

Three short, elongated features with lengths of 1-2.5 m, widths of 15-30 cm and depths of at most 30 cm were found in different areas in the central and western parts of the dune. They were not visibly related to any of the other features and appeared to represent the deepest parts of longer, shallow ditches whose functions are not clear. The irregular course of the longest feature makes it more likely that they were drainage ditches rather than parts of structures (foundation trenches).

3.6.1 Wall-foundation trench, house plan

At the middle of the dune, in the comparatively empty area outside the dense clusters of postholes, was a unique feature: a trench marking a rectangular enclosure with rounded corners measuring 3.5 × 6 m (figs. 3.14-16). The trench was at most 30 cm wide and at most 30 cm deep and had a dark fill identical to the 'occupation layer'. The northwestern stretch of the trench was clearly deeper than the southeastern.

Along the eastern side of the enclosure was a distinct asymmetrically positioned opening or entrance with a width of 1.5 m. Here the two ends of the trench came to a clear, abrupt end. The trench was interrupted along the western side, too, but there the situation was less clear. At this point the trench was very shallow and appeared to be intersected by the fill of a pit. There was no indisputable second entrance.

As the trench appeared to be the foundation trench of the walls of a small house, remains of (wall) posts were searched for. To this end, the fill was sectioned both longitudinally and transversely, and parts of the base of the fill were shovelled down horizontally. However, no features of any posts or stakes were found, but it did become clear that the feature represented a deliberately dug structure.

Within the enclosure were a large number of small postholes, four of which - relatively large ones with diameters of 15-19 cm and depths of 25-37 cm – lay along the axis. They may be regarded as parts of the plan of the house and as the features of posts that supported a ridge beam. The posts in question were less sturdy than those that stood elsewhere on the dune. If there were any comparable structures, but then without a wall trench, on the dune, they could be represented by similar rows of roof supports, but no indisputable evidence of such rows is observable among or between the dense posthole clusters.

The dark fill of the trench and its location at the highest point of the dune suggest that the house dates from the final occupation phase. The northern stretch of the foundation trench intersects a pit fill. In view of the exceptional character of this structure it is possible that it is not associated with the period of occupation considered here, but with some incidental later use of the top part of the dune. We don't know of any comparable plans in the Lower Rhine area for this period.

Figure 3.14 Foundation trench of the hut, feature 16-500. This hut has been dated to a late phase in the occupation and possibly represents a period of more incidental use after the site had been abandoned.

Figure 3.15 The hut, feature 16-500, sectioned. Two hearth pits are visible on the left. Measuring staff with 20-cm divisions.

3.7 The small features: stake holes and postholes (fig. 3.17)

'Small features' are understood to be features associated with posts of varying thicknesses that were dug into the ground.

The features of this group were classified on the basis of their dimensions and diameters. The limits between the distinguished categories are not sharp, and hence somewhat arbitrary. We distinguished the following groups:

- stake holes: all features with diameters < 8 cm,
- postholes with post moulds,
- post moulds: the outlines of an actual post with a diameter ≥ 8 cm,
- postholes: fills of holes that are assumed to have held a post.

3.7.1 Stake holes

All features with a diameter of less than 8 cm were assumed to represent stake holes and stake moulds (N=768), irrespective of their depth. Of these stake holes and stake moulds, 293 belong to the fences that were found to have enclosed the dune. The stake holes that did not belong to these fence features varied substantially in dimensions. Their diameters varied from 2 to 7 cm, with an average of 6 cm, and their depths relative to level C were on the whole fairly small (on average 7.5 cm), but in some cases greater than 20 cm, *i.e.* more than 50 cm relative to the former ground surface. Those features may represent fence posts or the wall posts of houses. It is not certain

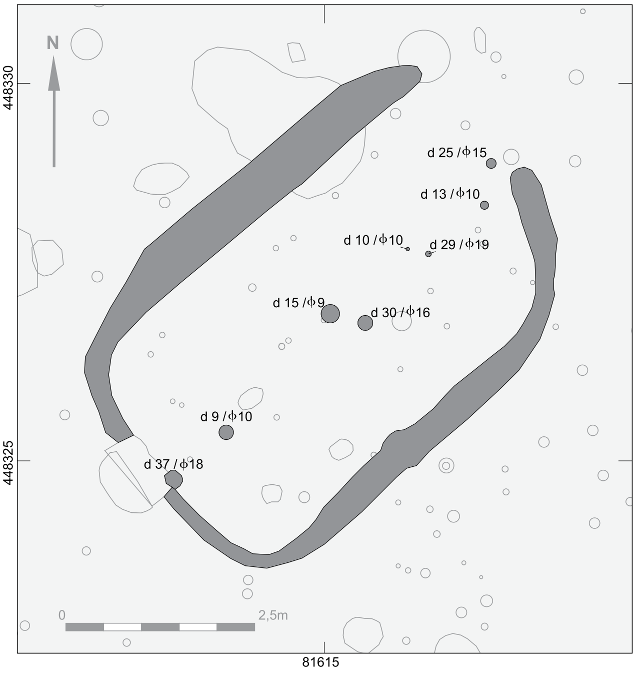

Figure 3.16 Plan of hut, feature 16-500 (scale 1:100).

whether the smallest and shallowest features indeed have any archaeological meaning.

3.7.2 Postholes with post moulds

In a small number of features the outlines of a post were observable (N=86, or part of the wooden post itself had survived (N=4). The holes of this category had diameters of 14-55 cm and the post moulds measured 10-22 cm. These dimensions show that there is a substantial amount of overlap between large post moulds and small postholes. The two categories were hence distinguished primarily on the basis of the feature's outlines.

3.7.3 Post moulds and postholes

The largest category by far is that of post moulds (N=3086). They are small features with regular outlines in vertical section, with diameters of 8-44 cm. Shallow post moulds have a semicircular cross-section, deep features have a rectangular cross-section and a flat, round or (sometimes) slightly pointed base. Their maximum depth relative to level C is 60 cm, which means that their depth relative to the original ground surface was at most approx. 90 cm. They are assumed to mark the places where a post either decayed in the soil or was pulled out of the ground. In the latter case the tugging will usually have resulted in a feature that widens towards the top rather than one with a purely cylindrical section.

The criterion for interpreting a feature as a 'post mould' was its resemblance to features found in other excavations, in particular at sites of a comparable age and with comparable soil and/or preservation conditions, where such features were found to form part of house plans. The sites in question are in the first place Wateringen 4 and Ypenburg, but also Haamstede-De Brabers (Vlaardingen group) and Molenaarsgraaf (Bell Beaker/Barbed Wire Beaker culture) (Raemaekers *et al.* 1997; pers. comm. H.Koot, Rijswijk; Verhart 1992; Louwe Kooijmans 1974).

A relatively small number of features with round or pointed bases in vertical section were interpreted as postholes (N=180). They had somewhat less regular outlines and were on average larger than the post moulds. The fact that the recorded, basal parts of these features already taper outwards towards the top, is regarded as evidence that the features are postholes rather than post moulds.

It is not certain how realistic the functional explanation of the morphological differences between the two categories actually is. The differences could indeed be attributable to greater disturbance due to bioturbation in the case of most of the postholes, especially the small ones. No distinction was made between these two categories in the map analysis.

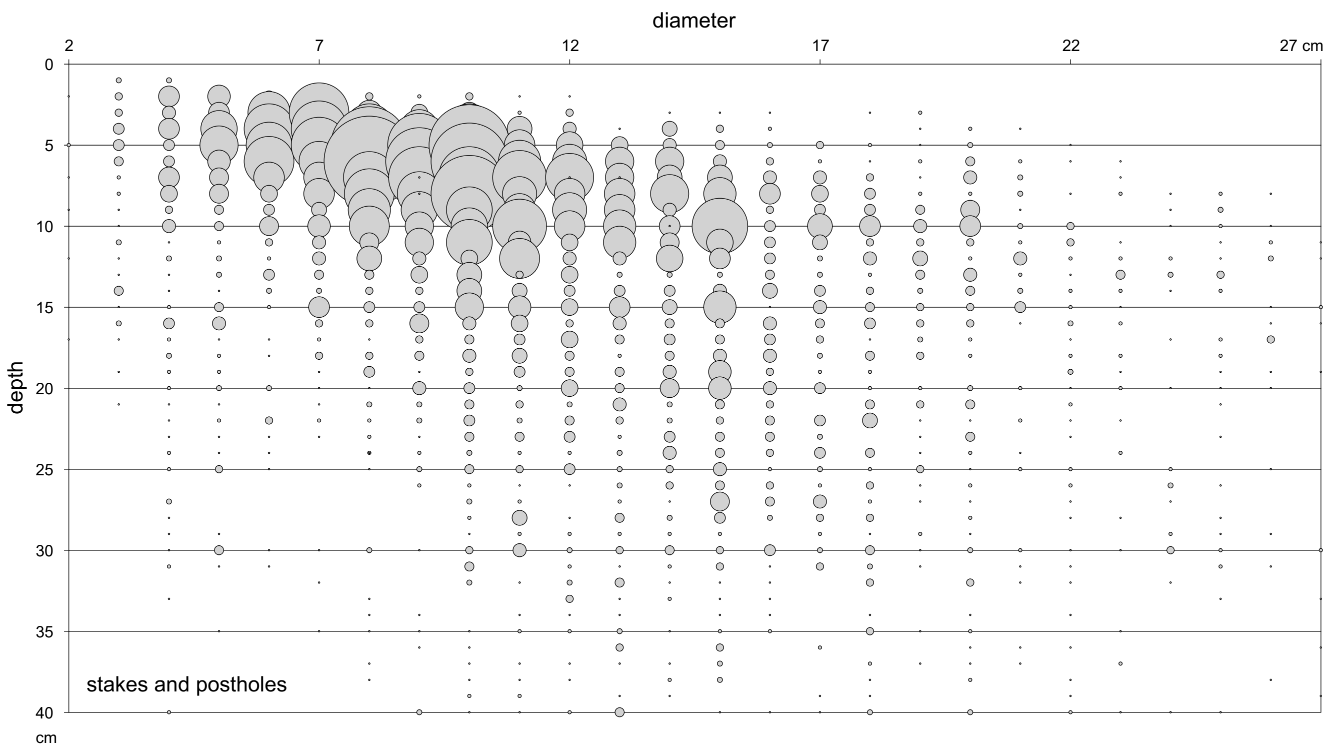

Figure 3.17 Stakes and postholes, diameter versus depth.

In the above discussion of the pits (section 3.4.1) it was already pointed out that there is some amount of overlap between the smallest pits on the one hand and the largest post moulds and postholes on the other, and that all features with diameters <50 cm were in the analysis regarded as probable postholes/post moulds.

3.8 CONFIGURATIONS OF POSTHOLES AND STAKE HOLES

3.8.1 Map analysis

Numerous stake holes and postholes came to light all over the entire dune, from the westernmost point to the northernmost, where the excavated area ended at the sheet piling. In the field, close attention was paid to identifying relations between the postholes, but without success. No house plans were identified in the field, and no outlines of granaries, which are nevertheless known from slightly later times (Haamstede-De Brabers, Verhart 1992). A handicap was of course the fact that the individual excavation trenches afforded insight into only slices of the overall site.

In the excavation maps (figs. 3.2-3) clusters of features with varying diameters can be visually distinguished – nineteen in total, with diameters of 5-12 m – but no distinct configurations of postholes can be made out within these clusters, certainly no linear or rectangular arrangements. The option of a series of round structures had to be dismissed on the basis of the databases due to the heterogeneity of the features and the incompleteness of the configurations. Linear arrangements are visible between the clusters: short rows of large features and longer rows of small features. The analyses of many of those arrangements however likewise yielded negative results. All this is partly due to the way in which the map was created. The features were recorded in the map as they were observed at level C, approximately 30 cm beneath the original ground surface. Level C was exposed as close to the surface as possible to avoid missing small and shallow features. The features observable at this level proved not to be representative of the underlying features: in many cases, small post moulds came to light beneath the large features exposed at level B and vice versa.

So the site map proved to be an unreliable analytical instrument. Attempts were subsequently made to identify structures by filtering the database and studying selections based on the depths and diameters of the features, but the maps obtained in those analyses likewise revealed very few patterns. Finally a new map was made in which each small feature was replaced by a symbol (circle), positioned at its centre coordinate, with a diameter relating to the feature's diameter and a colour relating to the feature's depth, both divided into 10-cm classes (fig. 3.3). This yielded a far more objective and (thanks to the depth data) more differentiated survey of the features. This new representation revealed new spatial relations. Some of the 'distinct clusters' identified in the site map proved to have merged, while short linear relations were observable between the largest features. These relations will be discussed below, leading to the question whether houses once stood at this site and, if so, what shape they may have had.

An interesting aspect are the remarkable features of long fences erected at the foot of the dune. They will be discussed first.

3.8.2 Fences along the foot of the dune

Description

Long rows of paired small features and/or postholes were observed along the periphery of the southwestern part of the dune, both on the northwestern side and on the southeastern side. These features, 308 in total, are assumed to represent stretches of fences (figs. 3.18-19). The majority (N=293) belong to the category of stake moulds. Of those features, 34 were too small, shallow or vague to be accurately measured; in those cases only the locations were measured. Only 15 of the features had larger diameters, up to 16 cm.

On the southern side the features were observed at the top of the grey clay (Unit 19), after the 'find layer' of Unit 18 had been removed by hand. Many of the features were poorly visible due to their small diameters or the abundance of large numbers of natural small features in their vicinity or because the top part of the feature sometimes appeared to have been compacted sideways. It would seem that most of the features were overlooked in the southern part of trench 10, which was the first to be dug, but the absence of fence postholes in trenches 2 and 3 was verified in the field. The first features were clearly identified in trench 4, after which specific attempts were made to find more of such features in the other trenches. But even in areas where parts of the fence must originally have stood, features were often absent. The fence was most clearly visible on the northern side, as remains of the wooden posts themselves had survived in many places there.

The good visibility of the fences is the result of the specific wetland conditions: the posts were hammered into the ground in a wet zone, in which the wooden points had in some cases survived, and were subsequently buried, and hence protected from later disturbance. All the fences, excluding stretch 1, were found to lie precisely in or just outside the zone where Unit 18 was covered by the colluvium of Units 15/16. This will certainly have contributed towards their preservation and archaeological visibility. This makes the absence of indisputable fence features on the dune itself quite understandable. Postholes from this era, let alone features of such thin fence stakes, rarely survive under the 'normal' dry conditions prevailing in the Dutch upland areas.

Figure 3.18 Sectioned postholes of the fence, stretch 1 in trench 4.

The features of the fence stakes had diameters of 2-7 cm, the same as those of the surviving stakes themselves (fig. 3.20). Viewed in detail, the stakes were rather irregularly arranged; many pairs were set askew to the course of the fence. The distance between the stakes of each pair moreover varied, from 5 to 25 cm with an average of approximately 10 cm, and the distance between the individual pairs was not constant either. On the whole, the pairs were set 70 to 80 cm apart, but in some places the distance between two pairs is only 20 or 40 cm, or on the contrary 140 cm. The setting is more suggestive of primary irregularity than of repair work. Where distances of 120 or 140 cm were observed, a pair of postholes may have been missed. In some places not two, but three postholes were found in a row; they may be seen as evidence of repair. The features of the fence stakes were on average deeper (at most 50 cm, on average 11 cm) than the stake features in general.

The fences were erected at the foot of the dune, at the edge of the surrounding swamp. On the northwestern side the fence coincided with the -4.4 to -4.5 m contour line of the former ground surface (level A). In that area there was a single 50-m-long fence enclosing the part of the site that contained the wells. On the southern side was a double, and in parts even a triple fence. A long, continuous fence could be followed for almost 80 m along more or less the same contour line, from excavation trench 4 (stretch 9) in the west via stretch 5 to stretch 6. It may have extended further into trench 21. The middle fence (stretch 4) was recorded over a length of 30 m. It stood higher up the slope, parallel to stretch 5, between contour lines -4.4 and -4.2 m. The innermost fence (stretch 3) was observed only in trench 11, at a depth of around -4.1 m. It probably formed a continuation of stretch 1, which was erected at the same altitude.

No indisputable entrance is observable in the recorded parts of the fence. The entrance may well have been narrow and fairly inconspicuous. There was no need for a broad entrance, since wagons were to our knowledge still unknown at this time.

Complete enclosures?

No evidence of fences was found on the northeastern side of the dune. Are we nevertheless to regard the recorded stretches as parts of an enclosure, or were they independent fences? The strongest argument in favour of a complete enclosure is the identical palaeogeographical positions of the fences at the dune/marsh transition on either side of the dune. The basic function of any fence is moreover to serve as an enclosure, separating a particular area from the outside world, either to keep something in or keep something else out. But the recorded stretches cannot be linked up in a straightforward manner.

In the west, stretches 1 and 2 come to an abrupt end. Four stake holes, two of which are arranged as a pair, seem to suggest that stretch 1 bent 90°, continuing in a northerly direction. This would support the assumption that the entire dune was enclosed. Stretch 1 can however not be connected to stretch 7 on account of the substantial difference in depth between the features of the two stretches. The comparable depths of the features, but also the obtained ^{14}C dates (see below) reveal a much closer correlation between stretches 9-5 and 7.

So did stretch 1 not extend any further? Features of a continuation of this stretch should have come to light at a comparable depth along the northwestern side of the dune, but this is precisely the zone that was badly disturbed by the many wells that were dug there. No *features* of stakes were observed in that area, but six points of wooden posts were found in five pit fills which are in every respect comparable

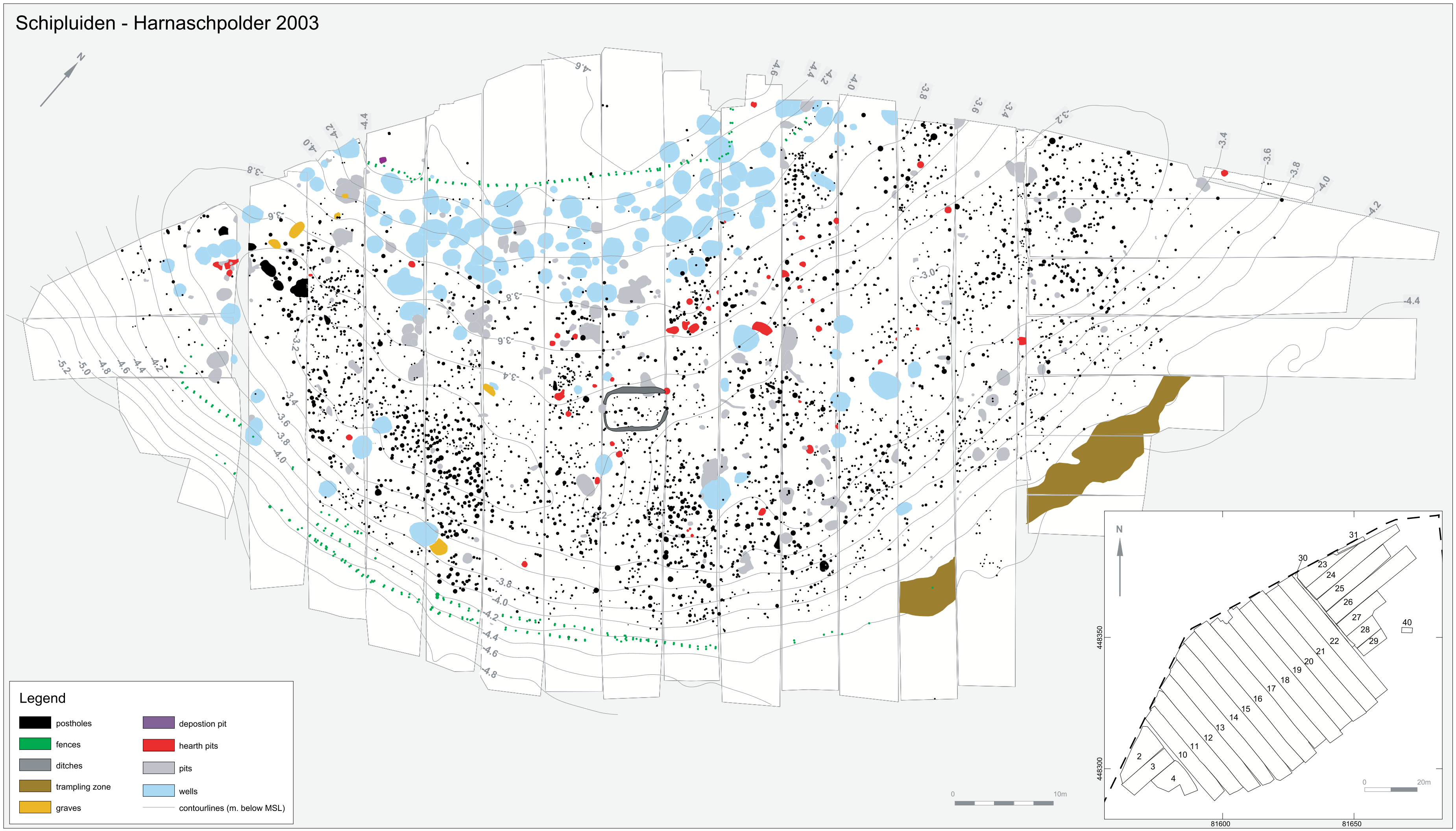

Figure 3.2 Over-all excavation plan of Schipluiden-Harnaschpolder showing all the interpreted anthropogenic features according to the field drawings (scale 1:400).

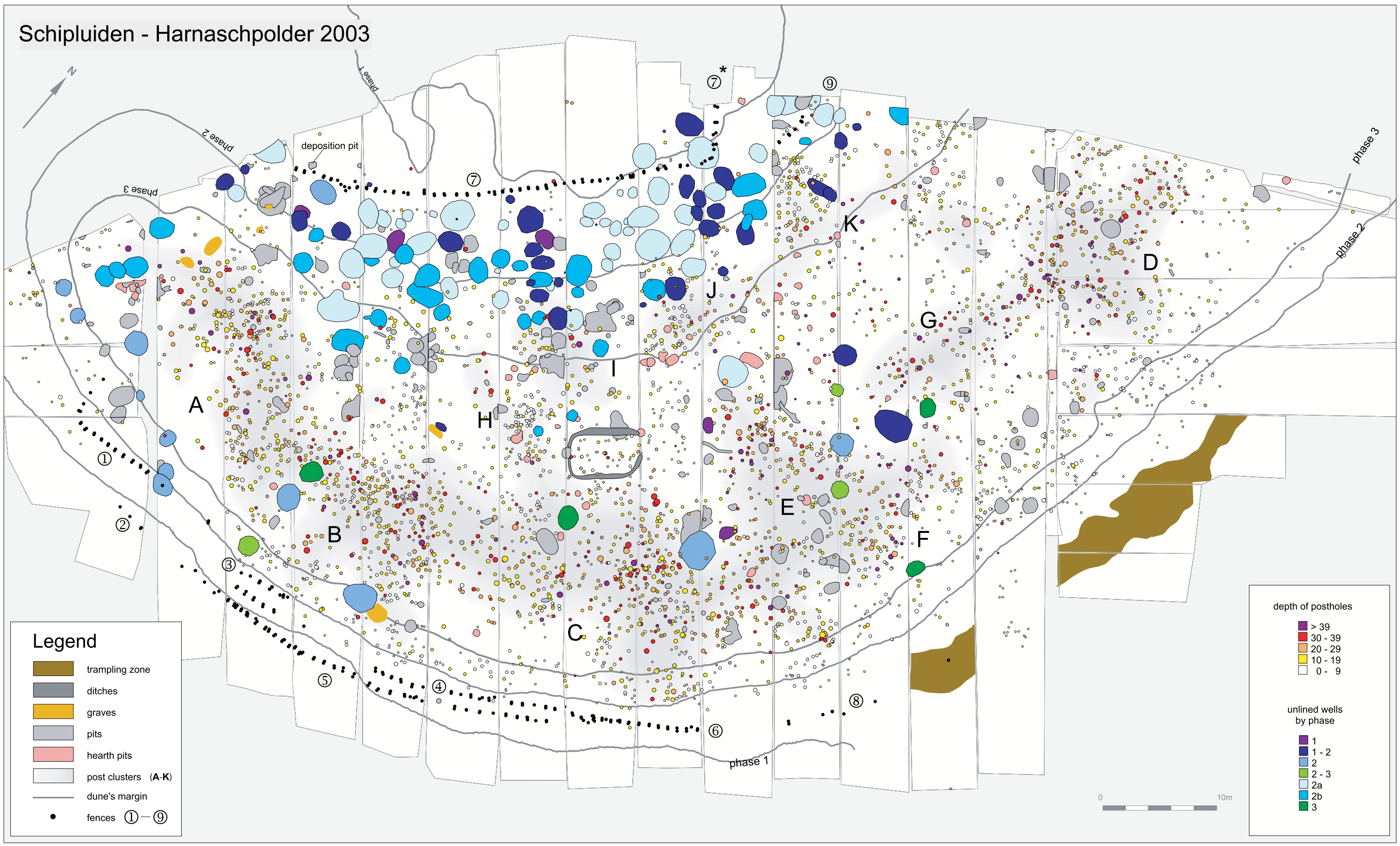

Figure 3.3 Cartogram of the Schipluiden excavation plan showing postholes coded on the basis of diameter and depth according to the field registration files (scale 1:400).

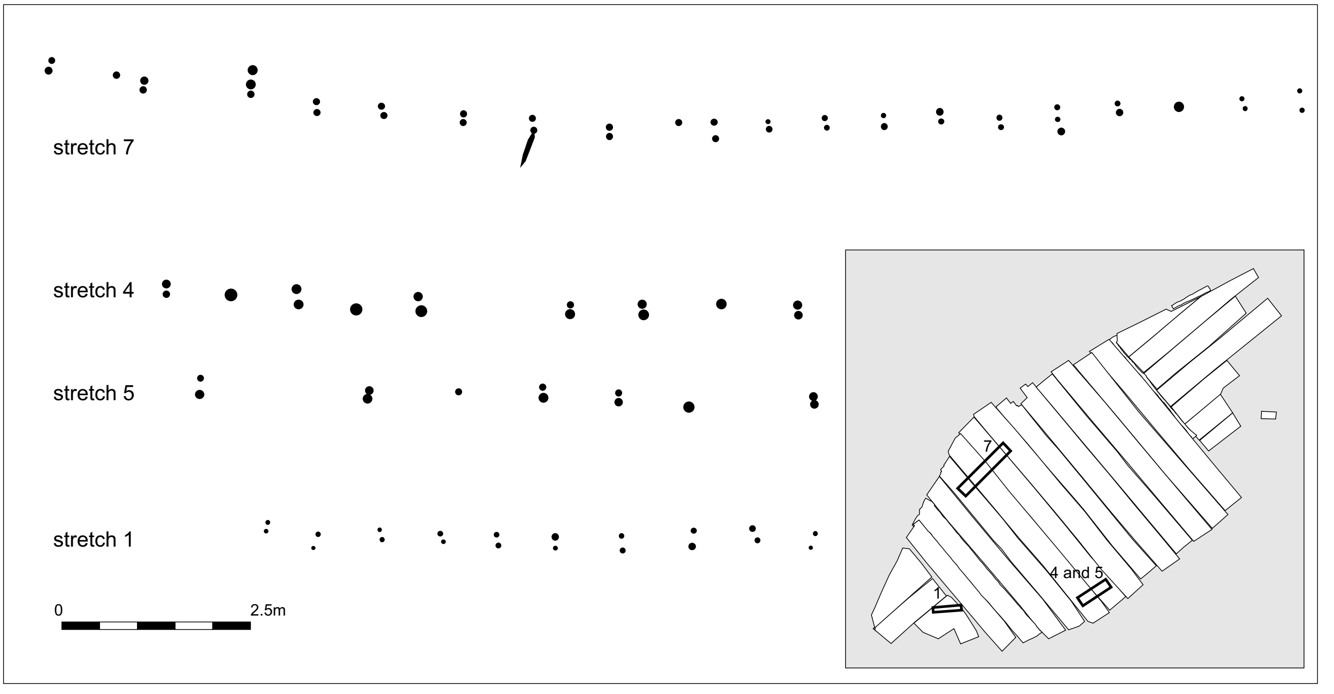

Figure 3.19 Selected sections of the fences (scale 1:100).

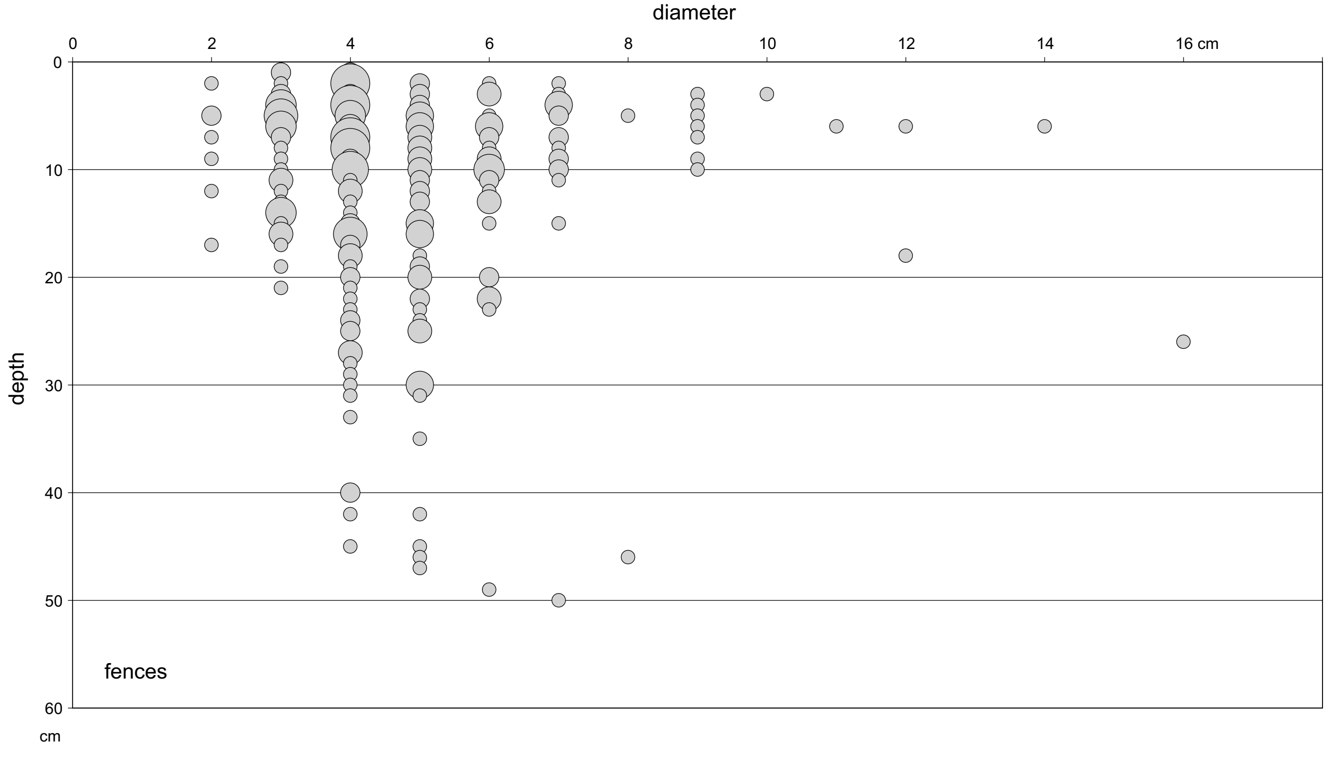

Figure 3.20 Stakes and postholes of the fences, diameter versus depth.

with those of stretch 7 and which may very well be the last remnants of one or more parallel fences. We certainly have no alternative or better explanation for those remains.

On the eastern side, stretch 7 curved 105º towards the northwest (stretch 7*) in trench 18, after which it could be followed no further due to an unfortunate concurrence of circumstances involving a drainage facility. What appeared to be further traces of the fence came to light five metres further northeast, but the features concerned, of four sets of paired stakes ('stretch 2'), were extremely small and shallow, making them insufficiently conclusive as evidence. The situation at the periphery of the excavated area moreover made their interpretation extra difficult. The analysis of the wood (section 11.4.5) however proved helpful: the posts of 7 and 7* were found to differ so much in character that 7* may be safely associated with a separate activity: a change to or extension of 7. This means that it is quite possible that the fence originally ran in a straight line and that stretch 7* was later added to it.

The features of the southern fence (stretch 6) became progressively less clear, in particular less deep, towards the east (table 3.3). The intensive search efforts led to the discovery of only a few features to the east of trench 17 ('stretch 8', fig. 3.3). A broad strip of deeply trampled soil along the foot of the dune was found precisely in the zone through which the fence may be assumed to have continued. Such a trampling zone is to be interpreted as a much used track, possibly where cattle were driven along the fence or gathered behind the fence, as can also be observed in present-day pastures. It is plausible that the fence continued along the (north)eastern side but, if so, its course can no longer be traced.

An observation suggesting that the fences may – in spite of the differences – nevertheless be regarded as parts of a single enclosure was made in the wood analyses (section 11.4.5): one post of stretch 7* and one of stretch 5 seem to have been hewn with the same axe, recognisable by a very similar pattern created by some burrs on the axe's cutting edge. This would imply that the same person worked on both of these far-apart-lying stretches of the fence within a very short

space of time. We can however not say with certainty that the two stretches belong to the same enclosure.

trench	N=	mean depth cm	mean diameter cm
4	20	25.5	4.5
10	2	9	4
11	46	7.2	5.1
12	17	16.2	5
13	23	10.4	4.1
14	13	10.3	6
15	18	7.7	5.4
16	21	7	3.6
17	15	5.4	4.3

Table 3.3 Stakes and stake holes of the fences along the southeastern margin of the dune showing a decreasing depth from west to east.

Phasing

The parallel fences on the southeastern side are probably not contemporary, but were presumably successively installed. The outermost, most deeply founded fence was probably installed first, along a flowing, continuous line. Later, when the water level gradually rose, it was in two steps replaced by a new fence a little further up the dune slope, when it acquired a somewhat less regular course. Stretch 4 can plausibly be regarded as the local replacement of part of the southern fence, and in that case it need not automatically have had a counterpart on the other side of the dune. Stretches 1 and 3 on the contrary seem to reflect a more drastic movement of the fence up to a higher position on the slope. But due to the poorer preservation conditions it is only partly visible.

Stratigraphy

On the southern side the eastern section of trench 12 was set so far back that it came to lie over the features of the outermost fence (stretch 5, fig. 3.21). This section showed that the tops of the postholes lay at the top of the clay (Unit 18) and their fills consisted of a humic clay that differed clearly from both the matrix of Unit 18 and the overlying peaty sand (Units 15/16). Only beneath those strata did they become visible in the grey clay of Unit 19. This means that the fence postdates the trampling horizon (Unit 18), and predates the colluvium. This enables us to stratigraphically date stretch 5 to the transition from phase 2a to phase 2b. If the fence had been older, then the top parts of the features would have been obliterated by the trampling.

An exactly comparable position was established for stretch 7. Many ends of the wooden posts of this stretch came to light already during the manual removal of the peaty clay of 19N, which means that by the time when they were driven into the ground, all or most of this clay had already been laid down. The woodless features however became visible only beneath this clay. This is comparable with the observations made at the southern fences in relation to Unit 18.

Insofar as they were observed, the features of stretch 4 were in a stratigraphical position comparable with that of the features of stretch 5. Those of stretch 3 however lay in the area in which Unit 18 dovetails the dune and which contains the transition from the colluvium of Units 15/16 to the occupation layer 20. The exact height of the tops of these features was not determined, but the thinness of Unit 18 and

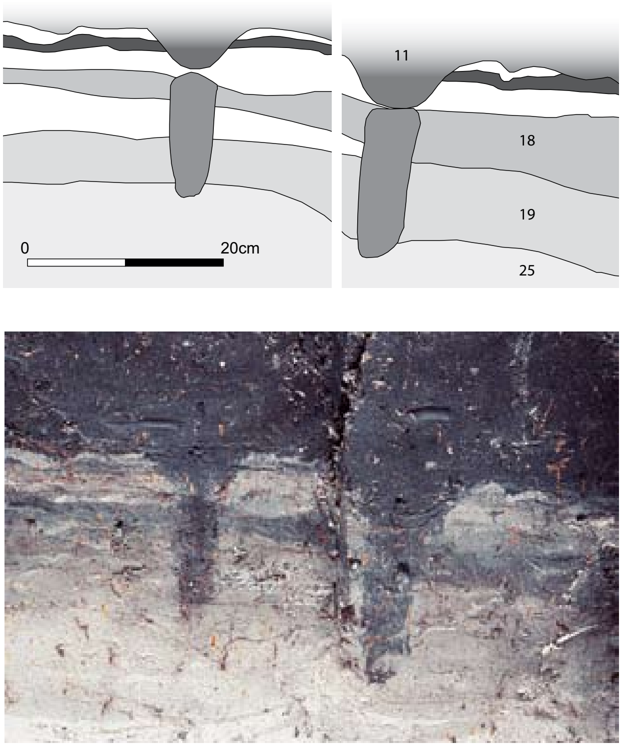

Figure 3.21 Fence, stretch 5. North section of trench 12 showing the relation of post moulds to the stratigraphy. These features lie just outside the limit of the colluvium of Units 15/16. The posts seem to have been driven into the ground from the surface of Unit 18. This unit is overlain by a sequence of thin clastic deposits (white), which were laid down while the posts were standing. Unit 11 bulges down into the post moulds, as a result of compaction of the moulds' loose composition.

the shallowness of the features of stretch 3 under level C suggest that the posts were dug into the ground from a higher level (the top of Unit 16).

All that could be determined of the features of stretch 1 was that they lay directly under Unit 20. The fact that a little determinable and even datable wood had in some cases nevertheless survived supports the relatively young date proposed for this stretch.

^{14}C dates
Four posts found in different parts of the dune and forming part of different stretches (1, 5, 7 and 7*) were subjected to ^{14}C analysis. The four were specifically selected to ensure that the dates obtained would on the basis of the posts' sharp stratigraphical correlation prove relevant for the site's internal chronology. These dates can only be soundly used in relation to the stratigraphy and the sequence of the fences. The one date obtained for the innermost stretch 1 is perfectly in accordance with the dates of phase 3, while the three dates obtained for the outermost fence (stretches 5 and 7) agree with the dates of phase 2, which confirms the sequence suggested above (see section 2.3).

Construction, function
Fences of a very similar type, composed of paired thin posts, are known from the Middle Bronze Age of Dutch prehistory, in particular from settlements in the rivers area, *i.e.* Zijderveld, Dodewaard, Geldermalsen (Eigenblok) and various others (Theunissen 1999, 167; Knippenberg/Jongste 2005; Jongste/Van Wijngaarden 2002). The distances between the paired postholes are the same (10-15 cm), but the pairs are set a good deal further apart: 1-3 m. The posts were originally dug 35 to 40 cm into the ground, implying that they were just over one metre high. Fences consisting of a single row of thin posts (type 1) were slightly more common. Their features tend to be encountered more frequently inside occupied areas, where the fences will have enclosed the farms, whereas fences of the double type were more common in the peripheral zones of settlements, enclosing cultivation areas. Theunissen assumes that the single fences comprised wattlework made of (willow) branches and that billet wood or branches were clamped between the posts of the double fences.

Several other structures are known from traditional European land use.[4] The paired posts may have been connected by one or more transverse beams or by (willow) branches, on top of which thin stems may have been horizontally or obliquely arranged. One, two or three horizontal beams result in a very open fence, but a solid, dense enclosure can be obtained with both horizontal and oblique infilling, certainly if split stems are used. As the Schipluiden site lay in a landscape that was fairly devoid of heavy wood, and its occupants employed a technology based on stone, we may assume that wood will have been used economically, and that people will have opted for the simplest structure for their fences, without any wood joints. The paired posts may in that case have been connected by willow branches at three heights. These connections will then have served to support thin horizontal stems placed between the posts. This fence-building technique was in former days commonly used in Norway (fig. 3.22), but also in Russia, as can be seen in the painting 'Afternoon in the village' by Piotr Suchodolski (1864) (Wagenaar/Jackson 2004, 25; fig. 3.23). The fences concerned were erected around kitchen gardens, to keep cattle out. The dimensions of the Oslo fence closely resemble those of the Schipluiden fence. The Oslo fence enclosed a pasture, and was evidently sturdy enough to keep cattle either inside or outside its confines. This function is also a likely option for the Schipluiden fences, which will have been far too insubstantial for keeping out wild animals or for defensive purposes.

A third possibility as far as the structure of the fences is concerned is also inspired by a traditional Scandinavian rural custom. According to this method, long (willow) branches were inserted obliquely downwards between the posts of each pair. Together, they constituted an enclosure that was as dense as a wattlework fence. It is not possible to choose between these three options on the basis of the features.

It is not very likely that the fences were intended to keep cattle *in*. After all, they enclosed not only wells, but also burials and the numerous (settlement) structures represented by the thousands of postholes that will be discussed below. So the most plausible option is that they were meant to keep cattle *out*: they will have protected the water supply and the settlement from the animals.

Figure 3.22 Traditional Scandinavian fence consisting of double posts and horizontal beams held together by osiers photographed in 1978 in the *Norsk Folkemuseum*, Oslo.

Dimensions, use of wood

The fence on the northwestern side (stretch 7) was recorded over a length of around 50 m, that along the southeastern side over a length of at least 55 m, possibly even 80 m. The assumed connection between the two parts around the north-western end of the dune would add an extra 30 m, bringing the total established length to 160 m. With an average distance of 70 cm between the paired posts, that would imply around 500 posts. Depending on the course of the fence in the northeastern part of the site, the total number of fence posts will at some time have been between 700 and 900. Assuming a structure with three horizontal beams, we arrive at 2000 to 2500 stretching metres of round timber with a diameter of 3-5 cm. If we assume that the wood was not imported from some distant source, this must mean that the landscape was no longer completely open by the transition from phase 2a to phase 2b, and that young trees grew in the immediate vicinity of the site.

The enclosure measured at least 3000 m^2, perhaps even double that area if the northern part of the dune was also fenced in. For a small farming community without means of transport the construction of such a fence will have implied quite an effort, which however pales before that involved in the construction of the contemporary large collective cause-wayed enclosures in large parts of northern and western Europe.

Two structures that are to some extent comparable with the Schipluiden fence are known from the Netherlands. The first is a slightly later palisade that was found at the foot of the Hazendonk river dune, which enclosed an area of about 1000 m^2. The palisade was recorded over a length of 40 m, predominantly in excavation unit C, and consisted of approximately 10-cm-thick posts (mostly alder) that were set about 25 cm apart. It was dated to 33/3100 cal BC, phase 1b of the Vlaardingen group (Louwe Kooijmans 1977). The second structure is the well-known enclosure of Anloo, which was interpreted as a cattle pen. This has been dated to the early Havelte style phase of the TRB culture, *c*. 3100 cal. BC (Waterbolk 1960, Harsema 1982). This structure was likewise a palisade set in a foundation trench. The three-phased structure enclosed an area ranging in size from around 3000 (the smallest enclosure) to 5000 m^2 (the largest). Both enclosures were substantially sturdier than that of Schipluiden, so it is not certain whether they had a comparable function or were perhaps intended for defensive purposes, too.

Ends of wooden posts

Many of the fence features were found to contain more or less well preserved remains of the wooden posts. See section 11.4.5 for the analysis of these post remains.

3.8.3 Clusters of postholes (figs. 3.2-3)
The majority of the large postholes, with diameters and depths exceeding 20 cm, were found in a long zone in the highest part of the dune. On the southeastern side, the limits of this zone more or less coincide with the -3.4 m contour line of the original dune surface, and on the northwestern side they coincide with the -3.2 m line. The zone has a length of 120 m, from the westernmost end to the limit of the excavated area in the north, and a width varying from 5 to 20 m. The southwestern half is an uninterrupted area, but in the central and northern parts the previously distinguished clusters are still roughly identifiable. This zone is surrounded by a peripheral area containing numerous small features, and a few large ones which are rarely deeper than 20 cm. The irregular shape of this zone reflects a long row of activity areas, where sturdy posts were dug into the soil. This altogether shows that the entire dune area was used over a long period of time.

On the southeastern side of this postholes zone are a number of projecting areas extending at most down to the -4.0 m contour line. Everywhere between -3.2 and -4.0 m on the northwestern side are open clusters of shallow postholes and the odd feature of a sturdier post. This zone extends to the area containing the wells, even overlapping the edge of that area. The low altitude of the postholes shows that they date from an early phase (1 or 2a) of the occupation period, because this part of the slope was gradually covered by expanding peat growth in later phases. The shorter period of use explains the lesser density of features in this area. These low-lying clusters also include large, deep postholes, but in smaller numbers. The four main dense clusters in the highest part of the dune were labelled A-D and the minor clusters E-K. Clusters A-D were also analysed by computer (section 4.3.2, fig. 4.5).

Figure 3.23 Piotr Suchodolski 1864 'Afternoon in the village', one of the paintings shown in the 2003-2004 exhibition focusing on 'the Russian Landscape' in the Groninger Museum. The double-post structure of the fence surrounding the kitchen garden is a very plausible option for the Schipluiden fences.

The fact that all the clusters of postholes include features of posts that were dug deep into the ground suggests that these clusters mark the sites of houses or huts of the kinds whose features have been found at other sites in the neighbourhood (see below). That we are unable to identify actual plans must be attributable to frequent rebuilding of new houses on the same spot, which would be understandable at this site on a narrow ridge in swampy surroundings. The absence of good-quality timber (with the exception of *Juniperus*) moreover implies that the occupants will have to have repaired or rebuilt their dwellings more often than people elsewhere. In view of the favourable preservation conditions, arrangements of postholes should nevertheless be identifiable, especially in the low-lying open clusters on the northwestern side of the dune, which was used for a shorter length of time and which should hence contain fewer overlapping plans.

3.8.4 Rows of postholes

At first sight, the largest postholes (diameters >30 cm, depths >30 cm) appear to be quite randomly arranged. On closer inspection many of them however prove to form part of rows with lengths of 5-12 m (commonly 7-11 m) comprising the features of 3-5 relatively heavy posts set 2-4 m apart. They have been numbered per cluster (fig. 3.24). Many of the postholes lie along straight lines, but some are slightly out of line. In a few cases double or even triple features were found. The rows show no preference for a particular orientation, but many do lie parallel or perpendicular to the dune's longitudinal axis. Many moreover intersect one another. Two or more parallel rows were not encountered anywhere.

Before attempting to interpret these rows we first had to determine whether such linear arrangements are observable in any random distribution of postholes. This is certainly the case as far as rows of three postholes set at irregular distances from one another are concerned, but less convincing in the case of rows of four postholes.

Good testing areas were the low-lying open clusters (H-K) on the northwestern side of the dune, which comprised only a limited number of large postholes, some of which were clearly arranged in short rows. In total, six rows with lengths of 7-11 m comprising 3-4 postholes set 2.3 to 4.8 m apart were distinguished in these clusters. Some of the rows are more regular (H1 and D1) than others. We regard this occurrence of rows in the open areas as an argument against random distribution and in favour of a functional meaning.

Distinguishing rows of postholes in the large clusters on top of the dune was far more difficult due to the great multitude of features in that area. Especially in the densest clusters (A, B, C, D) there are in each case several possible alternatives. Most convincing are the rows extending from postholes at the edges of the clusters (*e.g.* A6, A7, C1) and the (scarce) rows of postholes of equivalent dimensions and outlines set at regular distances relative to one another (*e.g.* B1, B6). Ultimately 36 rows were distinguished in these dense clusters, but we do not flatter ourselves into assuming that we have solved the puzzle. It was for example not possible to assign all of the largest postholes to such rows and we have not succeeded in interpreting the numerous shallower, smaller postholes.

3.8.5 Houses?

The rows of postholes cannot be functionally interpreted in isolation. We can however turn to the (admittedly scarce) evidence obtained at other sites for help. The chronologically and geographically closest frame of reference is provided by the contemporary house plans of Wateringen 4 (fig. 3.25) and Ypenburg, and the slightly younger (Vlaardingen group) plans of Haamstede and Vlaardingen.

The Wateringen plan (Raemakers *et al.* 1997) is two-aisled and measures 10.9 × 4.0 m. Four posts along the axial line, two of which were incorporated in the short walls, will have supported the ridge beam. They were set at distances of 4.2 to 3 m relative to one another. The wall posts were arranged on average 1 m apart along a slightly curved line. The postholes had varying diameters (up to 50 cm) and depths (up to 50 cm beneath the excavated level). The employed timber comprised stems of alders (central supports) and junipers (wall posts) with diameters of 6-16 cm, *i.e.* much smaller than the diameters of the features in which the surviving ends of the posts were found (Hänninen/Vermeeren 1995).

The three house plans of Ypenburg are two-aisled, 8-9 m long and 3.5-4.5 m wide (Koot in prep.). The postholes along the axial line set at varying distances relative to one another will have held the original roof supports and extra supports installed at a later date. The wall posts were spaced closely apart. The diameters of the postholes are 20-50 cm.

The largest and clearest plan of Haamstede-De Brabers (Verhart 1992) bears a close resemblance to that of Wateringen 4. The plan, which is also two-aisled, measures 9.1 × 3.8 m. One of the postholes that will have held the roof supports was situated in a short wall, the other three are in the interior. The distances between them vary from 1.5 to 4 m. The distances between the wall postholes are small, generally 50 cm. There where the distances appear to be much larger, postholes may have been overlooked. The holes that held the roof supports have diameters of 35 cm. They contained post moulds with diameters of 15-20 cm and depths of 50-60 cm relative to the excavated level. The wall posts were less sturdy, with diameters of approx. 15 cm and depths of 13-40 cm. There seems to have been a wall made of stakes between the wall posts. A second house plan found at this site was a good deal smaller (7 × 4 m).

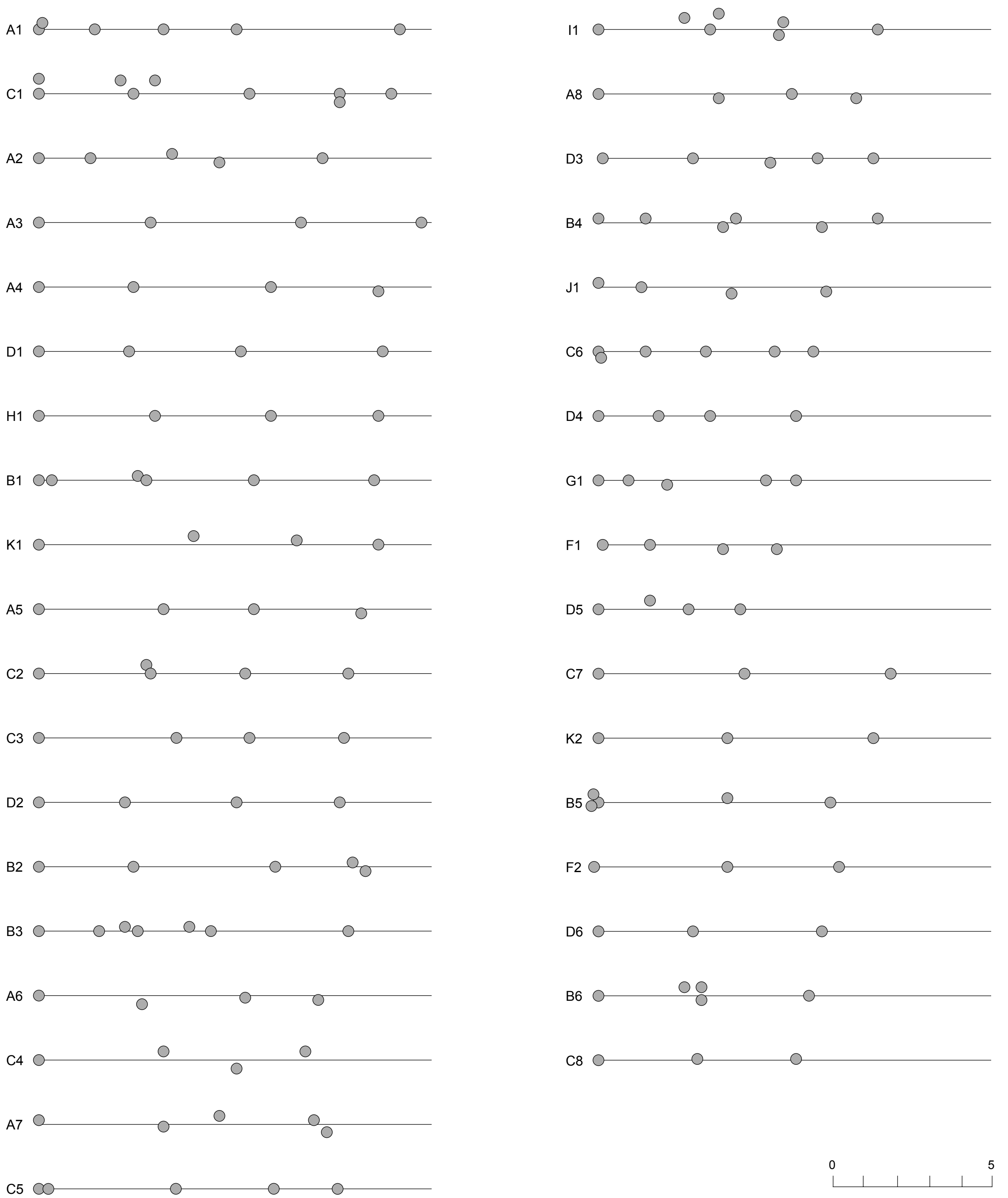

Figure 3.24 Selected rows of main postholes of the posthole clusters interpreted as the central rows of roof supports of small two-aisled houses. Row codes: cluster code plus serial number (scale 1:200).

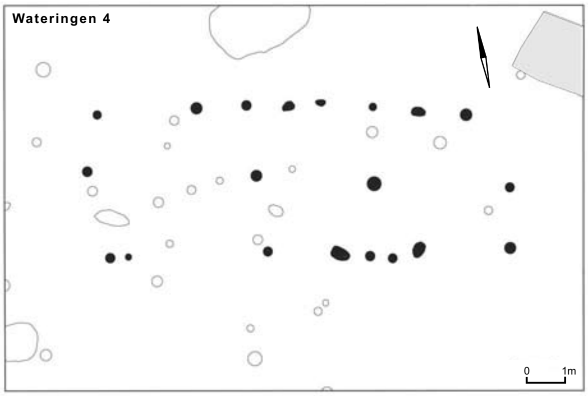

Figure 3.25 Wateringen 4, house plan of the Hazendonk group (scale 1:200).

The two-aisled plan that was found on the western levee at Vlaardingen measures 10 × 5.3 to 5.8 m, which means it is a lot wider than the other plans. The ridge beam was supported by six 10-16-cm-thick posts that were set 1.8-2.1 m apart and were evidently – judging from surviving ends – dug into the ground to a depth of 1.10 m. The associated postholes had diameters of 40 cm or more. The wall posts, which were arranged in slightly curving rows, were less sturdy. A second house, whose plan came to light on the other side of the creek, was much smaller (7.2(?) × 3.5 m, Glasbergen *et al*. 1966).

These plans of the four sites have a lot in common: they are all two-aisled, 9-11 m long and 3.5- 5.5 m wide. The irregular spacing of the central posts seems to be a characteristic feature of pre-Middle Bronze Age house plans in the Low Countries (pers. inf. S. Arnoldussen). The posts, in particular the central roof supports, of the Vlaardingen houses were somewhat more regularly arranged than those of the Hazendonk group. A conspicuous aspect of both the Wateringen and the Vlaardingen house are the slightly curved walls. The dimensions of the features correspond to those of Schipluiden. So why is it that we are unable to identify comparable plans at Schipluiden and can at best distinguish only single rows of relatively large postholes set at irregular distances relative to one another? There are two possible answers: the first is that there were no houses at Schipluiden, but other structures; the second is that the postholes of the identified rows held the roof supports, and that the postholes of the wall posts are not visible because they were lighter than those of the houses at Wateringen and Ypenburg. In view of the many arguments in favour of a normal settlement function for the Schipluiden settlement, the second option (rows of roof supports) is preferred.

Between one (F, G, H) and three (I) rows were identified in the northwestern, low-lying open clusters, with in the case of G evidence for replacement in the form of multiple features. From this we conclude that in the earliest phase of the occupation of the northwestern side of the dune there were for a few house generations at most four small houses, possibly no more than two if we regard F and G and H and I, respectively, as each other's successors. It is quite understandable that people will have built their houses in such somewhat sheltered locations next to the dune in the otherwise open landscape of this period.

On top of the dune we distinguished 5-11 rows per cluster: 8 in A, 6 in B, 11 in C, 5 in D/E and around 8 in K. As many features have not yet been interpreted in this manner, these figures should be seen as minimum figures. If these rows indeed represent the lines of the ridge beams of houses (excluding one another within a cluster), then this must mean that each identified cluster represents the frequent rebuilding of a house on the same spot. The fact that refuse was in all phases deposited over the entire southeastern waterfront strongly suggests that the houses represented by these clusters were in use at the same time, certainly in phases 2b and 3. We conclude that the rising water level forced the occupants to move their houses to a location on top of the dune at an early stage, possibly in phase 2a. People then continued to live there for at least eleven house generations in probably at most five contemporary houses. We may assume that some of the house sites (K, A) were in use for a longer period of time than others (D/E).

A house built from poor-quality timber (alder) will not have lasted very long. If we assume a house life of 15 years, we arrive at a minimum duration for the entire occupation period of a good two centuries. The ^{14}C chronology for phases 2b and 3 together spans roughly three centuries. Considering all the uncertainties, this is a good match. It should be borne in mind that these are the results of model calculations, based on the assumption that the rows of postholes represent the lines of ridge beams, and dependent on the numbers of rows identified per cluster, the synchronicity of the low- and high-lying clusters and the assumed life span of a house.

3.8.6 Rows of stake holes

In some places straight rows of relatively deep holes of stakes or thin posts were observed in the open areas between the posthole clusters. Most of these holes were deeper than 30 cm below level C, and the rows were at most 11 m long. Most of the holes were set 1-2.5 m apart. We may assume that the features do not represent parts (walls) of houses, because they appear to be totally unrelated to the assumed rows of roof supports. They are most probably the features of fences of structures other than the large enclosure. No comparable rows could be distinguished within the clusters due to the great multitude of features.

3.8.7 Posthole cluster in Units 1 and 2 (figs. 3.26-27)
When trench 22 was being mechanically dug, 29 ends of wooden posts were found next to the dune, at the base of the peat of Unit 1 and in the clay of Unit 2, above the foot of the dune. They were lying and standing dispersed in a cluster with a diameter of approx. 6 m. The posts had diameters of 3-8 cm and were generally at most 30 cm long, with one exception of 75 cm. Most of the ends of the posts had been sharpened into a point and had from an indeterminate level been driven through the clay of Unit 2 into the peat of Unit 1, in some cases into the underlying dune sand. Some of the pointed ends showed a burr, which will have been formed when the posts were driven into the ground (in particular into the sand). The weight of the layers that were later deposited on top of this part, in particular that of Unit 0, caused dense compaction of the peat, and in the process also compressed the posts like an accordion. ^{14}C analysis of these posts yielded a date of *c*. 2300-2050 cal BC, *i.e*. the Bell Beaker culture. By this time the groundwater had reached a level of around -2.5 m NAP (Van de Plassche 1982, 86) and the entire dune had been buried by the expanding peat, but its position may still have been recognisable by a different (higher) vegetation. The employed types of wood reflect the contemporary swampy environment: 18 determinations yielded 5× alder and 13× willow (section 11.6).

The absence of associated finds and the random arrangement of the remains make it impossible to say for what purpose these posts were driven into the ground.

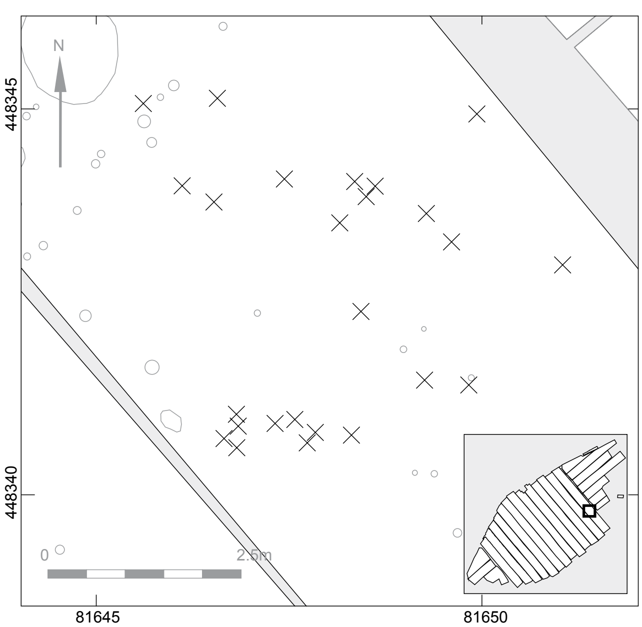

Figure 3.26 Cluster of posts (X) in peat Unit 1, trench 20, dated to 2300-2050 cal BC (scale 1:100).

Figure 3.27 Two posts of the post cluster in Unit 1 showing deformation resulting from later compaction.

3.9 Phasing

In the foregoing survey, attempts have been made to assign the different types of features to the stratigraphically distinguished occupation phases on the basis of various criteria. Those criteria are stratigraphy, the nature of the fills and the depth zone. Due to the rise in sea level and the associated rise in local groundwater level the dune gradually became 'submerged', *i.e*. covered with aquatic deposits, mainly peat. This means that the deepest features do not date from phases 2b or 3, but from the beginning of the occupation period, phases 1 and 2a.

The conclusions of the previous sections can be summarised per phase as follows.

Phase 1

Around 3600 cal BC the waterfront lay on the southeastern side of the dune. Refuse was deposited there over the entire length of the dune. It is not clear whether the low-lying postholes of clusters A, B and C and the concentration at the western end date from this early phase. What we do know for sure is that a child was buried in this phase (burial 5). On the other side of the dune the first wells were dug in this phase. This is taken to imply regular problems with fresh-water supplies. It is possible that one or two small houses were in this phase built in the areas of clusters F and I in this part of the dune. If there were any structures on top of the dune in this phase, their features cannot be distinguished from later features.

Phase 2a

After the site had been temporarily abandoned due to floods, it was soon taken in to use again, in the same general pattern, characterised by deposition along the waterfront and the digging of wells on the northwestern side. In spite of the short interruption in occupation, there is nevertheless evidence of continuity in spatial layout. The structures represented by the low-lying posthole clusters may still have been in use in (the earliest part of) this phase. Due to the unclear correlation between Units 19N and 18 on the southern side, the features can unfortunately not be as precisely classified as the remains that were found embedded along the waterfront.

A small area at the western end of the site was intended for rituals: cult depositions in a small pit and the burial of deceased in a small cemetery.

Phase 2b

Around 3500 cal BC, at the end of phase 2a, the dune was for the first time enclosed with a large fence. The fence was founded not in the sand, but just beyond it, in the peripheral zone of the swamp, and on the northwestern side enclosing all the old wells. In the course of phase 2b the fence – or at least the stretch along the southeastern side – was replaced twice by fences placed higher up the slope.

From this phase onwards people lived at the crown of the dune, at four or five contemporary house sites (A, B, C/E D). Wells were dug a little higher up the slope and at more disperse locations, especially around the western end of the dune.

The more intensive use of the top of the dune throughout the entire phase 2 led to the formation of an anthropogenic soil ('occupation layer') and colluviation along the edges (Unit 16).

Phase 3

Between 3500 and 3400 cal BC – in phase 3 – the level of the groundwater rose from -4.0 to -3.7 m. The top part of the dune projected no more than 1-0.5 m above the surface of the surrounding swamp and had by this time shrunk to a width of 30 m. The entire southeastern edge was still used for dumping refuse, showing that the entire crown was still occupied. The youngest fence (stretches 1 and 4) probably dates from this phase. Only a few wells were dug in this phase, probably because sufficient freshwater was naturally available in the surrounding swamp and the sea no longer penetrated to the site.

The small hut whose features came to light between clusters C, G and F may date from the final occupation phase.

After the occupation

A flood around 3200 cal BC, during which the clay of 02 was deposited, marked the end of the site's occupation. Nevertheless, people returned to the site from time to time, as can be inferred from two pieces of partly carbonised wood found in the west and a cluster of postholes in the east. The latter have been ^{14}C dated to the late Bell Beaker period, 2300-2050 cal BC. This find shows that people were by this time living elsewhere, and that the site had only a supporting function, probably as a fishing station.

notes

1 The word 'level' is here used to indicate a cleaned, slightly domed exposed surface following the stratigraphy.

2 We decided to use the word 'well' throughout this publication for the sake of brevity and conformity with earlier publications, although the features in question are merely pits and may have served as water supplies for people and cattle alike.

3 A single hearth pit of type 1 was recorded at Wateringen 4, too (Raemaekers *et al*. 1997). This now proves not to have been an incidental discovery. The difference in numbers again demonstrates the great difference in scale between the two sites.

4 We would like to thank Prof. dr W. Haio Zimmermann, *Niedersächsisches Institut für historischen Küstenforschung,* Wilhelmshaven, for the information and documents he provided on historical and traditional fences in Norway, Bohemia, Germany and Austria.

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4 The archaeological remains: a critical spatial approach

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Leendert Louwe Kooijmans

To what part of the archaeological remains that survived in the soil do our analyses and distribution maps relate? To what extent was the research target of total find recovery of all remains larger than 2 cm realised? How do the remains collected by hand and those recovered from the sieve relate to one another? What factors determine the spatial patterns of the different categories of remains and can any original activity areas still be identified, in spite of the preservation, erosion and recovery biases?

This chapter presents the results of a critical approach to the material basis of the research, and a spatial analysis based on the visualisation of large-scale patterns obtained via a moving average analysis of the primary data.

4.1 Introduction and objectives

The focus of this chapter and the ultimate objective of this investigation is to obtain an understanding of the settlement's original size and spatial differentiation, and of its continuity and/or discontinuity throughout the period of occupation based on the assumption that the distribution of the artefacts in relation to the features provides insight into the organisation and size of the local community.

The analysis is based on a critical approach to the representativeness of the primary data in the form of an assessment of the recovery processes. Two more factors that have to be assessed are the extent to which the recorded spatial patterns were determined not by occupation, but by natural processes, and the degree in which the original patterns – to be interpreted as specific activity areas – are still visible.

In addition to the horizontal patterns, the stratigraphy in the southeastern peripheral zone of the site also yields information that can be used in arriving at a chronological differentiation of the use of space, *i.e.* the dynamic character (or absence of such a character) of the local group.

The general spatial patterns of the different find categories presented here ultimately also yield a spatial context for the specialist analyses in the following chapters.

4.2 A critical analysis of the dataset and the recovery processes

The aim of the excavation of any find scatter is usually total find recovery. Sometimes the excavation method is specifically geared to that aim, comprising meticulous trowelling or systematic sieving through a specific mesh width. Usually, the collection method will however depend on the working methods and accuracy and available time, and the recovered remains will in terms of composition and distribution represent only a proportion of what had actually survived in the soil. We are well aware of this factor, but often tend to ignore or trivialise its implications.

4.2.1 Find collection

At Schipluiden it was decided to collect the remains by hand, partly in view of the site's size and the available capacity and partly on account of vulnerability considerations (use-wear traces, fragile bones). But we also set up a partial sieving programme to check the accuracy of our work. This programme comprised sieving the soil that was excavated (and had already been searched through) from a limited number of 1-metre broad strips running across the dune. So in these strips the aim of total find recovery was realised: all remains larger than the 4 mm mesh width were recovered. On the basis of the remains recovered from these 'sieved strips' statements can be made on the accuracy of the manual collection method, the quantity and composition of the remains that were not recovered and the representativeness of ratios and patterns in the analysis of the recovered remains. It is even possible – and in some cases advisable – to extrapolate the data of such sieve residues to the entire excavation for the purpose of correcting the ratios of manually collected remains. See for example the beads in chapter 9. Such correction is of course not feasible in the case of spatial patterns.

4.2.2 Manually collected remains

The data available for the spatial analysis consist primarily of the remains that were collected by hand from the different layers. The layers concerned were excavated in segments of 1 × 1 metre and per lithological unit, following the geological stratification. Each find unit had a maximum thickness of 10 cm. There where a lithological unit was found to be thicker, a new level was defined after 10 cm, which was assigned the same layer code as that of the level above it.

In the field each layer was assigned a four-digit code to distinguish the layers from the features. The layer codes comprise a prefix (20, 40, 60, 80) referring to one of the four sides of the dune and a suffix referring to the layer concerned (10, 11, 17, 18, 19 or 20) (see section 2.1). Below, only the suffixes will be used in referring to the various lithological units.

The find-collection method involved shovelling the soil by hand. In the design it was assumed that this would already lead to the recovery of all finds larger than 2 cm, providing that the work would be done by skilled field workers, in this case students in archaeology.

The collected remains were during the fieldwork sorted according to find category, counted and weighed. The resulting dataset was used in the analyses discussed in this chapter. It was found that some of the finds had been incorrectly categorised, in spite of the field workers' dedicated efforts. It is difficult to assess the impact of those errors on the identifications, but they seem to have had only little influence on the general distribution maps.

The finds were too numerous for the specialists to process them all. They therefore coded only a selection of the total number, employing for each category a lower limit based on the finds' informative value. In the case of pottery, for example, only sherds weighing more than 10 grams were coded. The lower limit chosen for stone artefacts was 2 grams, that for flint was 'modification' and that for zoological remains 'the possibility of identification to species level'. The distribution maps of the material specialists hence provide selective impressions. The 'field data' is actually the only source that can be used to obtain an overall picture of the spatial distribution of the finds.

The employed basic find-registration method enabled us to draw detailed distribution maps per find category (in numbers and weights) for the individual excavation levels and the individual lithological Units, or combined for all the manually collected remains from certain layers or all layers together.

4.2.3 *The sieved strips*

A sieving programme was carried out to check the accuracy of the manual collection method. The soil from a strip with a width of one metre in the 6 metre-broad trenches was sieved through a mesh width of 4 mm. In this way the effectiveness of the manual collection method was tested in a number of strips running transversely across the dune. It was assumed in advance that this sieving programme would ensure the recovery of all small artefacts (of 4 to 20 mm), but also any larger ones that had been overlooked during the shovelling.

The efficiency of this time-consuming sieving procedure was assessed already during the fieldwork by studying the results obtained for the first trenches. The data of transverse sections across the dune were visually compared by studying the number of finds collected by hand from the entire 6-m-broad trench in relation to the number of finds collected from the 1-m-broad 'sieved strip'. This comparison is here illustrated on the basis of the flint artefacts from trench 14 (fig. 4.1). The two distribution patterns across the dune prove to be very similar. So the sieving programme yielded little new spatial information. This meant that the excavation strategy could without objection be adapted halfway the fieldwork. Only the soil from the strips in each evenly numbered trench was sieved and no soil was sieved from the oddly numbered trenches, so that the available working capacity could be used elsewhere. The sieving programme can hence be regarded as a 1/12 systematic sample.

4.2.4 *The composition of the finds*

So before the work was started it was assumed that the manually collected remains, on which the distribution maps and the spatial analysis described below are based, would reliably represent the artefacts larger than 20 mm. In view of the employed collection method, smaller finds would not, or virtually not, end up in this dataset, but would exclusively be recovered via the sieving of the soil from the evenly numbered trenches. After the fieldwork, the correctness of this assumption was checked for the pottery and flint from the sieved strips in trenches 10 and 18. The length (largest measurement) of all the collected artefacts was determined and the size distributions were compared. This was done for the pottery by the first author and for the flint by Annelou van Gijn (see chapter 7).

Flint

The absolute numbers of manually collected flint artefacts are small, but they nevertheless clearly reveal a broad distribution, with a peak in the 12-14-mm fraction (fig. 4.2). The number of small flint artefacts, with lengths from approx. 8-12 mm upwards, is surprisingly high. The finds recovered from the sieve fractions also show a skewed distribution, with a narrow peak at 6-8 mm and a fairly steep decline in the larger sizes, to a maximum length of 36 mm. Relatively few large artefacts were encountered in the sieving, but in absolute numbers they nevertheless exceed the manually collected finds over a long trajectory. With increasing size, the proportion of manually collected finds gradually increases from 50% at approx. 22 mm to 100% at 36 mm.

A dilemma is that increasing the lower limit of the dimensions of the manually collected flint finds causes the distribution patterns of the numbers to become completer, and hence also more representative, but also emptier. For example, 70% of the flint artefacts of the fraction larger than 28 mm were collected by hand. The distribution pattern of these finds may be more reliable, but the number of finds

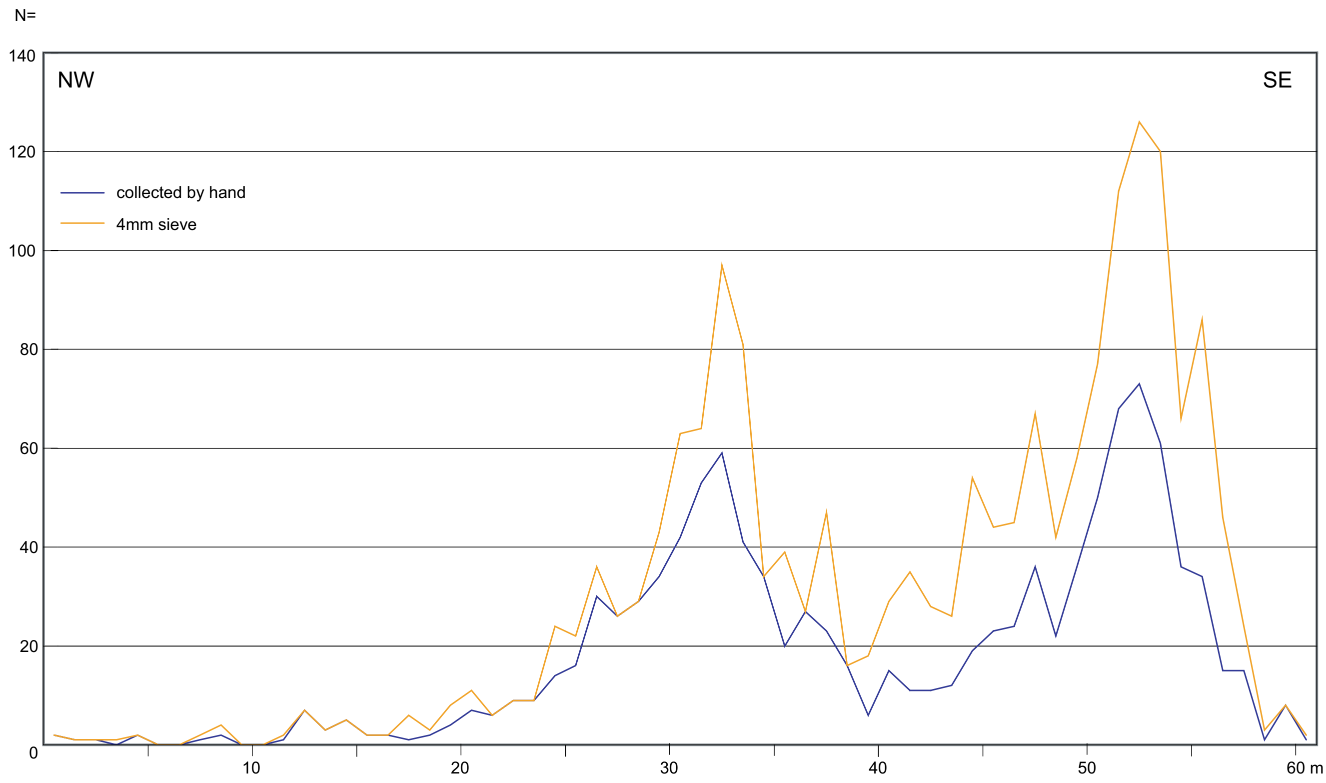


Figure 4.1 Flint, numbers collected by hand and by wet-sieving through a 4-mm mesh of the soil from a one-metre strip in trench 14 dug in a NW-SE section across the dune.

from trenches 10 and 18 is only 22. The majority of the manually collected flint artefacts in the general distribution maps (fig. 4.10) prove to belong not to the >20 mm fraction (as initially assumed), but to the 8-28 mm fraction. That is however also the fraction in which fairly large quantities of additional finds were encountered in the sieving.

Pottery

In the case of pottery the size determination was less reliable than in the case of flint artefacts, largely owing to (secondary) fracture and the poor identifiability of sherds of 2-6 mm. The diagrams should therefore be interpreted with some caution (fig. 4.3). The diagram obtained for the manually collected finds – again based on relatively small numbers – shows a wide range, representing sherds of 8-36 mm. That obtained for the much larger numbers of finds from the sieve residues shows a narrow peak at 4-10 mm, followed by a fairly gradual decrease to a maximum of 64 mm. In the case of pottery, too, the manually collected finds start to predominate only gradually with increasing size. Only in the fraction of sherds larger than 32 mm does the proportion of manually collected finds exceed 70%. The sherds in question, from trenches 10 and 18 together, are only 54 in total. Contrary to what had been assumed in the design, fairly large quantities of small sherds (from 4 mm upwards) were evidently collected during the shoveling. The distribution maps consequently display a substantial proportion of these small pottery sherds.

Maps showing exclusively flint artefacts larger than 28 mm or sherds larger than 32 mm would provide a more reliable picture of the artefacts' distribution. Such maps can however not be drawn on the basis of the field data because not all the individual artefacts were measured during the fieldwork. The distribution maps of the specialists illustrated in the chapters will fortunately bypass these limitations.

4.2.5 Conclusions

A number of conclusions can be drawn from the above comparison of the manually collected finds and the finds recovered from the 4-mm sieve residues.

First of all, the aim to collect all finds larger than the specified minimum of 2 cm by hand was not realised. This does not necessarily mean that the collection procedure was too coarse or too inaccurate; it simply shows us the actual

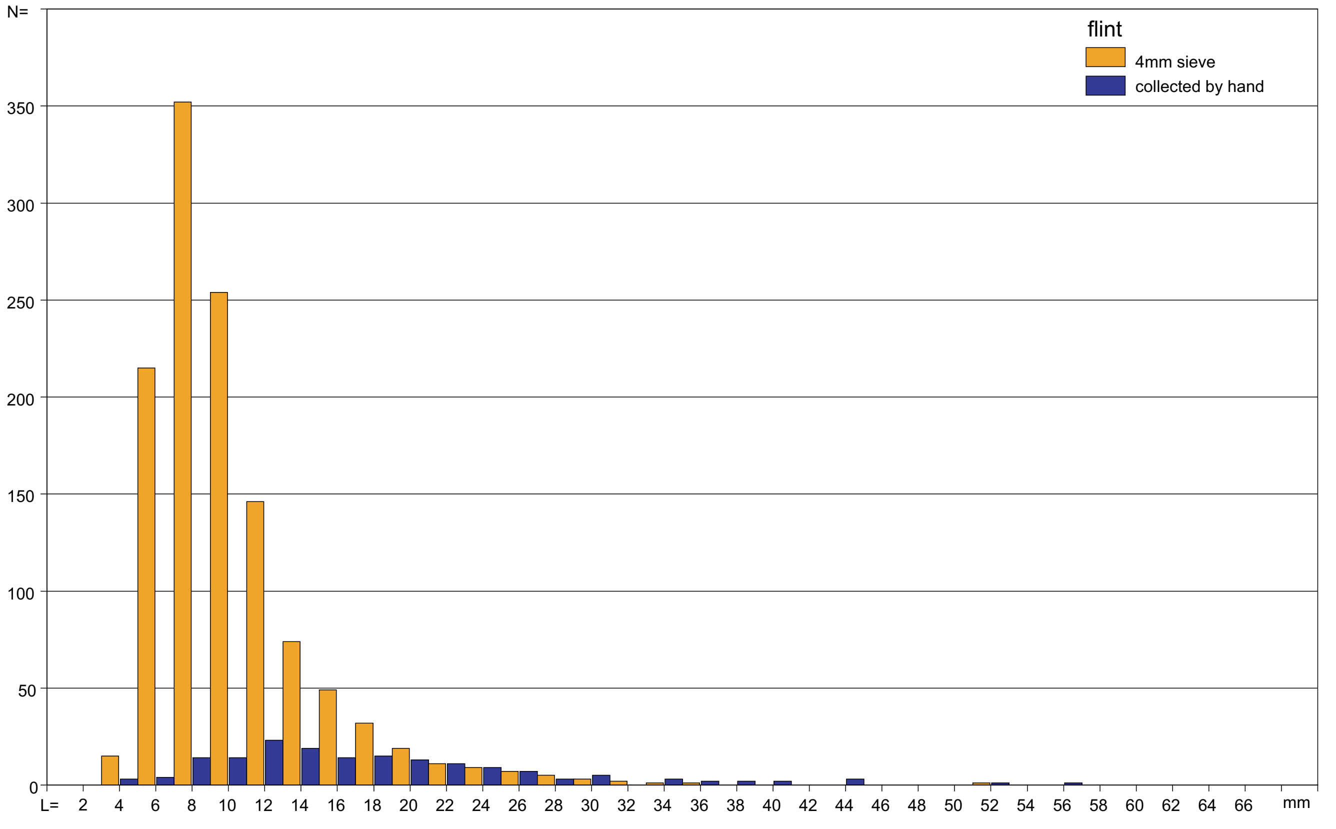


Figure 4.2 Flint, numbers per dimension class (lengths) in trenches 10 and 18. Remains collected by hand and recovered from the 4-mm sieve residues from the rows of segments.

result of the employed method, which has never before been evaluated in this manner. Under the practical conditions at Schipluiden, the lower limit for 'almost total' (approximately 70%) manual find recovery proved to lie not at 2 cm, but more around 3 cm in the case of both flint and pottery.

The second conclusion is that the manual collection with shovels did lead to the recovery of a large number of small finds, but the fraction decreased along with the dimensions. This is of course not surprising: in practice it is impossible to advise field workers/students not to collect such small finds, or to discard any such small finds once they have been collected because the fraction concerned will at a later stage be recovered by sieving. It is however clear that the finds comprise largely overlapping artefact populations rather than individual populations.

In the third place, total find recovery was realised for finds > 4 mm only in the 'sieved strips'. The area concerned covers approx. 8% (1/12) of the excavated area. By comparing the find ratios of this sample with those of the manually collected finds from the entire excavated area it is possible to estimate the actual numbers of finds. This is of course of particular interest in the case of categories of small artefacts such as beads (chapter 9) and certain types of flint artefacts (chapter 7).

The 'actual' ratios may differ substantially from the archaeologically recorded ones. This – needless to say – once again shows that adding up the finds recovered according to the two collection methods has sense only from an administrative viewpoint, not a scientific one.

All this has important consequences for the distribution maps per artefact category of the manually collected finds. Many of the finds illustrated in those maps come from an incompletely collected fraction. The smaller the finds, the less representative they are of the actual number of finds.

The employed collection method implied a systematic discrepancy between the artefacts that were still preserved in the soil in early 2002 (the sample population) and those actually included in the sample that are available for the spatial analysis. This recovery bias cannot be corrected, but it may be assumed to have more or less the same influence on almost all the distribution maps showing *numbers* of finds.

The manual collection of large quantities of small finds along with larger finds of course has a much greater effect on

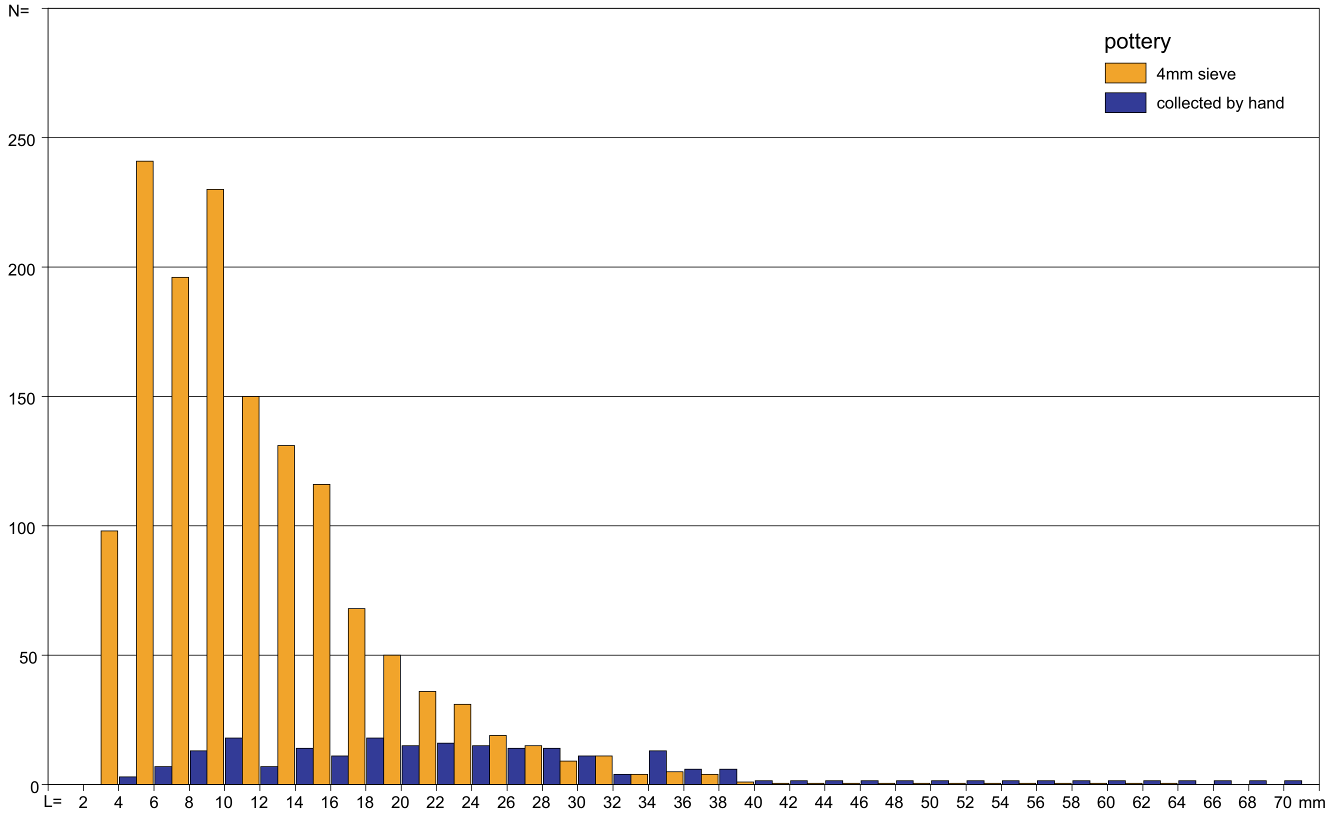


Figure 4.3 Pottery, numbers of sherds per dimension class in trenches 10 and 18. Remains collected by hand and recovered from the 4-mm sieve residues from the rows of segments.

distribution maps based on numbers of finds than on those based on the weights of finds per segment. In principle, the latter are hence more reliable and more representative than the former. In the case of Schipluiden, the two distribution maps of all the find categories are however very similar, implying that the large and small artefacts in each case occurred together, in the same find areas.

Local contrasts in the artefact density per m^2 will have been enhanced by personal differences in working accuracy. Such differences will however have only a limited influence on the larger patterns because a more or less equal percentage of the remains will in general have been overlooked, and the only effect is a weaker general picture. The ideal solution under these conditions is smoothing according to the moving average method.

4.3 Interfering geological processes

4.3.1 Zones of erosion and embedding, weathering and preservation

For a time span of several centuries, largely coinciding with the period of occupation, the dune was exposed and suffered the consequences of natural 'postdepositional' processes such as soil formation, bioturbation, trampling and colluviation, erosion and the deposition of sediments. Insofar as they affected the features, these processes have been described in detail in chapters 2 and 3. These processes, but to a great extent also (selective) weathering, played a tremendously important role in the formation of the find patterns, both during and after the period of occupation. Viewed from this perspective, the site has a concentric structure and five zones can be distinguished in the maps, which are closely associated with the dune's contours from high to low (fig. 4.4):

1) a zone at the top of the dune where the entire occupation level has disappeared due to erosion in much later times and the artefacts remaining on the dune and their distribution patterns were lost entirely;
2) a surrounding zone in which part of the occupation level has disappeared and the find densities are hence proportionally lower;
3) a zone in which the entire occupation level has survived, but where selective weathering and other postdepositional processes have been of dominant influence;

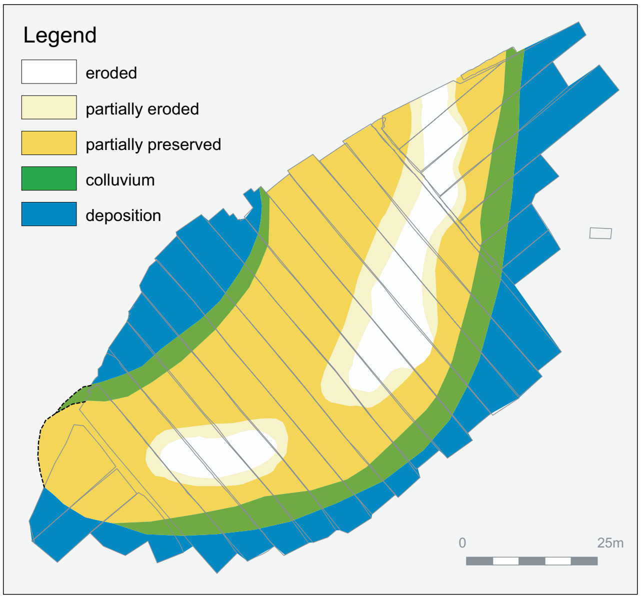


Figure 4.4 The five zones of preservation distinguished on the dune. In the 'partially preserved' zone the 'occupation layer' was not eroded, but organic remains were not, or poorly preserved.

4) a colluviation zone at the foot of the dune, where remains washed down from the dune accumulated and became mixed with primarily deposited remains. This zone has been affected by the aforementioned distortion processes to a limited extent;
5) a deposition zone in the surrounding aquatic deposits in which distribution patterns and the ratios of the different find categories have survived virtually unchanged.

The limits between these zones are naturally vague, but nevertheless quite useful, certainly as contexts for interpretations.

4.3.2 The features as a frame of reference

Like the archaeological remains, the features, too, reflect former activity areas. The features moreover present the advantage of not having been affected or moved by selective weathering, *etc*. It should however be added that all features that were shallower than 40 cm have disappeared due to the formation of the occupation level (Unit 20). By a stroke of luck, the erosion of the top of the dune however nowhere extended beyond the 'features level', so, in an entirely different form, the features – contrary to the find scatters – do provide a representative picture of activity areas high up the dune, and in particular also on top of it.

As we were particularly interested in the places where the standard domestic activities took place, we focused on the clusters of large postholes, which are assumed to represent house sites, as argued in chapter 3. The areas containing the large features (pit fills) we left out of consideration as the pits concerned show a more scattered distribution and we assume that they were (also) dug at the periphery of the occupation area and outside the farmyards. A smoothed local density analysis was then performed to visualise at a higher level of abstraction the concentration areas of postholes extending deeper than 20 cm beneath the excavation level and having a cross-section of >20 cm (fig. 4.5). This revealed four distinct clusters (A-D), the same as those that were already distinguished in a more impressionistic approach (section 3.8.3). The smaller clusters (E-K) did not come out in this analysis. For their further interpretation, in particular that of the divisions, we refer to the final conclusions (section 4.9).

These 'posthole areas' largely coincide with zones 1 and 2 distinguished above and partly extend into zone 3. Only the fringes of the find concentrations originally associated with those zones have survived, in particular the waste-disposal areas in zones 4 and 5.

These posthole clusters, representing primary activity areas and possible farmyards, will below be compared with the concentration areas observable in the find distributions, and will play a role in the interpretation of those distributions.

4.4 Method of spatial analysis

4.4.1 Spatial analysis techniques

In the spatial analysis efforts were made to visualise increases and decreases in the find densities as distinctly as possible, and to explain the patterns on the basis of the aforementioned formation processes: where do geological or research factors play a role in the final picture and where are there indications of different activity zones?

In the distribution maps, grouped classifications were used for both the counts and the weights of the finds. The quantities are represented by a limited number of colours, increasing in shade intensity. The classes were distinguished by a technique implemented as natural break in MapInfo with which the differentiation at low find densities was made more distinct than that at high find densities.

The moving average method was used to smooth the sometimes quite substantial differences between adjacent segments. These differences appeared to relate to differences in the accuracy of the excavators, local preservation and small-scale deposition patterns (<1 m), whereas our aim was to identify preservation zones and larger activity areas. With this technique the level of generalisation can be adjusted. For Schipluiden we decided to calculate a moving (unweighed) average of the counts and weights for segments measuring 3 × 3, 5 × 5 and 9 × 9 m. When such a template is enlarged, local details gradually give way to more general trends in distribution (figs. 4.6a-d). A disadvantage is that limits that were originally sharp and clearly defined become vague. But allowance can be made for this in the interpretation. The

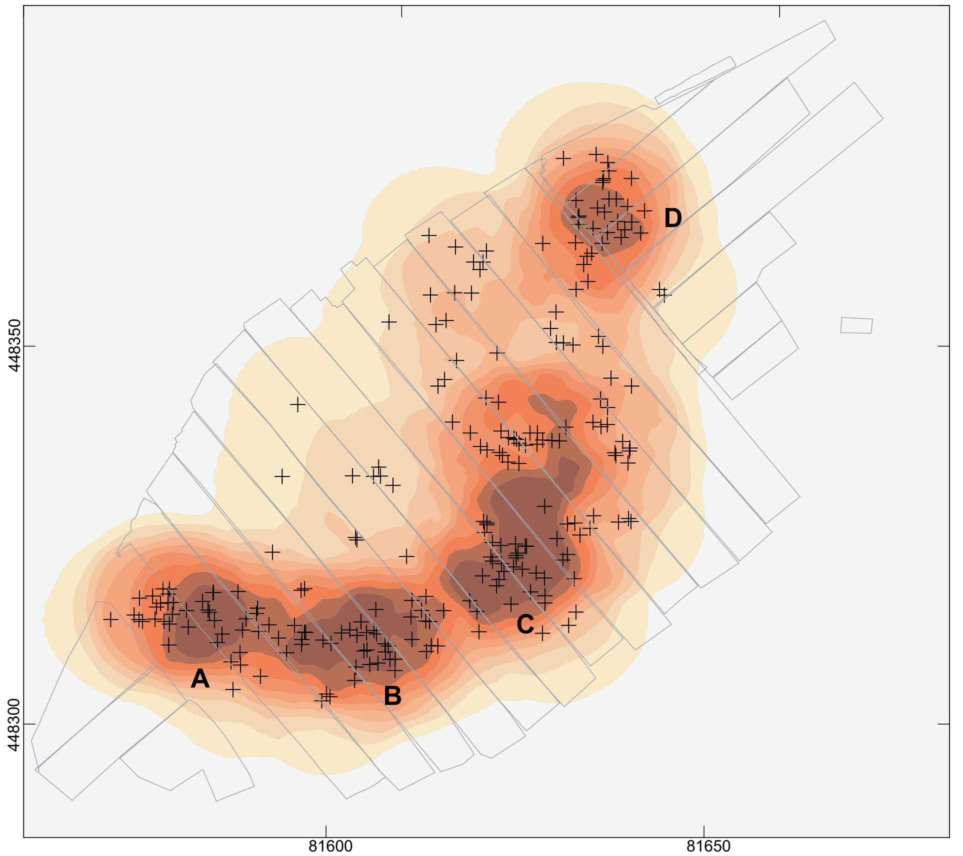


Figure 4.5 Smoothed results of local density analysis of postholes deeper than 20 cm with diameters >20 cm showing four distinct clusters A-D (scale 1:1000).

moving average technique was applied only to the three most important find categories, notably pottery, flint and bone. In the spatial analysis of Schipluiden different types of distribution maps were placed side by side to obtain a good visual impression of the relative find densities. The different visualisations complement one another.

4.4.2 Spatial analysis of stratigraphic sites

The Schipluiden site is a dune with remains stratigraphically embedded in (natural) deposits along its flanks. It was not possible to determine the chronological span of the remains with any greater accuracy than a few (two to three) centuries (chapter 2).

First the different lithological units and the number of levels in which they were excavated were visualised. It was found that finds had not been uniformly assigned to the different layers during the fieldwork. The assignment varied from trench to trench due to our advancing insight (during the excavation and the analysis) into the site's stratigraphy, local (geological) factors or unclear limits between individual layers or erroneous interpretations. Layer assignments that were evidently incorrect were corrected where possible before this analysis. Seven layers were ultimately identified in the spatial analysis (fig. 4.7). Unit 19N will be considered separately here due to its less clear stratigraphic assignment.

It was not easy to determine relations between the site's geological stratification and human activities (phasing) (see chapter 2). This can probably best be illustrated by the following example. Units 15/16 consist of a colluvium comprising deposits accumulated by aeolian action and rainwash that were affected by trampling. This colluvium was identifiable as a separate layer only above Units 17/18. It extended laterally into Unit 20. Colluviation will certainly have occurred in the area of Unit 20, too, but it was not identifiable as such in that Unit. Some of the finds recovered from Units 15/16 made their way into those units from higher layers. They may in principle therefore date from any time in the entire preceding period of occupation. So the finds cannot be indisputably dated to a specific phase. Some important units (Unit 20) span the entire period of occupation, whereas others (Units 15/16 and 11) to varying extents contain secondarily admixed older artefacts. The study of the pottery (section 6.5.2) incidentally showed that this factor was not that influential in practice, and it was

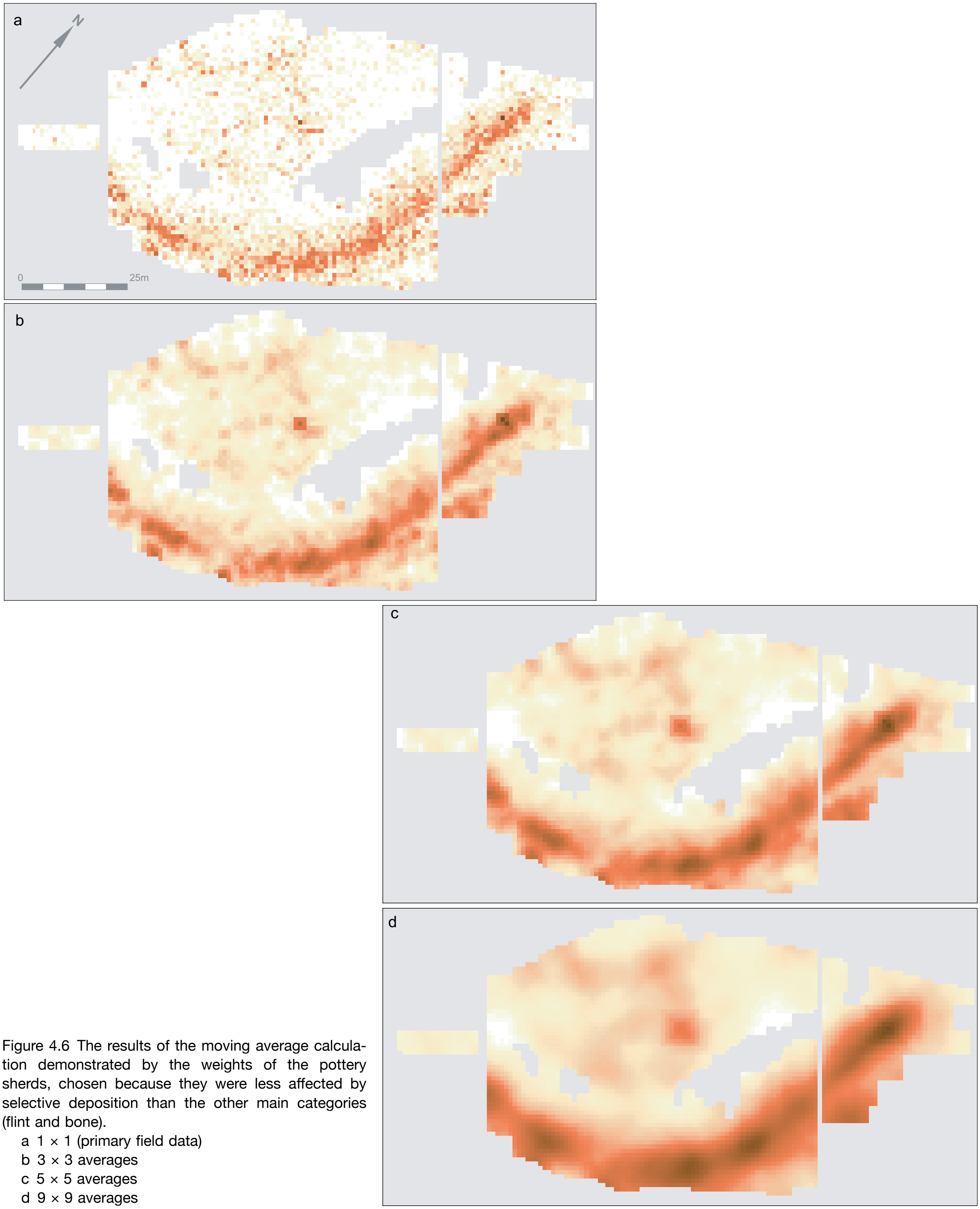


Figure 4.6 The results of the moving average calculation demonstrated by the weights of the pottery sherds, chosen because they were less affected by selective deposition than the other main categories (flint and bone).
a 1 × 1 (primary field data)
b 3 × 3 averages
c 5 × 5 averages
d 9 × 9 averages

therefore ignored in those analyses. Only remains from the southeastern side of the dune could be unambiguously phased on the basis of the local stratigraphic sequence of Units 19S, 17/18, 15/16 and 10/11.

In the spatial analysis of Schipluiden all the stratigraphic data were first of all combined and the outcomes were studied per find category. After that attempts were made to add a dynamic, diachronic component based on the phased distributions in the southeastern peripheral zone.

4.5 RESULTS

4.5.1 Layer thickness and erosion

The 'occupation layers', which had an overall depth of at most 50 cm, were excavated at a number of different levels. This number of levels (spits) can be used as an indication of the thickness of the overall find layer (fig. 4.8). The layer was thickest on the flanks of the dune, both on the fairly steep southeastern side and on the less steep northwestern flank. There proved to be a relation between the thickness of the find layers and the numbers of finds per square metre. Thicker find layers were excavated in more spits, which led to higher find densities in particular in the case of the colluvium and the trampling horizons.

At the top of the dune Dunkirk I erosion had caused major gaps in the distribution patterns. Clearly visible is the zone (1) where the occupation layers had completely disappeared due to erosion and no segments were excavated. This zone comprises four irregular linked areas, in which Unit 00 was directly, erosively based on the virgin dune sand (Unit 25). These areas represent the (originally) highest parts of the dune. Outside this zone the influence of erosion was still visible in a transitional zone with a width of 3 to 4 m, in which an occupation layer was excavated that was found to be entirely devoid of finds (fig. 4.9). Next comes a zone (2) with a width of 5 to 6 m with a low find density. This is best illustrated by the flint distribution map, which shows substantially lower find densities next to the eroded areas (fig. 4.10). This find category suffered comparatively little influence of selective weathering.

The spatial differentiation of the erosion makes it more difficult to interpret the artefact distributions. In the following discussion of the spatial distributions of the different find categories, figures 4.8 and 4.9 should therefore be used as frames of reference.

All the finds that were recovered by hand from the various layers were first of all collectively indicated in a single distribution map. The individual maps hence represent several centuries of occupation during which the lower limit of the area suitable for occupation (the boundary between the dune and the surrounding swamp) moved up the dune flanks, *i.e.* inwards in the maps.

4.5.2 Flint (figs. 4.10, 7.1)

In total, more than 15,000 flint artefacts with an overall weight of more than 53 kg were collected by hand (table 4.1). Flint is one of the few find categories to have a distribution map that is not affected by selective weathering. This find category therefore provides the best impression of the distribution of material remains on the dune slopes.

Like almost all the spatial distributions, that of the flint artefacts shows large numbers of finds on the southeastern side of the dune, in a zone with a width of almost 10 m with a remarkably sharp boundary along the low side lying just within the aquatic deposits. The flint artefacts were evidently

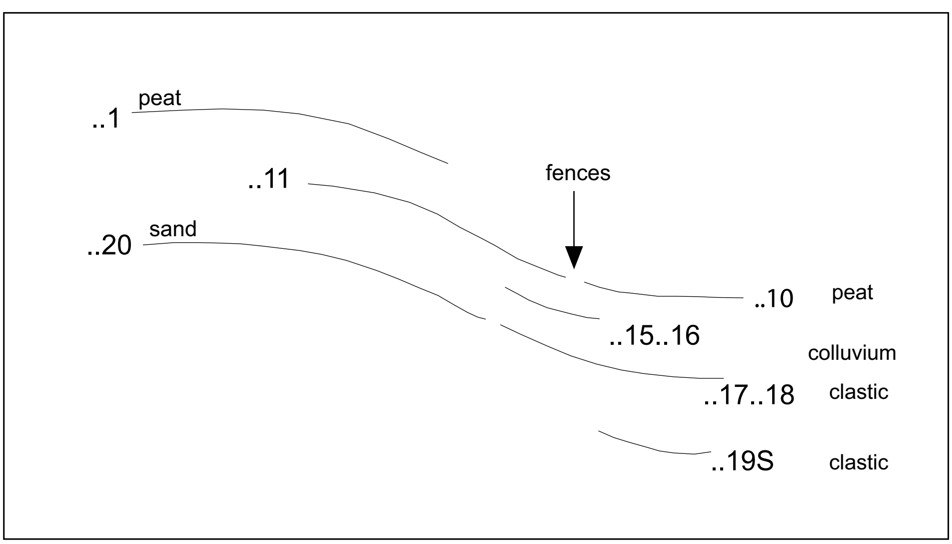


Figure 4.7 Schematic model of the sequence of the successive lithological units on the southeastern slope of the dune.

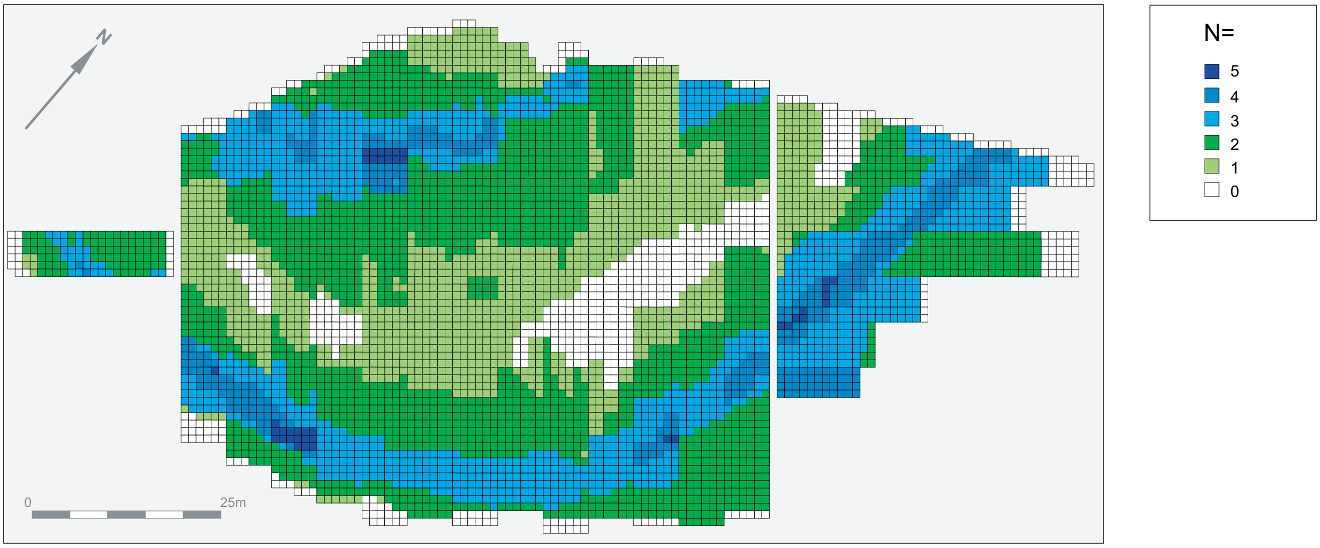


Figure 4.8 Number of excavated spits per segment.

collected by hand	N=	weight (kg)
flint	15,401	53.4
pottery	29,318	155.1
bone	73,187	161.8
stone	4,587	47.7
charcoal	5,650	2.4
loam	657	2.9

Table 4.1 Categories of manually collected archaeological finds; total numbers and weights.

discarded on the flank of the dune and/or ended up there as a result of colluviation. Substantially fewer flint artefacts were found on the less steep northwestern flank. This cannot be attributed to postdepositional processes. A western and a central concentration of finds visible in that area most probably represent activity areas. Flint finds were scarcer in a northerly direction. On this side, too, virtually no flint artefacts were found in the low-lying wet area next to the dune.

A few segments with higher find densities are observable in the find zone on the southeastern side, especially in the maps based on find weights. They are even more distinct in the moving average maps. At an increasing degree of generalisation an unmistakable concentration emerges in the southwestern corner (B) and three less distinct concentrations at the centre and in the (north)east (C, D). The remains concerned appear to represent refuse from adjacent activity areas on the dune.

In the top part of the dune the complete and partial – and irregular – erosion is an important factor affecting distribution patterns in a zone with a width of around 15 m. We assume that the limits of the described find scatters high up the dune slopes were determined by erosion, and that they originally lay within this zone further up the slopes.

As classes with equal widths were used in the moving averages basic map, the degree of differentiation is less at low find densities, and some isolated segments with exceptionally large numbers of finds clearly stand out, even at an increasing degree of generalisation, such as find no. 1930 (trench 16, segment 282, 74 flint artefacts, 28.5 grams). These segments indicate a specific activity or deposition.

4.5.3 Pottery (figs. 4.11, 6.9)

More than 29,000 sherds with a total weight of 155 kg (table 4.1) were collected by hand. Pottery is less suitable for identifying activity areas on the dune than flint because for the time that it lay exposed at the surface, the pottery was subject to trampling and selective weathering by varying moisture conditions and frost.

In contrast to that of the flint, the distribution of the pottery shows a conspicuous narrow band with a width of around 5 m with higher find densities at the foot of the southeastern flank. This band largely coincides with the colluvium (Units 15/16) and the area where the fences stood. It is a zone combining special deposition and favourable embedding conditions. Within this zone a number of find concentrations are distinguishable: a distinct (double) concentration in the (north)eastern corner (D), a series of smaller concentrations (C) in the central part and another double concentration (B) at the western end. The pattern is

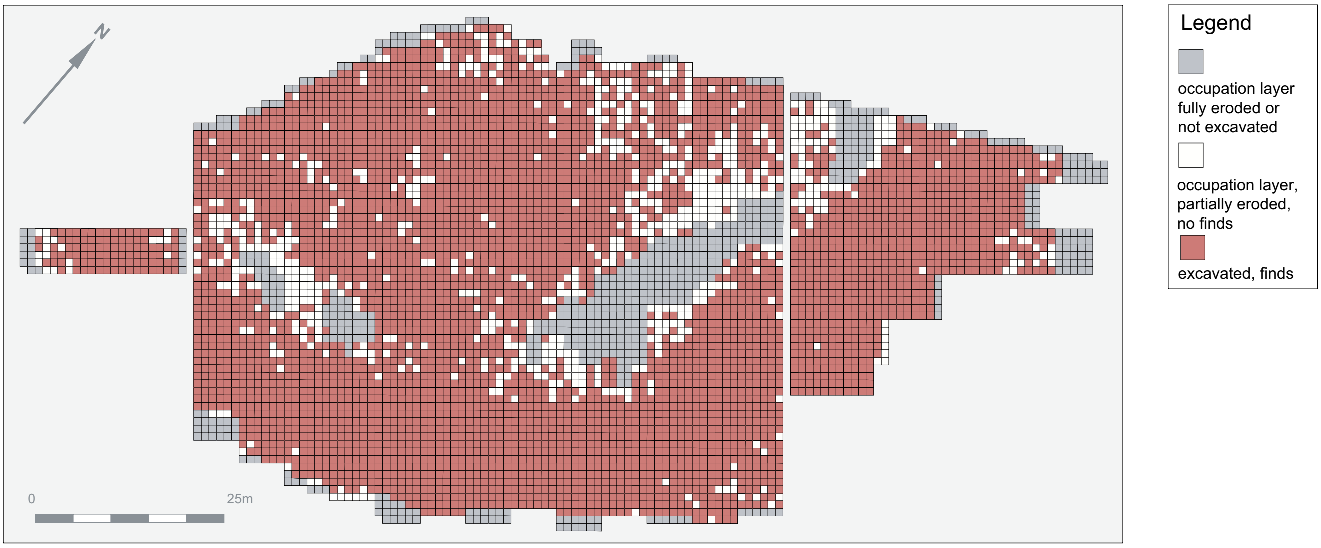


Figure 4.9 Presence or absence of manually collected finds.

somewhat more differentiated than that of the flint artefacts. In the northeast, at some distance from the foot of the dune, in the sedimentation area and next to the trampling zone, is another isolated find concentration that was only partly excavated. (D*). Generally speaking, pottery was found in the aquatic deposits at much greater distances from the dune than flint artefacts. This cannot be attributable to selective preservation; instead, it must be a consequence of differences in disposal. It would seem that fractured pottery was deliberately thrown (far) away, in a classic toss zone.
The flint artefacts will to a much greater extent have been affected by natural processes (colluviation) in the areas where they were discarded.

The parts of the northwestern flank of the dune outside the eroded zone contained a uniform, thin find scatter that was devoid of concentrations, even in the moving average maps. There, too, the find scatter extended into the marshy zone outside the dune. We assume that this side of the dune formed part of the area where the occupants performed their daily activities, and that the find densities were substantially reduced through selective weathering between the period of occupation and the time when the remains became buried beneath the surface, which will have obliterated any patterns originally present. This makes one segment with an exceptionally large number of finds at the centre of this area quite remarkable. This segment, which yielded 262 sherds with a total weight of 891 grams (nos. 7095, 7098 and 7681, trench 17, segment 304) remained clearly visible in all the generalisations.

The distributions of the pottery likewise seem to show the fringes of find areas of which large parts higher up the dune have been obliterated by erosion and selective weathering. The pottery patterns differ from the flint patterns in that they display more detailed concentrations on the southeastern flank and extend further into the low surroundings of the dune. In overall layout they are however quite similar.

4.5.4 *Bone* (figs. 4.12, 22.1)

In total, more than 73,000 bone fragments with an overall weight of almost 162 kg were collected by hand (table 4.1). The segments with the largest concentrations yielded more than 1000 (small) fragments (estimated count), or a weight of almost 2 kilos. Preservation was an important factor in determining the distribution pattern: bone was found almost exclusively in the wet peripheral zones of the dune and was almost completely absent in the dry sandy deposits. The sharp upper limit was determined by preservation. Two concentrations, one in the southwest (B) and the other in the northeast (D), seem to be the outcomes of deposition in a late occupation phase (see section 4.8.4).

The distribution maps obtained for bone closely resemble those of the pottery finds. The remains were indisputably concentrated along the southeastern edge of the dune, in a zone with a width of around 5 m which as it were enclosed the entire dune on that side. The southwestern and north-eastern ends of this zone lay within the limits of the excavated area. This zone with high densities lies a little further away from the dune than that observable in the pottery maps and is also larger. As in the case of the pottery, the generalised maps reveal a (double) concentration (D) in the (north)eastern corner of this zone and a second, narrow zone with a high

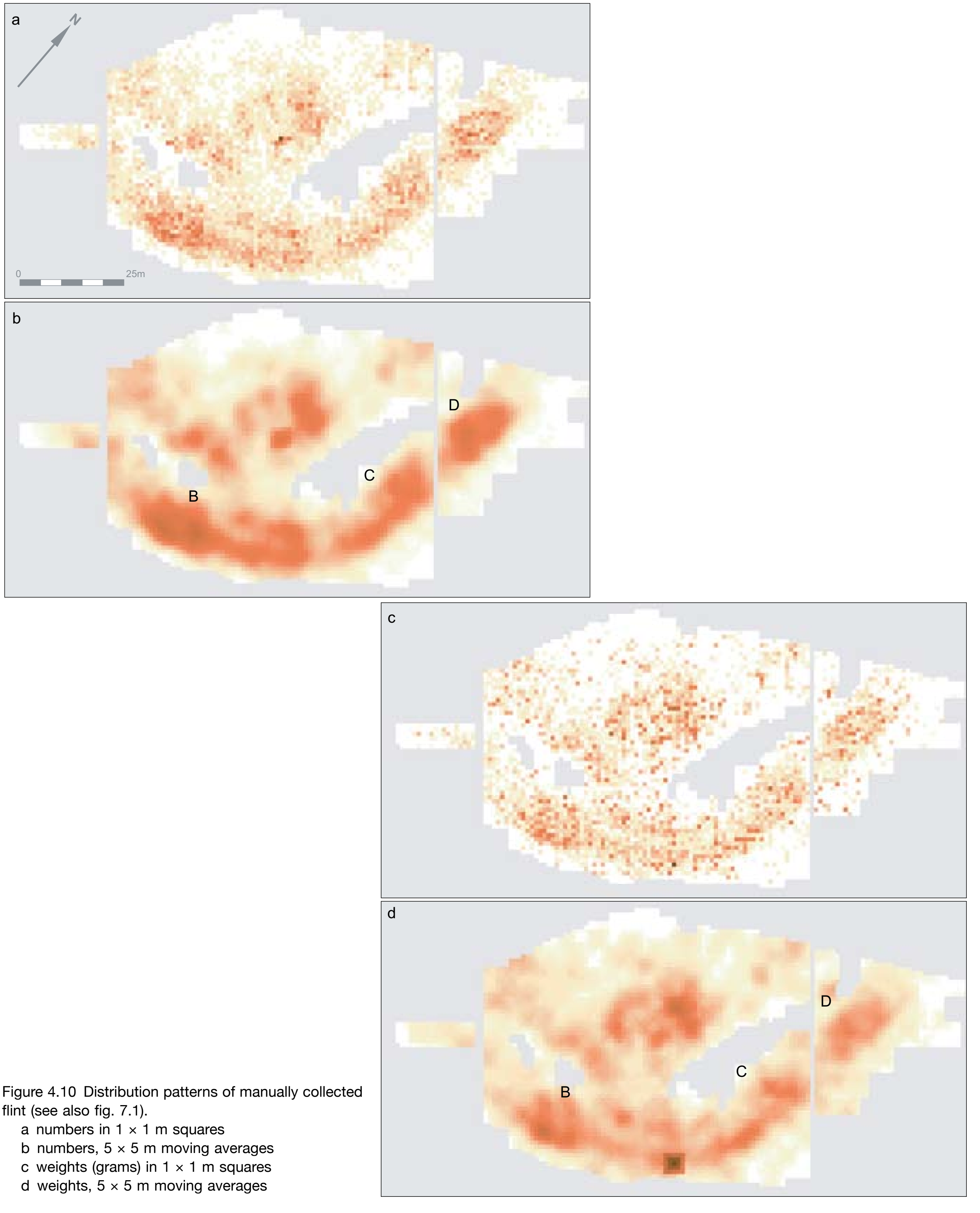


Figure 4.10 Distribution patterns of manually collected flint (see also fig. 7.1).
a numbers in 1 × 1 m squares
b numbers, 5 × 5 m moving averages
c weights (grams) in 1 × 1 m squares
d weights, 5 × 5 m moving averages

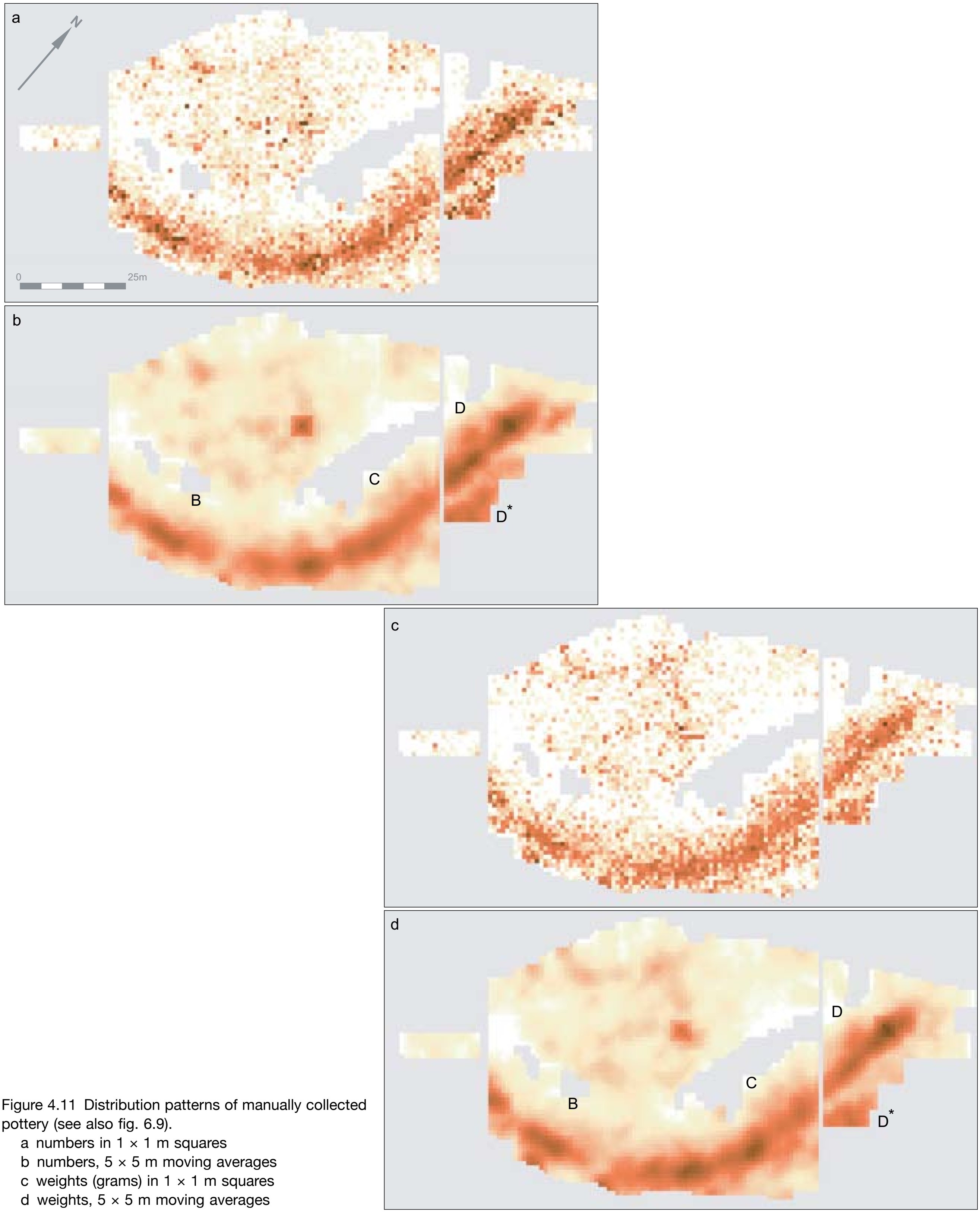


Figure 4.11 Distribution patterns of manually collected pottery (see also fig. 6.9).
a numbers in 1 × 1 m squares
b numbers, 5 × 5 m moving averages
c weights (grams) in 1 × 1 m squares
d weights, 5 × 5 m moving averages

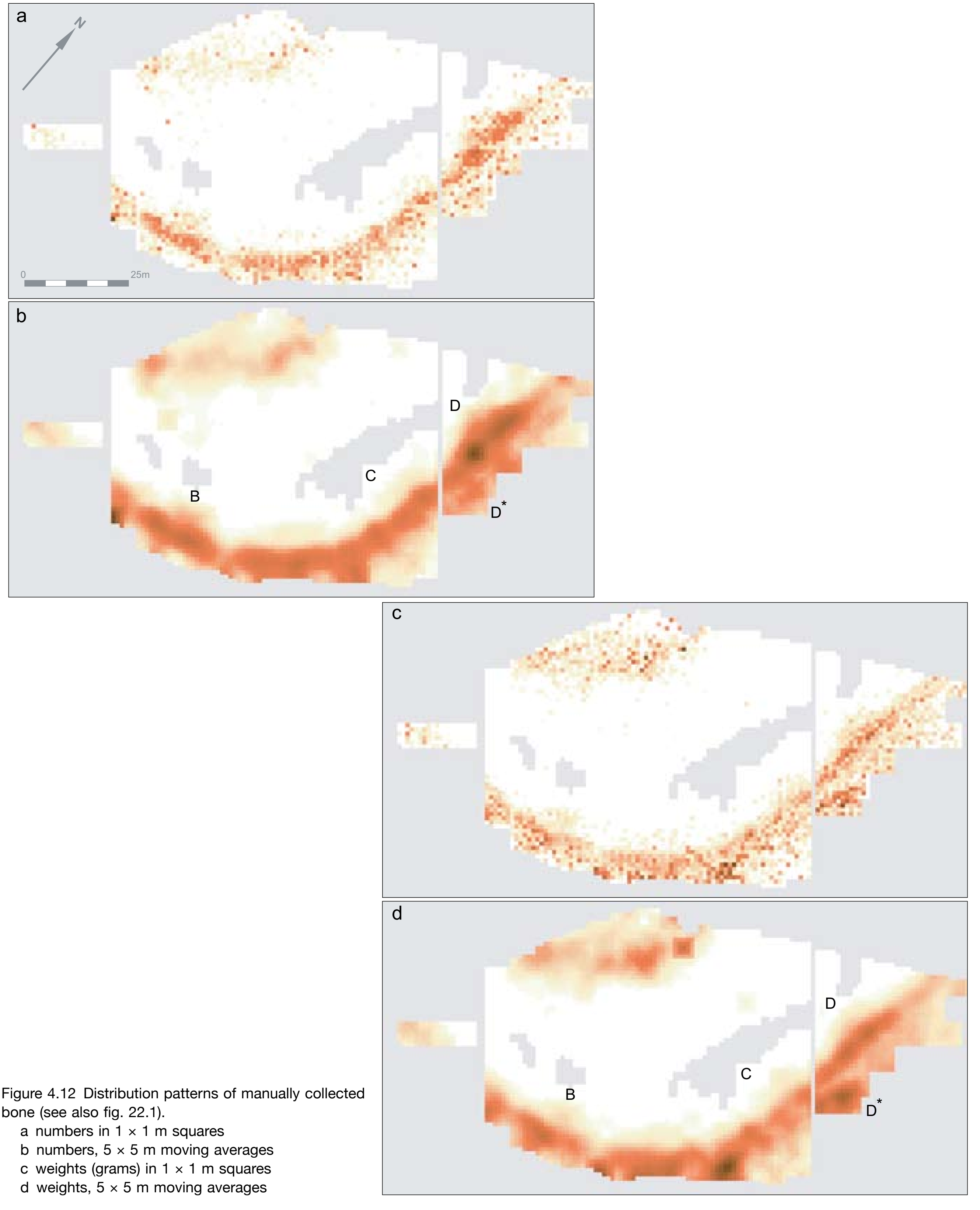


Figure 4.12 Distribution patterns of manually collected bone (see also fig. 22.1).
a numbers in 1 × 1 m squares
b numbers, 5 × 5 m moving averages
c weights (grams) in 1 × 1 m squares
d weights, 5 × 5 m moving averages

density of finds in Units 17/18 (D*). Whereas the distributions of the flint show high densities on the slope of the dune, those of the bones and pottery sherds on the contrary point to disposal next to the dune. The central part of the find zone shows a series of unclear, poorly pronounced densities (C), but a distinct separate concentration is observable in the west (B).

Another conspicuous aspect of the bone distributions is a find density that is modest in an absolute respect but nevertheless quite high in relative terms in the low-lying area northwest of the dune. This density stands out more in the distribution based on weight than in that based on quantities, implying that the finds in question are comparatively large fragments. This is in marked contrast with the pottery and flint distributions, which are both conspicuously empty in the northwestern area. The only conclusion that can be drawn from this is that we are to assume different, separate disposal processes for the three find categories. Viewed in this context, the observed more subtle differences between the bone and pottery distributions on the other side of the dune may also be seen to represent differences in disposal, all the more so as they cannot be explained in terms of preservation.

4.5.5 Stone artefacts (fig. 6.1)

In total, more than 4500 pieces of stone were coded, with an overall weight of more than 47 kg. The largest stone artefact (no. 1300, part of a grindstone) weighs 3.7 kg. The distributions of this find category were hardly affected by selective weathering, but they do show the consequences of a research factor. The small pebbles (<1 cm) that naturally occur in sand were not always properly distinguished from anthropogenically used/modified stone. That distinction was made in quantitative terms only in the lithic analysis (chapter 8). This factor affected the distributions on the dune in particular, and those based on quantities more so than those based on weight.

The distributions of the lithic artefacts closely resemble those of the flint artefacts in that they reveal a broad zone with high find densities along the south side that does not extend far into the aquatic deposits beyond the dune, and small numbers of finds on the northern flank. A find concentration clearly visible at the centre of the southeastern side (C) corresponds to one of the concentrations observable in the pottery distributions. There are also two less conspicuous concentrations in the (north)eastern and southwestern corners (D and B). The dune itself revealed only a thin, diffuse scatter, part of which consisted of natural stone.

4.5.6 Charcoal

5650 charcoal particles with a total weight of around 2½ kg were collected by hand. The interpretative value of the distribution of this find category is very limited. The charcoal was collected in a very unsystematic manner, and in some areas features rich in charcoal strongly influenced the find densities. This is typically a distribution that must be corrected on the basis of the sieve finds.

The distribution map shows a very thin scatter with slightly higher densities only in the waste-disposal zone along the southeastern edge. At the centre of this zone is a concentration that coincides with concentrations (C) in the pottery and lithic artefact distributions.

4.5.7 Daub

657 lumps of daub (approx. 3 kg) were identified as such. Daub (and clay) likewise provides a fairly unreliable picture because it will in many cases not have been identified as such in the field and in the processing of the finds.

The daub seems to be restricted to the central part of the southern flank and a concentration just to the east of it, but it is questionable whether any significance should be attached to its absence in other parts of the dune.

4.6 The results of the sieving

The soil from one row of segments in all the evenly numbered trenches was sieved through a sieve with a mesh width of 4 mm (section 1.3.2). The finds recovered from the sieve residues were also counted and weighed per working unit. The resulting find densities provide a complementary spatial impression of the fraction between 4 and approximately 30 mm. Soil from Unit 10 (peat containing large quantities of coarse plant remains) and Units 17/18 (a deposit with a high clay concentration) was not systematically sieved on account of those units' specific conditions. No sieve data are available for Unit 19S either, as this layer was not shovelled in 1 × 1 m segments.

The number of finds recovered from the sieve residues can be termed high, especially considering that the sieving programme covered only 1/12 of the excavated volume of soil. In terms of weight, the finds however constitute only a small proportion of the overall find assemblage (table 4.2).

Distribution maps were made of the results of the sieving, for both the individual layers and for all layers together. These maps were visually assessed to see whether they

4 mm sieve	N=	weight (kg)
flint	7,264	2.0
pottery	9,663	6.5
bone	53,554	7.7
stone	3,011	1.0
charcoal	92,392	4.3
loam	31	< 0.1

Table 4.2 Categories of archaeological finds collected by sieving through a 4-mm mesh; total numbers and weights.

showed any (ir)regularities relative to or deviations from the above distributions obtained for the manually collected finds.

In terms of both quantities and weight, the distributions based on the results of the sieving differ little from the general distributions of the flint, pottery, bone and lithic artefacts. The flint and pottery finds show a more uniform distribution on the dune. The fine fraction was evidently distributed more diffusely across the occupation area, but some sieved segments nevertheless contained comparatively large numbers of finds, especially lithic and flint artefacts. These distributions confirm the distribution patterns of the manually collected finds.

Charcoal clearly constitutes an exception (fig 4.13), having been only incidentally collected by hand. Charcoal was encountered in large quantities in the sieve residues, up to more than 3000 particles and 180 grams per m^2. So the sieved segments yielded complementary spatial information for this find category. Charcoal was very uniformly distributed across the entire dune; its distribution seems to have been influenced only by the (partial) erosion at the top. As in the case of all the other find categories, the largest quantities were found on the southeastern flank. A few segments with particularly high charcoal concentrations probably represent hearths. The uniform scatter across the entire dune supports the assumption that the human activities took place in areas all over the dune.

Virtually no loam whatsoever was found in the sieve residues. Being soft, it evidently did not survive the sieving process.

4.7 SITE STRUCTURE

Together, the distribution maps of the different find categories provide a good impression of the site's general structure. Occupation and deposition evidently took place across the entire dune, but also in a zone outside it, to a distance of more than 20 m from the dune, making the total area of the site not 0.5 ha but 1 ha. Although the site was occupied for only a few centuries, fairly large, diffuse concentrations have nevertheless remained visible, thanks to the fact that the remains became buried relatively soon after the end of occupation. This points to a fixed main layout of the site throughout the entire period of occupation. There are only very few small-scale find concentrations, with high quantities or weights of finds, in a single segment. They may represent specific activities in the final occupation phase, whose remains suffered little postdepositional disturbance.

Many remains ended up on the relatively steep southeastern slope of the dune and in the adjacent aquatic deposits. The limits of this zone were observed in the southwest and the northeast. Within this zone the distributions of the different find categories show three clearly distinct sections with a few concentrations coinciding with three of the four main clusters in the postholes distribution: one in the southwest (B), one at the centre (C) and one in the (north)east (D). The dump zone of cluster A seems to have coincided largely with trenches in which finds could not be systematically collected. We assume that these concentrations in the waste-disposal zone spatially represent the adjacent activity areas on the dune. The patterns differ

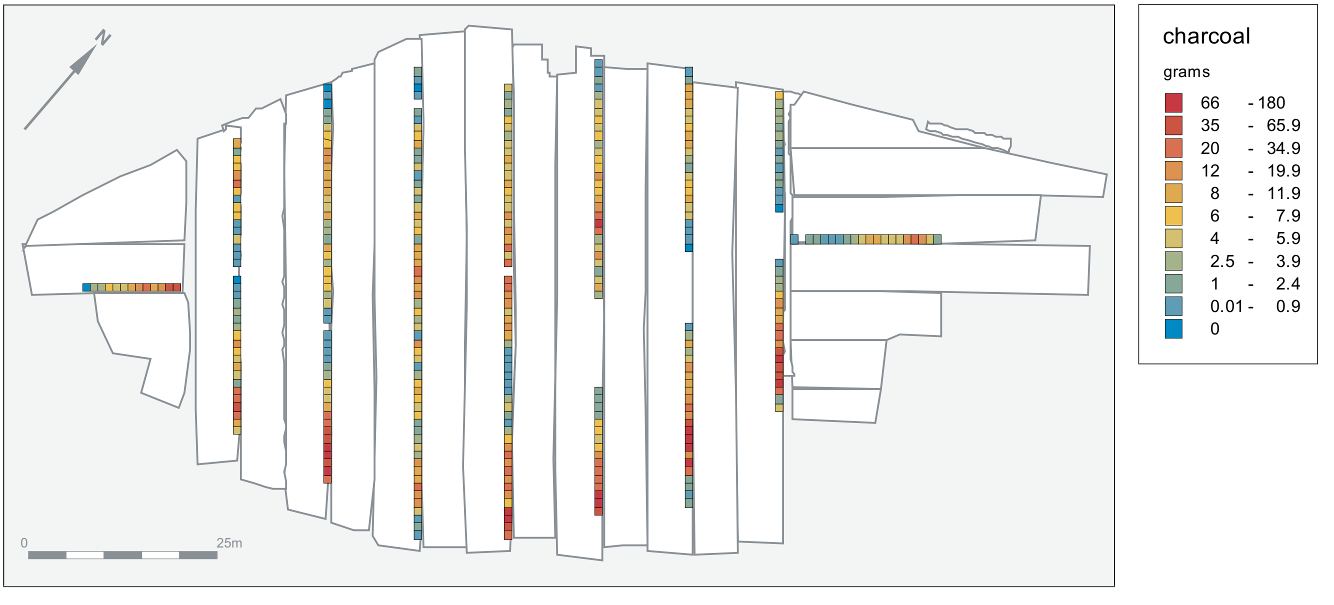


Figure 4.13 Distribution of charcoal (weight in grams) recovered from the 4-mm sieve residues.

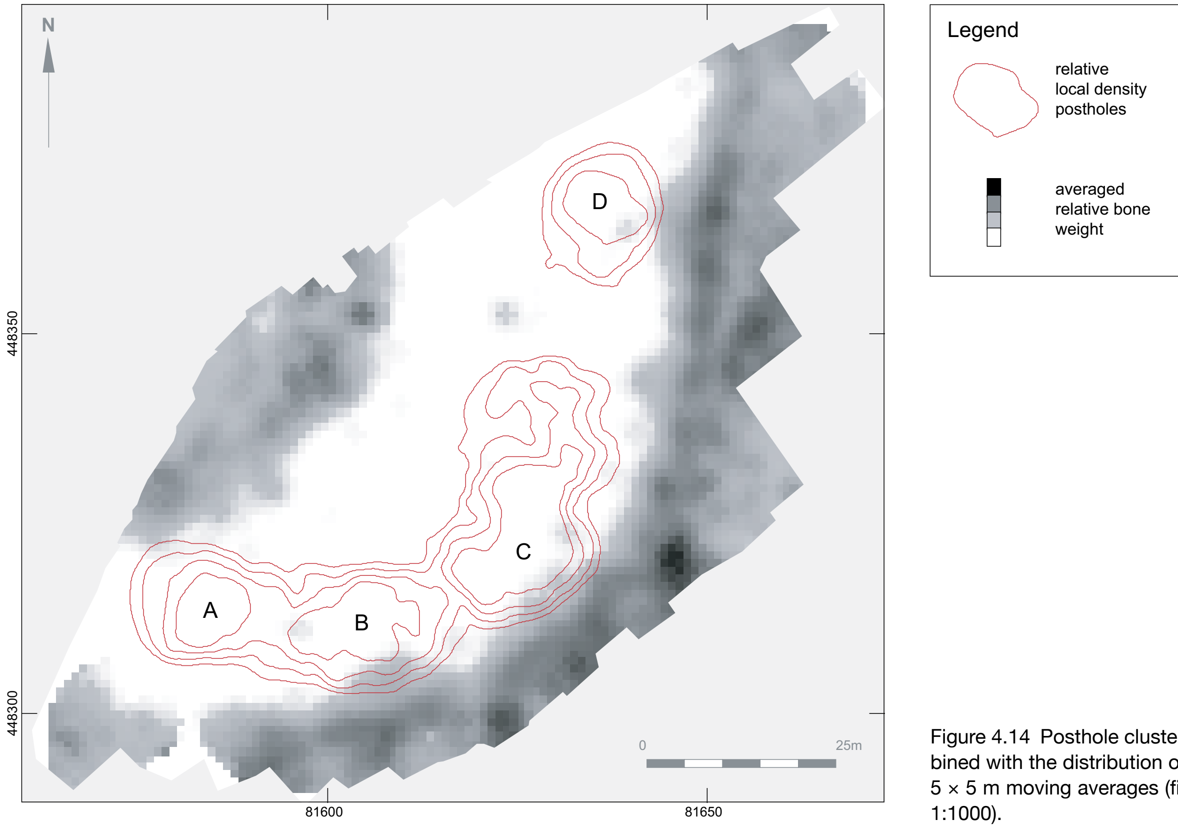


Figure 4.14 Posthole clusters (fig. 4.5) combined with the distribution of bone weight in 5 × 5 m moving averages (fig. 4.11d), (scale 1:1000).

somewhat from one find category to another, but those differences are attributable to differences in deposition and preservation (figs 4.14).

The narrow zone D* with high densities of pottery and (somewhat less clear) bone in the northeasternmost corner is associated with a path, represented by the trampling zone in Unit 18 (phase 2a).

Much less refuse was discarded on and alongside the less steep northwestern slope. This indicates that this part of the dune was used for a shorter length of time and/or it had a marginal position within the settlement.

During the period of occupation already the original deposition pattern was to a great extent obliterated by trampling, weathering and colluviation. The lateral movement of sediment and artefacts led to a decrease in the density of archaeological remains on the slopes of the dune and an increase in their density in the colluvium at the foot of the dune. Besides deliberate deposition and colluviation, the good preservation conditions were an important factor in the formation of the distribution patterns in this zone.

Beneath the peat (Units 10/11 and 01), which had extended across the entire dune area by around 3000 cal BC, the find distributions were fossilised without notable changes. Much later, the erosion that accompanied the formation of the Dunkirk I deposits (Unit 0) led to the formation of several large gaps in the distribution patterns at the centre of the settlement, and only those in the peripheral zones have survived. This makes it difficult to interpret the site in terms of organisation and the size of the local community. Fortunately this is to some extent compensated by the phased information provided by the aquatic deposits.

4.8 Phasing (fig. 4.15)

Distribution maps of the three most important find categories (flint, bone and pottery) were made for each phase (combination of units). Those maps were compared with one another and with the general (overall) distributions. The patterns are difficult to interpret because they are diffuse and because of the sharp boundary between the layer concerned and Unit 20. Only the pottery distributions are illustrated here. There are also substantial differences in the numbers of finds from the different phases (table 4.3).

4.8.1 Phase 1 (Unit 19S)

In Unit 19S the finds were not collected by hand in segments of 1 × 1 m, but with the aid of a digging machine in larger

		N=			%		
phase	Unit	flint	pottery	bone	flint	pottery	bone
1-3	20	8,140	9,429	8,345	52.8	31.5	11.3
3	10	157	580	5,132	1.0	1.9	7.0
3	11	4,287	3,752	6,291	27.8	12.5	8.5
2b	15/16	2,021	5,162	19,335	13.1	17.2	26.2
2a	17/18	723	9,770	31,697	4.7	32.6	42.9
1-2a	19N	71	625	2,387	0.5	2.1	3.2
1	19S	6	639	632	0.0	2.1	0.9
Totals		*15,405*	*29,957*	*73,819*	*100*	*100*	*100*

Table 4.3 Categories of archaeological finds; absolute numbers and percentages per phase and lithological unit.

segments (see section 1.3.3). The distribution map of this unit (fig. 4.15d) therefore differs from the other maps in a cartographic respect.

Relatively few finds are available from this earliest phase. Like the scatters of the later phases, the thin find scatter has a length of at least 70 m along the southeastern edge of the dune. Insofar as it was recorded, the scatter is very uniform, with a slightly greater density of finds on the dune flank. The finds concerned are almost all fragments of bone and sherds of relatively large dimensions, which were evidently discarded in the gulley that was at this time gradually filling up with sediments. One find for example comprises three sherds with a total weight of 515 grams.

In total only six pieces of flint were found. This small number may be partly – but certainly not exclusively – attributable to the collection method. One possibility is that flint was not discarded in water; flint will have been a scarce commodity and will have been used and reused for as long as possible. The number of flint finds from phase 2a recovered from the clay of Unit 17/18 is also rather small.

The find patterns in Unit 19N also span phase 1, but they will be discussed under phase 2a on the assumption that the younger remains will prevail in this layer.

4.8.2 Phase 2a (Units 19N and 17/18)

Large quantities of bone and pottery were found along the entire southeastern side of the dune, over an area with a length of around 150 m. The limits of this refuse zone lie beyond the limits of the excavated area; the boundary of the find scatter was not observed in the trenches in the sedimentation area either. Bones were even found in the small trench that was dug 20 m from the foot of the dune to obtain samples for pollen analysis (trench 40). So in this phase a broad zone of the surrounding deposits formed part of the settlement site.

The distribution of flint artefacts is very limited and diffuse. The pottery and bone distributions likewise reveal few variations in density. Two vague concentrations – D and D* – separated by a narrow strip with a slightly lower find density along the trampling zone can just be made out.

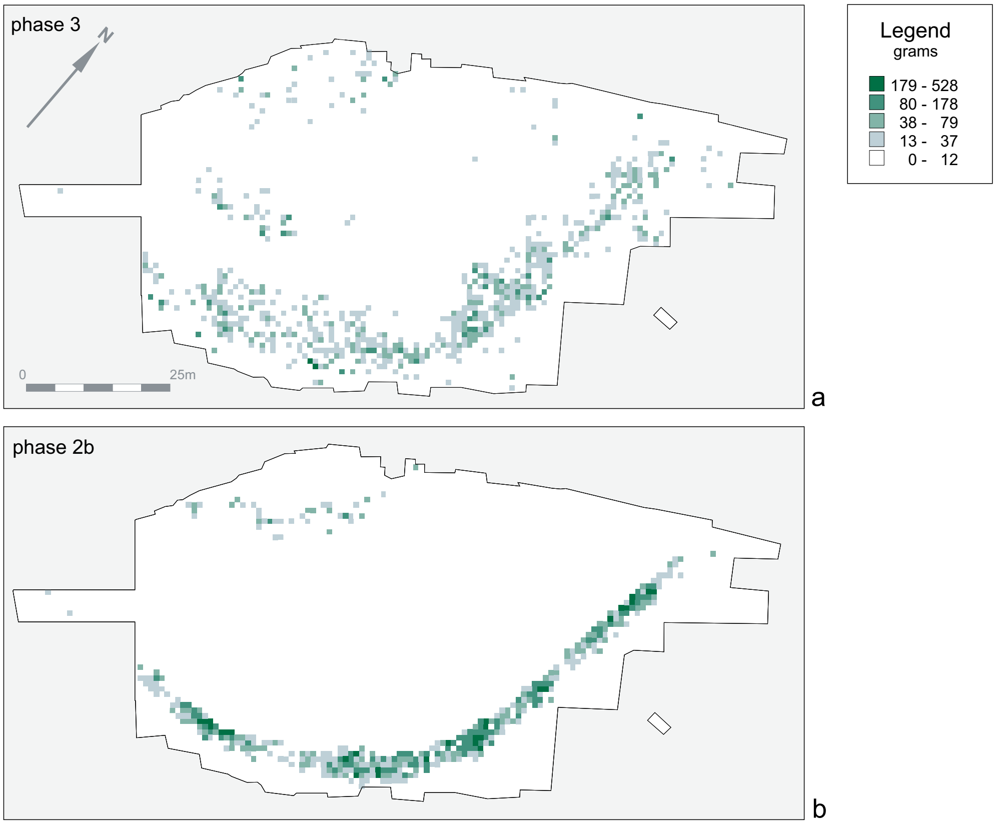
The numbers and densities of the finds recovered on the northwestern side (19N) are much lower than those on the southeastern side, but the ratios of the different find categories are comparable. This makes it more likely that the northwestern side was an area with a low deposition intensity than that it had some other function.

4.8.3 Phase 2b (Units 15/16 and part of Unit 20)

The colluvium (Unit 15/16) yielded a large number of finds in a high density, in roughly the same pottery and bone ratios as the finds recovered from Units 17/18. It comprised a narrow zone with a width of only 5 to 6 metres surrounding the dune on both its northwestern and its southeastern side that lay by definition directly above Units 17/18. In the north the limit of the find scatter was determined in the excavation; in the southwest the density of finds gradually decreased, the actual limit lying somewhere beyond the boundary of the trench. This narrow strip shows no interruptions, but fairly randomly distributed small areas with slightly higher concentrations of finds, especially flint and bone, are observable. This being such a narrow strip makes it difficult to interpret this differentiation. Units 15/16 are however the natural continuation of Unit 20, the 'occupation layer' on the dune body. The patterns in Units 15/16 may therefore be assumed to be the continuation of the pattern at the base of Unit 20, especially because the base of Unit 20 – and Units 15/16 – became buried by Unit 11 during phase 3 already. This does not hold for the higher part of the dune.

4.8.4 Phase 3 (Units 10/11)

Phase 3 is represented by the finds recovered from Units 10 and 11. Unit 11 yielded large quantities of flint, pottery and bone, but not quite as many finds as the previous units (table 4.3). Unit 10, which lies further away from the dune, yielded only few finds. The finds were concentrated in a zone along the former foot of the dune, above the base of Unit 20 and the colluvium of Units15/16, extending over a width of around 25 m (both units together). The limits of this zone were clearly observable in both the north and the southwest in the case of all the find categories. Within this zone the



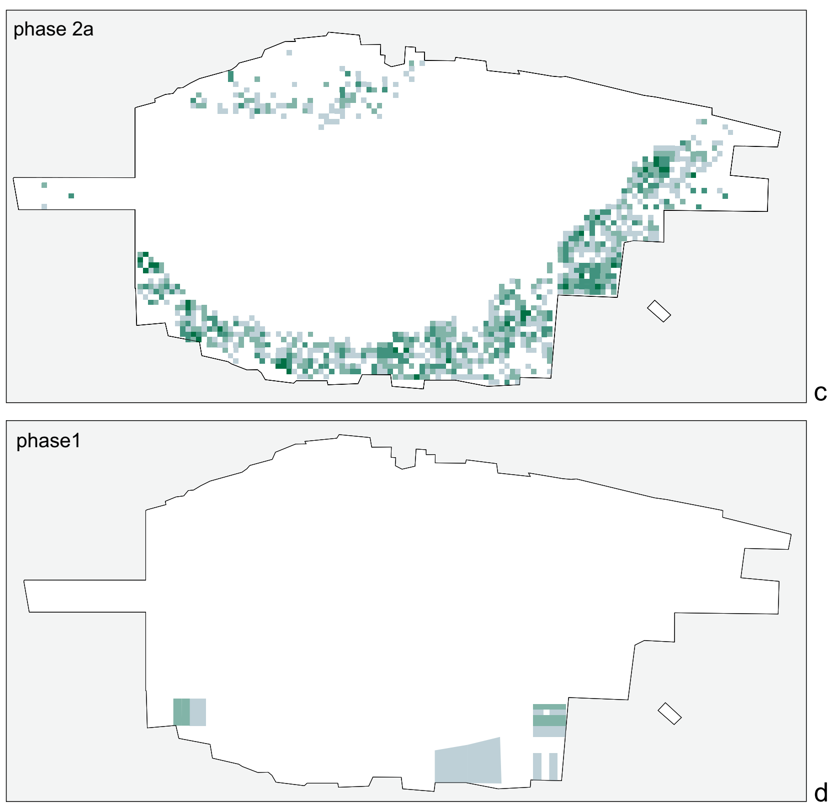


Figure 4.15 The distribution of pottery (weight in grams per square meter) in the marginal zones with syn-occupational stratigraphy in the subsequent occupation phases showing continuity of the overall deposition patterns and the effect of the shrinking size of the dune.

d phase 1 (Unit 19S)
c phase 2a (Units 17/18)
b phase 2b (Units 15/16)
a phase 3 (Units 10/11)

flint and bone distributions showed one concentration in the southwest (A) and one in the northeast (C), but the area between the two (B) also yielded many finds. This can be classed as a waste disposal zone, at some distance from the dune. The discarded objects are mainly bones; pottery was discarded in much smaller quantities and flint is almost completely absent.

The find scatter of Unit 11 of course continues in the distribution of the remains left behind in Unit 20 in phase 3. In the case of flint the remains in question can however not be distinguished from the other remains; pottery and bone remains have largely disintegrated.

4.8.5 Conclusions

Assuming that the disposal of objects in the aquatic deposits bordering the southeastern edge of the dune was directly associated with the occupation activities on the adjacent part of the dune, we can, on the basis of those embedded objects, assign chronological depth to those activity areas, as visualised in the posthole clusters.

In the first place, this zone was over its entire length evidently used for the disposal of refuse in all phases. From phase 1 until the end of phase 3, refuse was discarded next to clusters B, C and D. This means that the whole dune area was in use throughout the entire period of occupation; there was no movement of occupation centres across the dune within that period. The boundary of the refuse zone in the southeast shows that the activities covered a wider area in phase 2a (and Unit 20), extending beyond the limits of the excavated area, than in phases 2b and 3. In phase 2b the northern boundary clearly lay within the excavated area; the southwestern limit is diffuse. The two limits of this zone in phase 3 were both clearly visible. This slight reduction in the size of the occupied area will have been the result of the gradual burial of the lower parts of the dune by sediments.

Secondly, the most important find concentrations (B, D) of the different phases coincide, in each case separated by an area with thinner find scatters. This we regard as another argument in favour of long continuity, from phase 2a via 2b to phase 3.

In the third place, these find concentrations coincide with the identified posthole clusters, which means that the chronology of the entire occupation period can be applied to them. This further supports the assumption based on the analysis of the postholes, notably that this settlement comprised a number of locations where small houses were built and rebuilt on several occasions (section 3.8.3).

4.9 INTERPRETATION AND CONCLUSIONS

4.9.1 Methodical conclusions

Collecting remains by hand (with a shovel and incidentally also a trowel) inevitably leads to a fairly unsystematic sample of the remains surviving at the site. The 'sieved strips' proved a good test to visualise and quantify this. The extent to which the maps based on find numbers and find weights agree with one another shows that the recovery bias had little impact on the spatial analysis. All the maps were moreover affected by this factor in the same degree. The only exception concerns charcoal, which was not systematically collected by hand.

This bias is however an influential factor as far as the ratios of the different artefact categories are concerned, in particular the ratios of beads, small flint artefacts and remains of fish, birds and small mammals.

Smoothing of the maps on the basis of moving averages proved to be ideal for revealing trends in distributions and for eliminating small-scale, partly research-dependent variations. Visual comparison of many distribution maps made via different approaches using applied software led to a good understanding of the spatial structure of the site.

4.9.2 Interpretation of the distributions

The general find patterns were largely determined by natural factors, in particular differential weathering, erosion and colluviation. Nevertheless, a main deposition pattern relating to the activity areas represented by the clusters of postholes is identifiable on the dune. The occupants made intensive use of the entire dune and its peripheral zone in all phases. The area concerned decreased slightly – but not that much – in size towards the end of the occupation period. Throughout the phases there were four clusters of postholes (A-D) or farmyards with next to them the fringes of activity areas in the northwest and associated waste-disposal areas in the southeast. They seem to have remained in the same places and to have been in continuous use in all the phases. These three combined concentrations of finds and postholes have diameters of several dozen metres. They represent areas where a multitude of domestic activities were evidently concentrated around structures that were rebuilt several times (see section 3.8.3) and next to which refuse was discarded. This leads to the conclusion that there were at least four farmyards or households certainly from phase 2a onwards, but possibly already from phase 1 onwards.

Several separate activities appear to be represented in the waste-disposal zone, and all in the same pattern in all phases (2a-3). Flint was evidently very rarely discarded, and mainly on and at the foot of the dune. This implies that this raw material was economically used and – not surprising in this environment – in scarce supply. Pottery was found at greater distances from the dune and must have deliberately been discarded in the adjacent swamp. This holds to an even greater extent for the bones of slaughtered animals whose meat was consumed.

The less steep northwestern flank of the dune had a special function in all phases. In the earliest occupation phases (1 and 2a) wells were dug here. The scarcity of flint and the small number of postholes moreover point to less intensive use, though large amounts of slaughtering remains were discarded here. Hygienic considerations may have played a role. This part of the site may have been fairly swampy at an early stage already, as indeed suggested by the facies of Unit 19N.

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Part II

Man and materials

5 Graves and human remains

Liesbeth Smits
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At the Schipluiden site six burials containing the remains of seven individuals were uncovered, plus 36 human bones scattered among the refuse, representing at least another eight persons. Especially older men were buried, but some children as well, and all the burials are associated with only one of the households. The tightly flexed legs of the inhumations contrast with the stretched burials of the Swifterbant culture. One man was accompanied by an exceptional strike-a-light set. The people were of modest stature, strong and healthy, and hard labour was part of their way of life. ^{13}C and ^{15}N measurements point to a diet with an important freshwater fish input.

5.1 Introduction

Six graves and a number of scattered human skeletal remains were discovered in the excavated area (figs. 5.1, 5.9). The research questions relating to these remains cover three fields:

- the physical anthropological study of the remains focused on the biological characteristics of the people. Were there males, females and children present at the site? What was their health like and what was their age at death?
- stable isotopes, especially ^{13}C and ^{15}N, of the skeletal remains can provide information on the diet,
- burial postures and grave goods provide information on social differentiation and on cultural links with communities on a supraregional level.

Figure 5.1 Survey of the burials in the western part of the dune (scales 1:500 and 1:100).

5.2 Material and methods

5.2.1 *Excavation and preservation*

The skeletons were cleaned in the field with brushes and small wooden spatulas. The cleaned skeletons were drawn to a scale of 1:5. Photographs (general views and details) were made in the field and afterwards in the laboratory. In the field the bones were measured and preliminary age and sex diagnoses were performed. The skeletons, or parts of them, were subsequently lifted in blocks, to be transported and further excavated in the laboratory. The bones were not treated with a preservative. Samples were taken for ^{14}C, DNA and stable isotope studies.

On the whole the preservation of the skeletal remains was good. Five of the seven skeletons were very well preserved considering their age. The bones were complete and could be lifted individually. The skeletons from graves 2 and 4 were less well preserved than those from the other graves. Plant roots had penetrated the bones and remains of the roots were still present in all the bones. Especially the spongy parts of bones such as the ribs, vertebrae, pelvic girdle, metaphyseal and epiphyseal parts of the long bones had suffered such damage.

5.2.2 *Physical anthropological methods*

Sex diagnosis (Appendix 5.1)

The sex diagnoses of the adult individuals were based on the morphological traits of the skull and the pelvis because they show differences between males and females (WEA 1980). The male features are defined by greater robustness and more muscle attachment. The female pelvis is adapted to childbearing and is therefore different in size and shape. The pelvis is regarded as the most reliable feature. In view of their differential reliability, the individual sex traits were accorded a value from one to three points. The morphological traits were scored on a scale of -2, -1, 0, +1 and +2, corresponding to super feminine, feminine, indifferent, masculine and super masculine. The degree of sexualization is based on the mean weighed score of all observed traits.

Age diagnosis (Appendix 5.2)

The biological or physical age can be assessed by studying the skeleton. The relation with the calendar or 'real' age grows weaker as an individual advances in age. The influences of health and lifestyle, hormonal changes and genetic factors remain largely unknown (Jackes 2000; Kemkes-Grottenthaler 2002).

The ages of the sub-adults were assessed on the basis of the level of ossification of the skeleton, the formation and eruption of the deciduous and permanent teeth and the length of the long bones (Krogman/Isçan 1986; Ubelaker 1984; Maresh 1955, 17; Scheuer/Black 2000). Of these criteria the status of the teeth is considered the most reliable.

The ages of the adults were determined on the basis of degeneration features such as suture obliteration, attrition of the teeth and degeneration of the spine (Brothwell 1980). The 'complex method' of age determination is based on four features: suture obliteration, symphysis of the os pubis, the structure of the proximal femur and the humerus head (Broca 1875, Nemeskéri et al. 1960; Sjøvold 1975; WEA 1980). The degeneration of the auricular surface of the ilium was used as an additional criterion when necessary (Lovejoy et al. 1985).

ind. no.	grave number / find number	phase	sex	age (approx.)	stature (approx.)	pathology*	non-metric traits	grave gifts
1	1	2	male	38-45 years	173 cm	hypoplasia, DDD,VOA	squatting facets	
2	1	2	male	59-65 years	168 cm	trauma? DDD, POA	squatting facets	
3	2	2	male	46-49 years	168 cm	DDD,POA	squatting facets	flint + pyrite
4	3	3	male	41-50 years	169 cm	DDD	squatting facets	
5	4	2	male	25-40 years	166 cm			
6	5	1-2a	unknown	8 years				
7	6	2	unknown	2 years				bone beads
8	5278	2a	–	adult				
9	9267	2a	male	25-35 years				
10	8037	2a	–	10-11 years				
11	8010	2b	male	adult				
12	2670	2b	female?	17-25 years				
13	6506	3	–	9 months				
14	3648	3	–	30-60 years				
15	5001 + 8008	3	male?	17-25 years				

* DDD = degenerative disc disease, VOA = vertebral osteoarthritis, POA = periferal osteoarthritis

Table 5.1 Human remains. Characteristics of the individuals.

grave	ind.	posture	side	orient.	preserv.	sex	age	remarks
1	1	stretched	back	S-N	(+)	♂	38-45	
1	2	stretched	back	N-S	(+)	♂	59-65	violent death
2	3	str. flexed	left	W-E	+	♂	46-49	3 strike-a-lights, 1 pyrite
3	4	str. flexed	back	W-E	++	♂	41-50	
4	5	str. flexed	back	N-S	-	♂	25-40	disturbed
5	6	str. flexed	right	E-W	++	infant	8 y	
6	7	flexed	left	W-E	++	infant	2 y	2 bird bone beads

Table 5.2 Graves, basic parameters.

Stature (Appendix 5.3)

The stature was inferred from the measurements of the individual long bones and measurements of the complete skeletons *in situ* (Trotter/Gleser 1952, 1958; Trotter 1970). An individual's stature is related to the person's general health and genetic and climatic factors. Long-term trends within a specific area, such as northwest Europe, can be associated with different living conditions and health of populations (Maat 2003; Roede/Van Wieringen 1985).

Pathology (table 5.1)

Pathological features were described and interpreted to assess living conditions and health status (Ortner/Putschar 1985; Roberts/Manchester 1995). The cause of death can rarely be inferred from the skeleton. Long-term diseases can lead to bone changes. Alterations in bones can be indicative of a reaction to diseases, and hence be interpreted as evidence of a healing process.

Pathological features are classified in several categories, for instance deficiencies in the quality or quantity of the diet, infections, injuries, degeneration of the spine and the joints (Rogers/Waldron 1989, 1995). Pronounced muscle markings are a reaction to and indication of a way of life involving hard physical labour.

5.3 Observations

5.3.1 *The graves* (table 5.1)

Human burials were restricted to the southwestern part of the dune, where four (nos. 1, 2, 4, 6) were found in a small cluster, the other two in a more isolated position (fig. 5.1, see also section 3.5.2). The burials were assigned to different occupation phases on the basis of intersections with pit fills, the relation of the grave fills to the culture layer Unit 20 and, thirdly, their depths in absolute terms relative to the general rise in water level and the sedimentation. Grave 5 is assumed to be the oldest (phase 1 or early phase 2), the small cemetery was dated to phase 2 and grave 3 is the youngest, most probably dating from phase 3 (section 3.5.2).

The graves were oval or subrectangular. Their dimensions were in some cases (esp. graves 3 and 4) considerably larger than required for the burial of the tightly contracted body (table 5.2). Either the people who buried the deceased decided on this posture only after they had dug the pit, or organic grave goods (now completely decayed) were placed in the surplus space. The graves had a moderate depth, of between 60 and 95 cm below the former surface, their bases varying in depth from -4.65 to -4.0 m, which was presumably more or less the groundwater level at the time. These depths agree with the levels estimated on the basis of the aquatic deposits during phases 1-3: between -4.5 and -3.7 m NAP. This level rose in the course of time (section 2.4), but will also have fluctuated on a seasonal and a random, weather-related, basis. For this reason the base levels of the graves were not used for relative dating or sequencing of the graves. The good preservation of the skeletons supports the assumption that the corpses were buried close to the former groundwater level and came to lie below it shortly after inhumation.

Grave 1 (fig. 5.2)

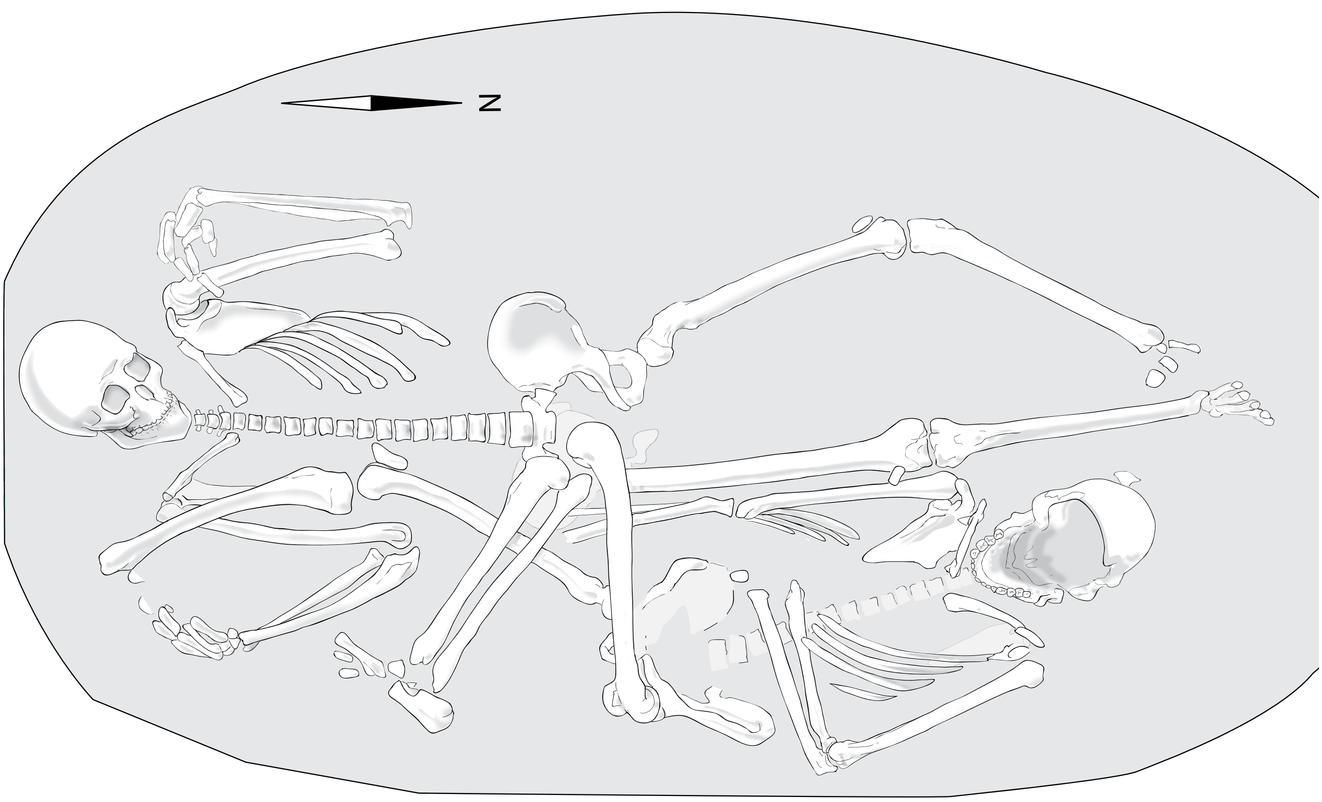
The grave, oval in shape, was orientated N-S and had a fill of dark humic sand, similar to Unit 20 in this area, implying a date well into phase 2.

The grave contained the remains of two male individuals: individuals 1 and 2. The manner in which they were buried differs from that observed in the case of the other burials in two ways. In the first place, this is the only double burial found at the site and, secondly, the postures of the skeletons differ from those in the other graves.

Both skeletons were articulated. Individual 1 was laid down in the grave first, with his head in the south and stretched on his back, with one leg straight and the other slightly bent. Both lower arms were bent back alongside the upper arms.

The second individual was buried next to individual 1, but with his head at the northern end, also on his back, but with a tilted pelvis and with bent arms and legs. Both legs overlap the body and right arm of the other person, showing that this individual was the second to be placed in the grave.

Individual 1. This skeleton is almost complete and reasonably well preserved. The spongy bones of the ribs and vertebrae are fragmented and damaged by plant roots. The skeleton


N

belonged to a man who died at an age of approx. 38-45. There are no injuries on the bone from which the cause of death can be inferred. This man suffered pain in his neck and lower back, possibly due to degeneration of the spine caused by physical labour. His teeth show enamel defects, pointing to health stress in early life (Hillson 2003; Schultz *et al*. 1998; Carli-Thiele 1996). Squatting facets are visible on the tibiae. The man's stature was approx. 173.8 cm and the shape of his skull is dolichocranial.

Individual 2. The skeleton of the second individual is more or less complete but the axial skeleton is fragmented as a result of the intrusion of plant roots. It is the skeleton of a man who lived to the well-advanced age of about 59-65. The vertebral column shows traces of degeneration and vertebral osteoarthritis in the thoracic and lumbar region. Both wrist joints are also affected by degeneration, the right one more so than the left one. The teeth are badly worn; chipping of several of the front teeth may be attributable to some specific use. A squatting facet was observed on both tibiae. The reconstructed stature is 168.6 cm.

There is one feature that may be related to the cause of death. Injuries observed on the skull were most probably inflicted at the time of death. Post-mortem damage to the head is possible, but provides no satisfactory explanation for all the observations. The best explanation for the damage to the skull is a severe blow to the head that smashed the frontal bone and parts of the face. This is based on the following details. The nasal part of the facial bones was found to the left of the head; some fragments of the skull were lying to the right of the skull and inside the bottom part of the skull. The skull later became filled with soil. This is an important clue to what might have happened. The skull was crushed, and after decomposition of the brains, the bone fragments came to rest on the inner table of the underlying part of the skull. Later the skull became filled with soil from the grave fill. In the case of post-mortem damage, the skull would have become filled with soil first, and the crushed pieces would have remained visible on the outside. At the time of the injury some of the bone fragments may have adhered to soft tissues such as flaps of skin, and thus have been removed from their original positions.

No signs of bone reaction or healing were observed, implying that the injury was caused around the time of death. Post-mortem damage can therefore not be ruled out completely.

An unnatural cause of death could explain why two adult men were buried in one grave.

Figure 5.2 Grave 1, field situation, plan (scale 1:10) and detail of skull individual 2.

Figure 5.3 Grave 2, field situation, detail of strike-a-light burial gift and plan (scale 1:10).

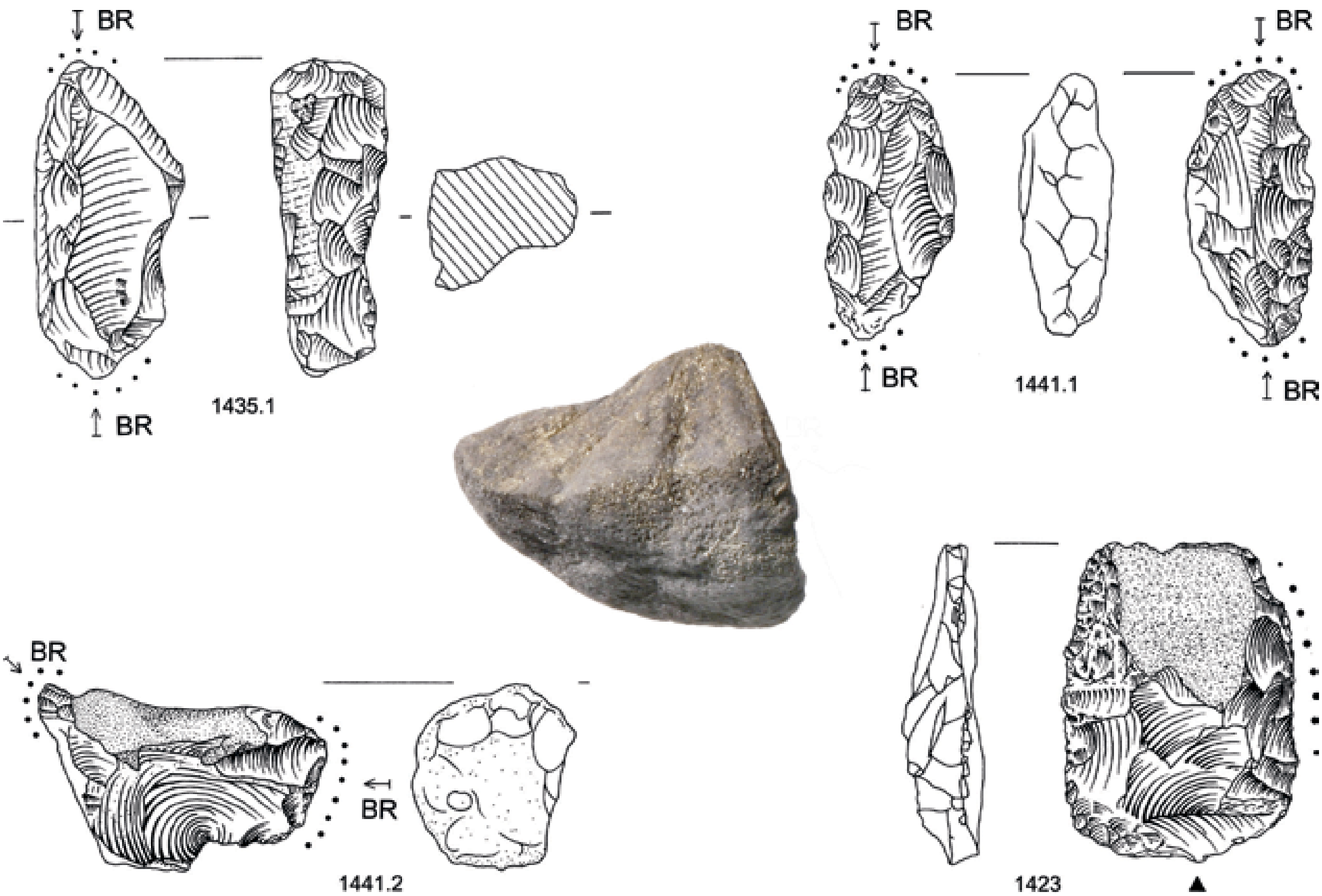


Figure 5.4 Grave 2, grave goods. Three strike-a-lights with a pyrite nodule and a retouched flake (scale 1:1)

Grave 2 (fig. 5.3)
The grave was orientated roughly W-E and irregular-oval in shape. The fill was similar to that of grave 1, indicating a similar date, well into phase 2. This grave contained the skeleton of an adult male, buried on his left side, with his head in the west, facing north. The legs were flexed so tightly as to imply that the limbs were bound together. In his hands, which were positioned in front of his face, he held three flint artefacts, identified as a strike-a-light set, and a lump of pyrite (fig. 5.4, see also chapters 7 and 8). These implements can be seen as the deceased's personal belongings. A (retouched) flint blade found near the feet can on the basis of its position and typology also be regarded as one of the grave goods. A small flake recovered from the pit fill is assumed to be an accidental find and no intentional grave gift.

The skeleton is almost complete. The condition of the bones is good; only parts of the pelvis were fragmented. This man died at an age of around 46-49. There are no indications on the bones pointing to the cause of death. The teeth are badly worn, especially the incisors and canines, possibly due to their use as a tool. Like individual 2, the man suffered pain in his lower back, and squatting facets were again observed on the tibiae. The right wrist joint shows signs of degeneration, which may have been caused by daily fire making. The reconstructed length of this man is 168.9 cm and his skull is dolichocranial.

Grave 3 (fig. 5.5)
Grave 3 was found on top of the dune. It was orientated W-E and had an irregular oval shape. The grave was dug partly through the fill of a well that was dated to phase 2 on the basis of characteristics of its fill. Large pieces of peat found in the heterogeneous fill of the grave are indications of peat in the vicinity of the grave. These observations, together with the position of the grave, justify a date towards the end of the occupation period, in phase 3. The bottom of the grave was lined with some organic fibres, indicating that this level

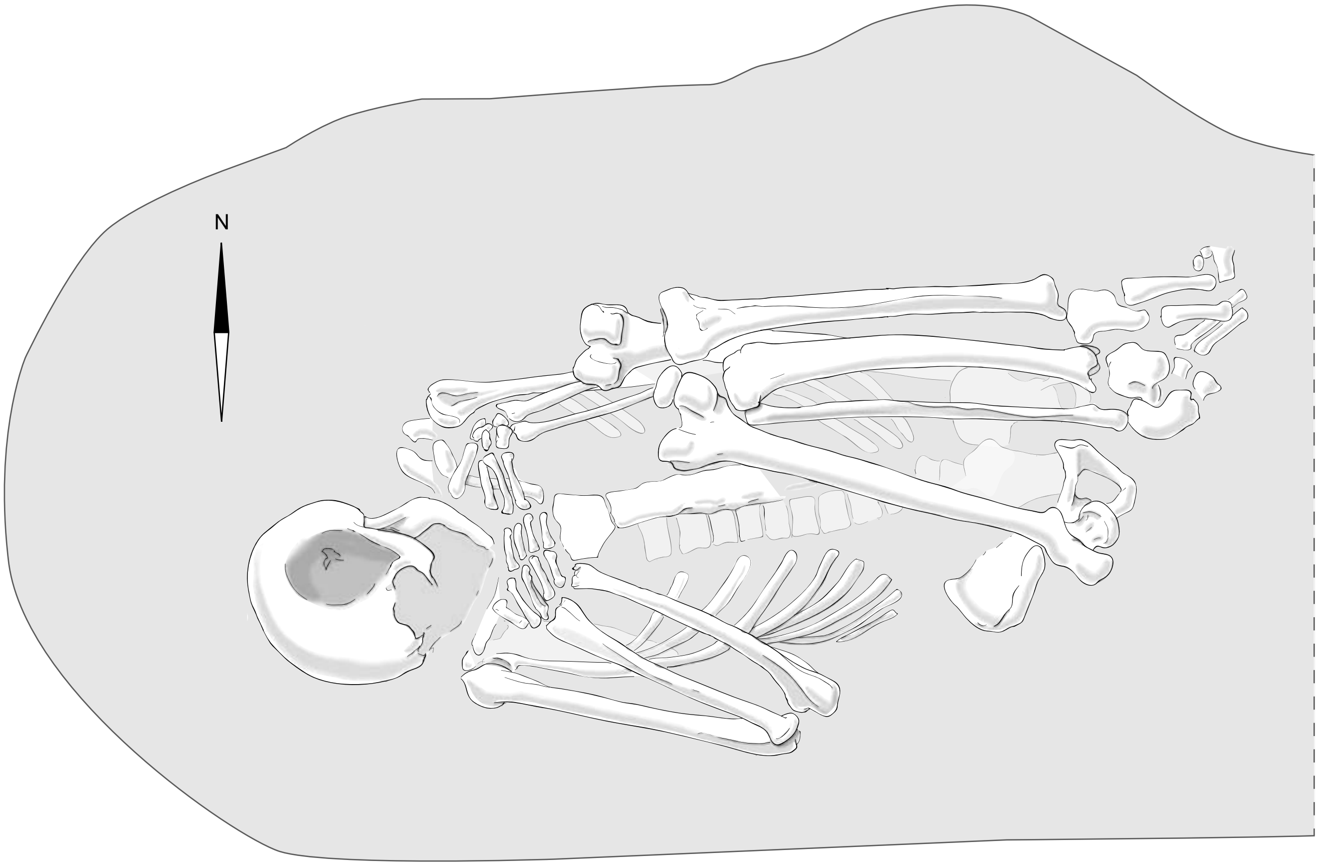


Figure 5.5 Grave 3 (scale 1:10).

(-4.15 m NAP) must have been below the groundwater already at the time of digging.

This grave contained the very well-preserved skeleton of an adult male. He was buried on his back, with his head in the west and his legs in a very tightly flexed position. The arms were bent close to the body, with both hands positioned on the chest below the chin. The man lived to an age of approximately 41-50. There are no indications of the cause of death. Degeneration of the lower spine is evident, as is dental disease. The teeth were badly worn and some were lost during the man's life due to decay. Squatting facets were observed on the tibiae. The man's stature was approx. 169.2 cm and the shape of his skull is dolichocranial.

Grave 4 (fig. 5.6)
This burial was found in the dark humic sand of the 'occupation layer' (Unit 20) on the northwestern slope of the dune, without any visible traces of a grave. The articulated body parts suggest that the individual was interred in a shallow grave in the late occupation phase. The grave must have been disturbed after the time of burial and it was also touched by the machine that dug the trench. These disturbances led to the disappearance of the upper parts of the skeleton (head, right hand and feet) and severe damage to the remaining bones. The disturbances may have been caused during the later occupation of the site; being so shallow, the grave will have been particularly susceptible to damage. The preserved remains indicate that the grave was orientated N-S and that the person was buried on its back, with its head in the north and with tightly flexed legs. The right lower arm was bent back, alongside the upper arm, the left hand rested in the lap.

Parts of the pelvis indicate that this is the skeleton of a man. His age at death was approximately 25-40. The bones show no indications of the cause of death. No pathological traits were observed on the vertebral column because of the fragmented and incomplete condition of this part of the skeleton. The reconstructed stature is approx. 165.6 cm.

Grave 5 (fig. 5.7)
Grave 5 was situated at the southeastern edge of the dune. It was orientated roughly W-E, relatively large, round-oval in form and had a light-coloured homogeneous fill and a darker coloured outline. The grave was intersected by a well, which had however not disturbed the inhumation itself. The well was dated to phase 2 on the basis of characteristics of its fill along with its position low down the dune, making an early date in the occupation sequence most likely for this grave.

In the grave a child was buried on its right side, with its head in the east, facing north, and its legs tightly flexed. The right arm was bent in front of the body and the chin was laid to rest on the right hand; the left arm was stretched down. The skeleton is complete and the bones are very well preserved. The age at death was around eight years. The cause of death is unknown.

Grave 6 (fig. 5.8)
Grave 6 was found when a number of large features – pits and wells dating from the early phases of occupation – were sectioned, and the skeleton was slightly damaged during this sectioning. The subrectangular grave was orientated SW-NE and its fill was very similar to the peaty sand of the pit fills into which the grave was dug. The local stratigraphy and the grave's depth imply that it dates from phase 2.

An infant was buried in this grave orientated W-E, with its head in the west, on its left side and with its legs in a tightly flexed position. The arms were bent, with the hands in front of the face. Two tubular beads made of bird bone were recovered from the dug-out fill of the grave. These finds, which are assumed to be grave goods, will be discussed in chapter 9.

The skeleton found in this grave is almost complete and the preservation of the bones is very good. The bones are those of an infant that was around two years old when it died. The cause of death is again unknown.

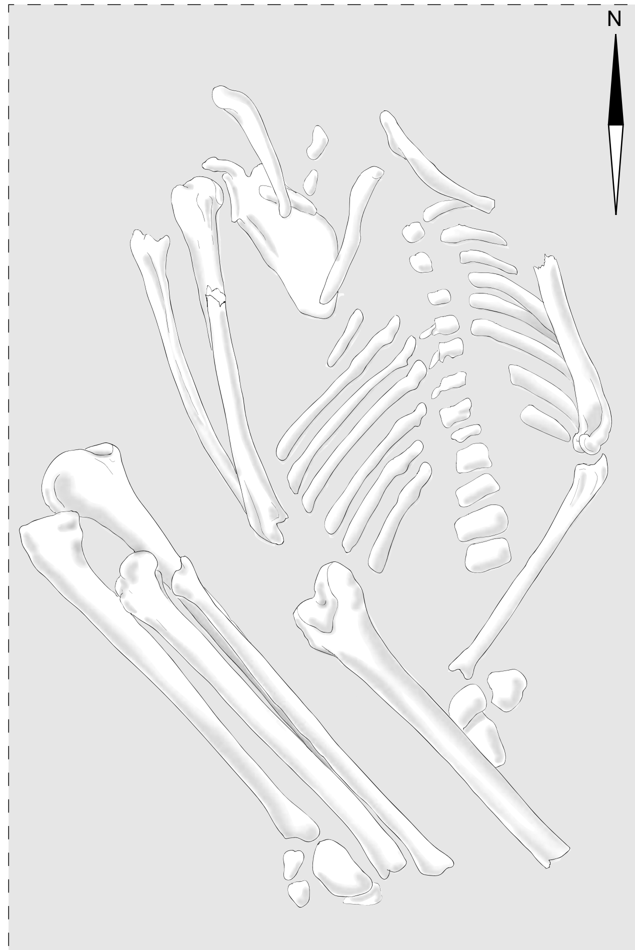


Figure 5.6 Grave 4 (scale 1:10).

5.3.2 The scattered remains
Fragments of human bone were found in 33 find numbers, amounting to a total of 36 skeletal parts, which were discovered as isolated finds scattered across the entire excavation area.

The majority of the remains derive from the refuse zone along the dune's edge. Only five fragments were found in pit fills. No concentrations could be made out in the refuse zone – quite the contrary: the remains appeared to be randomly distributed along the dune's edge, without any relation to the graves. The remains date from all the occupation phases, with higher concentrations from phase 2a on the southeastern slope, and phase 3 on the northwestern side and at the eastern end. In view of the small quantities and the small minimum number of individuals involved, little significance should be attached to this differentiation.

The remains are predominantly teeth and skull fragments; only a few fragments of long bones from the limbs and only one vertebra were recovered (table 5.3). There is a relation between the compact nature of the bones and the state of preservation. Compact bones – such as those of the crania and the shafts of the long bones (diaphysis) – are more likely to be preserved than the spongy bones of the axial skeleton. The teeth, however, are the strongest, so it is not surprising that they constitute the majority of the isolated finds.

There are several possible explanations for these isolated bones. In the first place, graves may have been accidentally or deliberately disturbed; this was for example the case with grave 4, individual 5, whose bones were scattered across the surrounding area. Another possibility is that other funerary rites besides burial in a grave were practised, for example excarnation. This could explain why bone

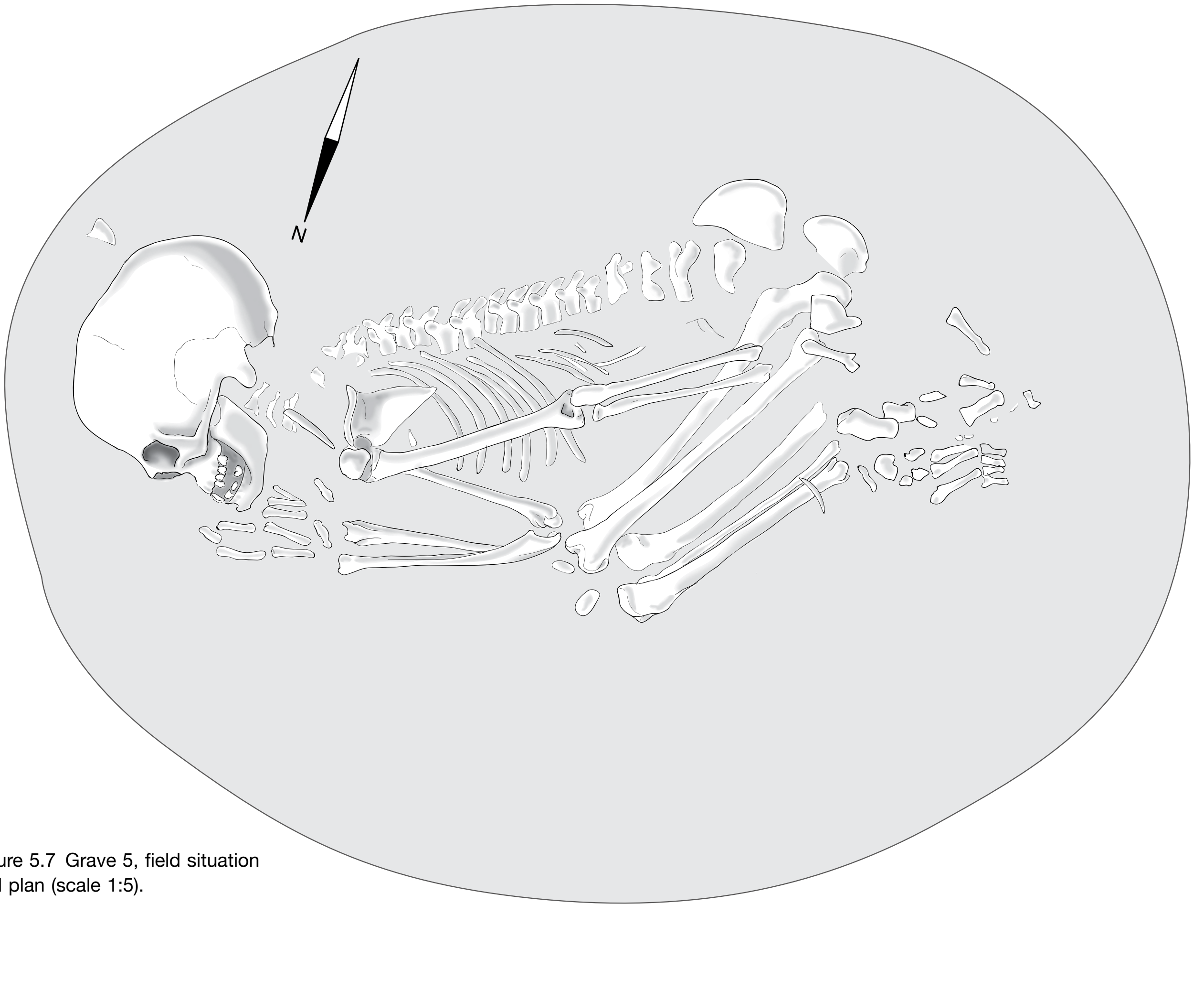


Figure 5.7 Grave 5, field situation and plan (scale 1:5).

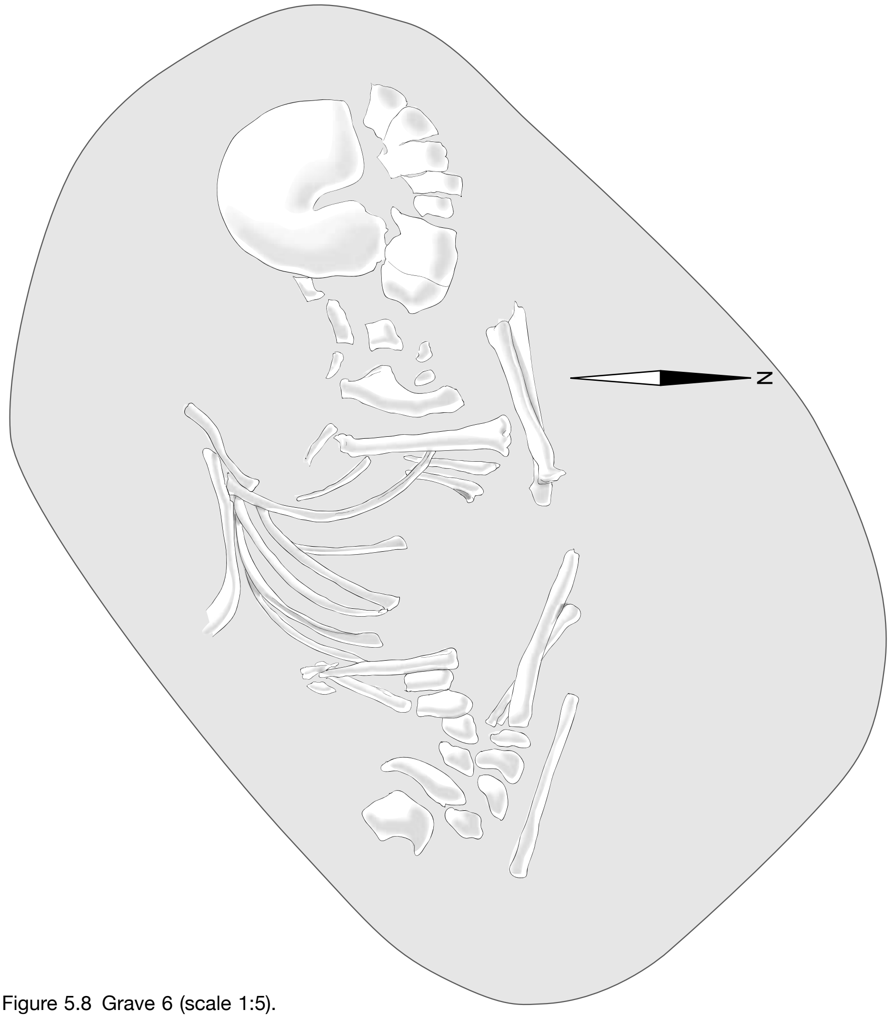


Figure 5.8 Grave 6 (scale 1:5).

fragments were found all over the site. The diaphyseal parts of a left and right femur (nos. 5525 and 8008) that were found 75 metres apart both show signs of periostitis and may very well derive from the same individual.

The minimum number of individuals represented by the human remains found at the site was estimated on the basis of the distribution and phasing of specific bones and their age differences (see table 5.4 and fig. 5.9). The scattered remains represent at least eight individuals: three from phase 2a, two from phase 2b and three from phase 3. The individuals concerned are six adults and two children. Cranial traits of two adults are indicative of men; the femur of another individual probably also belonged to a man. The gracile nature of the cranial vault thickness and the teeth suggest one female. The sex of the other two adults cannot be established.

5.3.3 *Stable isotope analysis* (table 5.5, fig. 5.10)

The stable isotopes of carbon and nitrogen can provide information on the consumption of animal and plant proteins, especially on the marine or aquatic versus the terrestrial component of the diet. In addition to the radiocarbon dating, the ^{13}C and ^{15}N ratios were also determined, using the same bone samples, with a view to assessing any reservoir effects

	N=
teeth	16
cranium	11
diaphysis + phalanges	8
axial	1
total	36

Table 5.3 Isolated human bones according to skeletal parts.

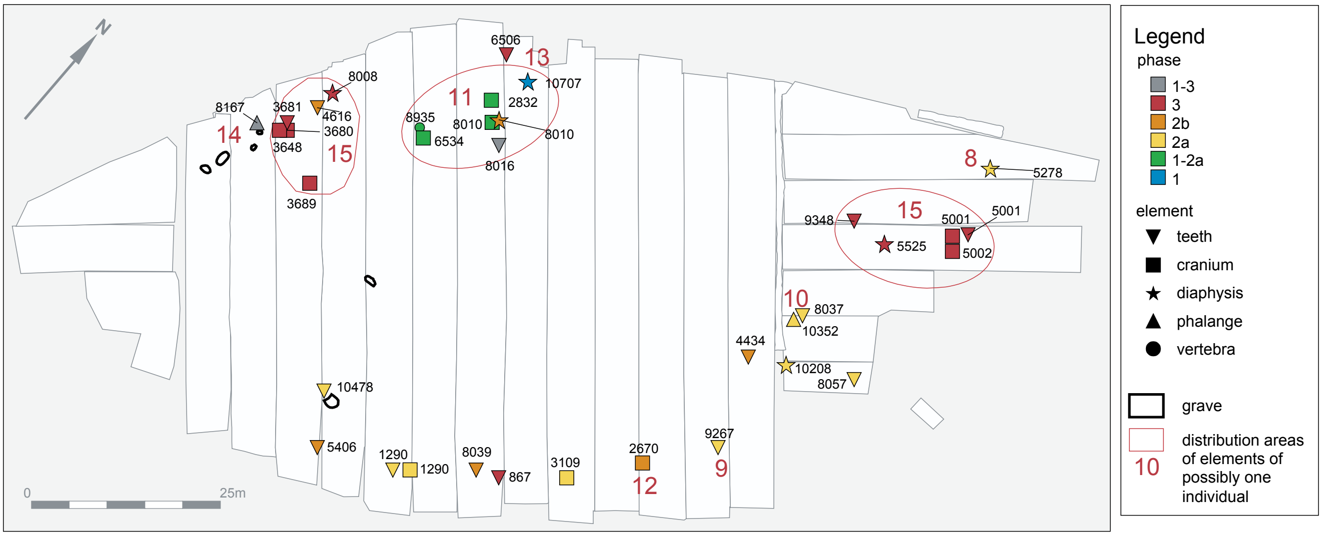


Figure 5.9 Position of isolated human remains classified per phase and skeletal element. Some distinct clusters of elements from the same phase – indicated by a thin red line – may derive from the same individual.

and gaining insight into the people's diet (Van der Merwe 1982; DeNiro 1987).[1] The results of this analysis (table 5.4) indeed reveal a reservoir effect, as ^{15}N values higher than 10‰ are usually regarded as indicative of a marine component, which is confirmed by the high ^{13}C values. This is in full agreement with all but one of the ^{14}C dates, which were systematically about 300 years older than those of botanical remains. There is one remarkable exception: the sample of individual 5 (grave 4) does not reveal a reservoir effect in the ^{14}C and ^{15}N values. The bone sample of individual 6 moreover contained insufficient material for ^{15}N detection, but on the whole the high ^{15}N values obtained for Schipluiden are in agreement with a marine food regime, implying a diet that contained freshwater fish.

In comparison with the carbon/nitrogen ratios obtained for various diets associated with coastal and inland populations and their subsistence strategies, the Schipluiden ratios form a distinctive group, with very high ^{15}N values combined with heavy loads on the ^{13}C scale (fig.5.10; Schulting 1998, 206). Inland hunter-gatherer groups and farmers are characterised by relatively low ^{15}N values in comparison with coastal fisher-hunter-gatherers. Isotope analysis of skeletal remains from the Iron Gates in the Danube region revealed a diet rich in fish characterised by a ^{13}C/^{15}N ratio comparable with that of the Schipluiden individuals (Bonsall *et al.*1997). So the apparent reservoir effect of all but one of the dates can be considered a freshwater effect.

Apart from the high ^{15}N values there is an additional feature indicating a diet rich in fish, namely considerable amounts of calculus or tartar formed on the individuals' teeth. Calculus formation is enhanced in an alkaline environment, which is in agreement with the consumption of fish (Hillson 1979; Lillie 2000). Although high ^{15}N values are not fully understood, as the process of fractionation of this isotope is very complicated, both the isotope ratio and the calculus formation on the teeth are indicative of a diet that contained freshwater fish.

A possible explanation for the aberrant values of individual 5 (grave 4) could be that this person did not eat fish. The person may have been raised in a different food regime, outside the region, and for example have died shortly after marrying into this coastal group.

A second series of samples of human and animal bone and soil was analysed at Durham University (Millard/Smits/Budd, in prep.). Nitrogen and carbon isotopes were measured for the reconstruction of the diet. Soil samples and the

find no.	phase	element	sex	age
5278	2a	ulna (left)	–	adult
9267	2a	mandible + molars	male	25-35 years
8037	2a	molar	–	10-11 years
8010	2b	cranial fragment	male	adult
2670	2b	cranial fragments + molars	female?	17-25 years
6506	3	molar		9 months (±3 months)
3648	3	cranial fragment	–	30-60 years
5001+ 8008	3	femur and molars	male?	17-25 years

Table 5.4 Isolated human remains. Minimum number of individuals based on sex and age indicators and phasing.

$^{87}Sr/^{86}SR$ ratio of the enamel of domestic and wild animal remains were determined as references. In addition, human tooth enamel was subjected to combined Pb, Sr and O isotope analyses to identify any possible immigrants in the population and their place of origin.

The results confirm those of the previous analyses and point to a significant marine protein input in the diet, and hence the exploitation of marine resources by the site's inhabitants. The soil strontium values are more varied than the values obtained for the animals and humans, implying that not all zones of the landscape were used for food procurement. The additional analyses showed that most individuals, especially those who were buried in the graves, were of local origin. Two individuals, represented by only a few loose teeth in the dune sediment, were identified as immigrants. One of them came from the east and the other from somewhere to the south of Schipluiden.

5.4 Anthropological interpretations

5.4.1 Group size and composition
(table 5.2, Appendix 5.1)

The group of people who were buried in this area consists of five men and two children. Another eight individuals are represented by the scattered remains. There is evidence of three men, one woman, two adults and two children. So the total number of individuals represented by the human skeletal remains is at least 15: eight men, one woman, two adults and four children (see table 5.3). The mean age of the adult men in the graves is about 46. The ages of the children and infants vary. There are two very young infants of nine months and two years old, and two children of around eight and ten years old.

There is only one, uncertain, indication of a female, which means that this group of individuals is not representative of a natural population. Women are evidently underrepresented,

grave	ind.	age	phase	^{14}C date BP		$\delta^{13}C$	$\delta^{15}N$
1	1	38-45	2	GrA-26650	5005 ± 40	-18,67	15,77
1	2	59-65	2	GrA-26652	5080 ± 40	-19,02	15,95
2	3	46-49	2	GrA-26653	5055 ± 40	-18,81	15,55
3*	4	41-50	3	GrA-26670	5055 ± 40	-21,52	12,79
				GrA-28037	5010 ± 40	-21,56	–
4*	5	25-40	2	GrA-26671	4650 ± 40	-20,50	10,07
				GrA-28150	5120 ± 45	-19,34	–
5	6	8	1-2a	GrA-26672	5170 ± 40	-18,50	–
6	7	2	2	GrA-26737	5070 ± 40	-21,05	16,36

* For two individuals an extra ^{14}C date is available. There is no explanation for the difference in outcome.

Table 5.5 Human remains, ^{13}C and ^{15}N values.

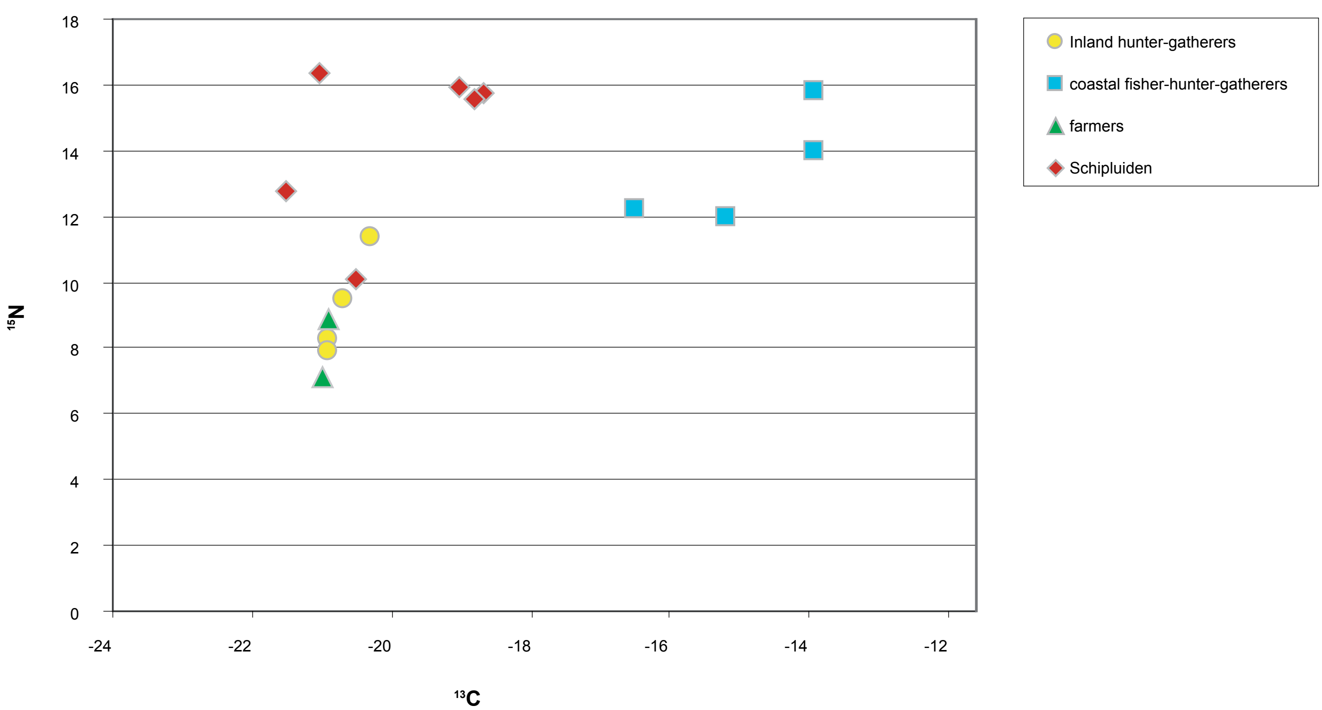


Figure 5.10 The $^{13}C/^{15}C$ ratios of human skeletal remains from Schipluiden in relation to those of populations with different forms of subsistence (data from Schulting 1998, 206).

although the burials of two young children suggest the presence of complete households. Deceased women were presumably usually disposed of in a different manner that is not evident in the archaeological record.

5.4.2 *Health and living conditions* (table 5.1)

The age at death varies from nine months to approximately 60 years. The mean age of the adult men is considerable. The stature of the adult men varied from 165.6 to 173.1, with a mean of 168.9 cm (Appendix 5.3). Muscle marks, degeneration of the joints and the vertebral column of most individuals indicate that physical strain and hard labour were characteristic of their way of life. A cortical defect at the site of a muscle attachment on a humerus – one of the individual bones, no. 8010 – is in agreement with this. Enamel defects are indicative of at least some spells of bad health during the youth of individual 1. Due to tartar formation and severe attrition, such defects could not be studied on the teeth of the other adults (fig. 5.11).

The age at death of the adults, the stature and the degeneration of the skeletons due to physical labour indicate a group of people who were strong and healthy. It should however be borne in mind that this small group is not necessarily representative of the larger population to which it belonged.

5.4.3 *Diet*

The conclusion of a diet with a considerable freshwater fish component does not seem to be well in agreement with the archaeozoological evidence (chapters 22-23), especially not with the evidence relating to fish (chapter 25). It should however be added that the ratio of terrestrial and aquatic protein inputs is hard to assess on the basis of archaeozoological data because of the great differences in the archaeological formation processes of mammal and fish remains. Fish might be underrepresented. The same holds for the ratios of widely differing fish species such as eel and sturgeon, which (along with flounders) were both dominant among the remains. Eel, although catadromous, is essentially fished in fresh water, as was confirmed by sample 898. And, last but not least, it is difficult to assess at this stage of the research what the effect of sturgeon on the isotope ratio will have been. The reservoir effect of the ^{14}C dates of all the measured charred food crusts indicates that many fish found their way into the cooking pots.

5.4.4 *Conclusion*

The physical-anthropological study has shown that the group of people whose remains were discovered at this site comprised at least 15 individuals, mostly men and children. Only one (possible) female could be identified. The health and living conditions were favourable, though hard physical labour was probably part of everyday life. Metric and non-metric traits of the adult men in the graves show some similarities: the dolichocephalic shape of the skull and the squatting facets on the tibia.

The dead were buried in a formalised manner, that is, in single burials in a flexed posture. An exception is the double burial in grave 1. Damage to the skull of individual 2 points to some kind of violent conflict. This, and the associated unnatural death, could have been the reason for this variation in the burial practice.

The scattered skeletal remains may indicate a different – aboveground – treatment of the deceased, for example in the open air, which led to the subsequent dispersion of the bones all over the site.

5.5 Archaeological interpretation

5.5.1 *The burial tradition*

During the period of occupation some of the deceased were buried at the site. The continuity of occupation, the high probability of year-round use of the site and the occurrence of both formal inhumations and isolated skeletal remains dating from all phases (except phase 1) make burial in an occupied settlement extremely likely and exclude the possibility of burial at a (temporarily) deserted settlement – a realistic option in many other cases.

Only a few individuals were granted a formal burial. Assuming that the dune was divided into a number of farmyards we may conclude that burial was practised by only one of the households – the southwestern one of ‘cluster A’ (section 3.8.3; fig. 4.5) – in all the phases, but within this household this form of treatment of the dead was used selectively, and reserved for (some) adult men of different ages and – more incidentally – also children. This led to the formation of a small ‘cemetery’ at the edge of the farmyard, on top of the dune. If we accept the assumption of a fixed farmyard layout we have to abandon the interpretation of there having been a ritual area in the west of the site, but in a more restricted sense there does seem to have been such an area associated with the southwestern farmyard, which also included the ‘deposition pit’ (section 3.5.3).

The more commonly applied treatment of the deceased is much more puzzling, as the only surviving evidence of that treatment comprises the scattered human bones that were found in the refuse zones around the site. The rite concerned was practised in all phases and by all the households. Again the deceased seem to have been mainly men and children, though we should not attach too much significance to this as women are difficult to identify in fragmentary bones. The individuals concerned are all represented by only a few fragments, and we must assume that many deceased elude us in an archaeological respect. There may moreover have been

Figure 5.11 Mandible of individual 2 showing dental wear; the detail shows tartar formation.

a third form of treatment of the deceased that left behind no evidence whatsoever at the site. Viewed from the perspective of permanent occupation of at least two centuries by around 25 persons, the minimum number of individuals whose remains have been found is indeed exceptionally small: around 10% on the assumption of an average life expectancy of 35 years.

In spite of the small number of formal burials we may nevertheless – with some reservation – speak of a 'tradition'. There is a certain preference for a W-E orientation and a remarkable tightly flexed burial posture. The double burial differs from the other burials in several respects: its orientation is at right angles to that of 'the tradition' and the postures of the deceased are also entirely different. This could indeed be associated with the exceptional disaster suggested by the fractured skull of one of the two men. Exceptional causes of death often lead to special rites (Binford 1972).

5.5.2 Comparison with Ypenburg

The treatment of the deceased as attested at Schipluiden differs substantially from that observed at Ypenburg – a site that is otherwise in many respects comparable with Schipluiden (Koot/Van der Have 2001, 21-29). The latter site was found to contain a formal cemetery comprising two clusters of burials – in total 31 burials containing the remains of 42 individuals: men, women and children, many of which were less than 6 years old. As at Schipluiden, the cemetery lay directly next to a house site, identifiable as a cluster of postholes, but at Ypenburg all the deceased, possibly of two households, were evidently formally buried for a period of time. Another nine human skeletal remains, including deciduous infant molars, were found mixed with faunal remains in excavation trenches dug on the (much larger) dune (De Vries 2004). So this is something the two sites do have in common.

No indisputable preferred orientation was observed at Ypenburg, but most of the deceased were buried in a flexed posture, some with their legs 'bound close together'. A few were found lying on their backs with their legs bent sideways (like individual 2 at Schipluiden) and only two in a fully stretched posture (like individual 1). There were seven multiple burials, but none of them contained the remains of two adult men. Most of them moreover comprised secondary inhumations whose burials had disturbed the older inhumations. Only one double burial contained the remains of two simultaneously buried individuals – two infants. So the 'standard' form of inhumation in a strongly flexed posture was practised at both Schipluiden and Ypenburg, and the postures of the deceased buried in the Schipluiden grave 1 were indeed (special) alternatives, and exceptional for double burials in general.

Grave goods were scarce at Ypenburg, too: all the graves together yielded only ten amber beads, three jet beads and a bone ring. There were no counterparts for the 'personal belongings' found in the Schipluiden grave 2. The grave goods suggest a socially fairly undifferentiated community at both sites.

Remarkable are the differences in ages observable between Schipluiden and Ypenburg: the ten Ypenburg women were at most 35-44 years old at death and the same holds for seven of the eight men; only one man was older, *i.e.* more than 54 years of age. This age distribution is in good agreement with that generally observed for Neolithic sites, but on the other hand it also confirms that formal inhumation was at Schipluiden mainly the privilege of 'wise old men', possibly lineage heads.

5.5.3 The burial rite in a wider context

In a wider context we see points of agreement and contrasts with what is known about the burial tradition of the Swifterbant culture and the preceding Late Mesolithic. Small cemeteries and independent, incidental inhumations at settlement sites, burial of men, women and children, scarce grave goods restricted to beads/body ornaments, human remains among settlement refuse – they are all points of agreement with sites such as Hardinxveld-Polderweg and Haradinxveld-De Bruin, Swifterbant S2 and Urk (Smits/Louwe Kooijmans 2003; Louwe Kooijmans/Smits 2003; Meiklejohn/Constandse-Westermann 1978; Peters/Peeters 2001). The most conspicuous difference is the strongly flexed position as the dominant burial posture as opposed to burial stretched out on the back as observed not only at the Swifterbant sites, but indeed all over northern Europe. The double cultural relations of the Hazendonk communities make it likely that the source of inspiration for this aspect of the burial rite lay in the south, in the Belgian branch of the Michelsberg culture, but we have no burial data for that branch. Interestingly, two Michelsberg burials discovered in the large-scale French Neolithic project conducted in the Aisne valley show exactly the same burial posture. Until this discovery, the only known example of an individual buried in this posture was a burial at Cuiry-lès-Chaudardes that was found within a dense scatter of Michelsberg features. It has recently been ^{14}C dated to 4980 ± 50 BP. It is a tightly flexed adult burial in a shallow oval pit, the body resting on its left side with the head facing west accompanied by two stone beads as grave goods (Ilett/Coudart 1983). In April 2005 a similar burial came to light at Beaurieux. As at Schipluiden, isolated human remains were found in ditch fills at nearby sites, one of which is Bazoches.[2] We therefore believe that this aspect of the Hazendonk burial rite was inspired by a southern Neolithic tradition.

5.5.4 Strike-a-lights as grave goods

Strike-a-lights are exceptional grave goods in the Low Countries. Objects found in six burials of the *Bandkeramik* cemetery of Aldenhoven-Niedermerz are on the basis of southern German examples assumed to be strike-a-light sets (Nieszery 1992, 367). A few strike-a-lights are known from *hunebedden,* some of which were accompanied by a lump of pyrite. A strike-a-light accompanied by pyrite for example came to light in a TRB stone cist found at Diever (Bakker 1979, 110, 186). The remarkably rich bell beaker burial of an adult male found near Lunteren yielded a strike-a-light and a piece of 'iron stone' (Bloemers *et al.* 1982, 49). A recently (2005) uncovered Beaker grave near Loxstedt (near Bremerhaven, Germany) contained an 'epimaritime' bell beaker, a K-type battle axe and a flint strike-a-light (pers. comm. Dr Erwin Strahl, Wilhelmshaven).

Nieszery (1992) has discussed the occurrence of strike-a-lights as grave goods in *Bandkeramik* cemeteries in southern Germany. Several artefact combinations have been interpreted as strike-a-lights. They were all found in relatively rich burials of fairly old men, and in many cases the various components lay close together, suggesting that they were contained in a pouch. The objects had in most cases been placed near the bent arms, and in one case in front of the face. The components are a lump of pyrite or marcasite, of which usually only traces remain, a flint nodule, one or more flint blades and a bone awl. The blades show little retouch and few or no use-wear traces. The men concerned are assumed to have had a special role in the community. The interpretation that the objects were contained in a leather pouch was inspired by the pouch that was found near 'Ötzi', 'the man in the ice', which contained a piece of punk with traces of pyrite dust on it (Egg 1993). No lump of pyrite was however found near him, nor a flint strike-a-light.

An entirely different cultural context is the cemetery of Ostorf near Schwerin, of a non-agricultural community at the periphery of the TRB culture from the second half of the 4th millennium – only a few centuries younger than Schipluiden – which was excavated in phases, in 1904, 1935 and 1961 (Bastian 1961; Schuldt 1961). Forty graves were found here. The deceased were buried stretched on their backs, usually orientated east-west. A few relatively well-equipped men's graves yielded a *Feuerschlagbesteck*. The objects in question are large, 8-12-cm-long flint percussion stones with a triangular cross-section and a point rounded through use, which are quite a bit larger than the specimens of the Dutch TRB and those of Schipluiden. They were sometimes accompanied by a bone awl and in one case by a flat stone encrusted with a 'rust-coloured metal-like substance'. Recent research has shown that the substance is the mineral goethite, one of the products formed in the decomposition of pyrite.[3]

The grave goods of the Schipluiden grave 2 belong in a widespread but rare Neolithic tradition, which has possibly often not been identified as such. In view of the other grave goods in the quoted examples it would seem that only men with a special position were buried accompanied by a strike-a-light. In the Dutch Swifterbant-Hazendonk situation, and at Schipluiden in particular, formal burial itself was already a privilege, and social differences were not expressed via grave goods, excluding the odd pendant or bead. The strike-a-light was a prestigious artefact in a class of its own.

Acknowledgements

We would like to thank Dr Michael Ilett for his information on the Michelsberg burials at Cuiry-lès-Chaudardes and Beaurieux in the Aisne valley and Dr H. Lübke for information on the goethite in the Ostorf cemetery.

notes

1 The analysis was performed by Dr Hans van der Plicht, Centre for Isotopic Research, Groningen.

2 Personal information, Dr Michael Ilett.

3 Research by Tosca Friedrich, Archäologisches Institut der Universität Hamburg, Germany.

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Appendices

grave	ind.	pelvis*	cranium*	mandible*	total cranium	robustness	sex
1	1	+1.74 (19)	+1.79 (24)	+0.88 (8)	+1.59 (32)		male
1	2	+1.81 (11)	+1.29 (21)	+0.25 (8)	+1 (29)		male
2	3	+1.58 (12)	+0.83 (24)	+0.88 (8)	+0.84 (32)		male
3	4	+1.58 (19)	+0.13 (24)	+0.13 (8)	+0.13 (32)		male
4	5	+1.75 (8)	–	–	–		male
	9	–	–	+1 (6)			male
	11	–	+2 (2)	–			male
	12					cranium + molars	female?
	15	–	–	–	–	femur	male?

* total weight of recorded traits

5.1 Sex diagnosis of adult individuals.

grave	ind.	dentition + epiphysis + fragment size	external sutures	internal sutures phase	femur phase	humerus phase	symphysis phase	auricular surface	dental attrition	age years
1	1		35-44	II-IV	III	–	II	–	33-45	38-45
1	2		55-75	IV	II	–	IV	–	33-45	59-65
2	3		–	IV	I	I-II	III	–	33-45	46-49
3	4		38-44	IV	–	–	II	–	<45	41-50
4	5		–	–	I-II	I-II	–	25-40		25-40
5	6	± 8								±8
6	7	± 2								±2
	8	cranium								adult
	9	cranium + molars							25-35	25-35
	10	± 10-11								± 10-11
	11	cranium								adult
	12								17-25	17-25
	13	± 9 months								± 9 months
	14		30-60							30-60
	15								17-25	17-25

5.2 Criteria used in the age diagnosis of the individuals.

grave	ind.	humerus	ulna	radius	femur	tibia	fibula	stature
1	1	34.2	29.3	26.3	46.4	38.1	37.4	173
1	2	34.2	–	25.8	44.8	36	36.6	168
2	3	31.1	–	–	43.7	37.2	–	169
3	4	33	26.5	24.5	45	36.4	35.4	169
4	5	30.3	–	–	–	34.5	–	166
5	6*	17.8	14.7	12.9	25	20.2	20.4	–
6	7*	11.9	10.6	9.1	15.1	12	11.6	–

* = diaphyseal length

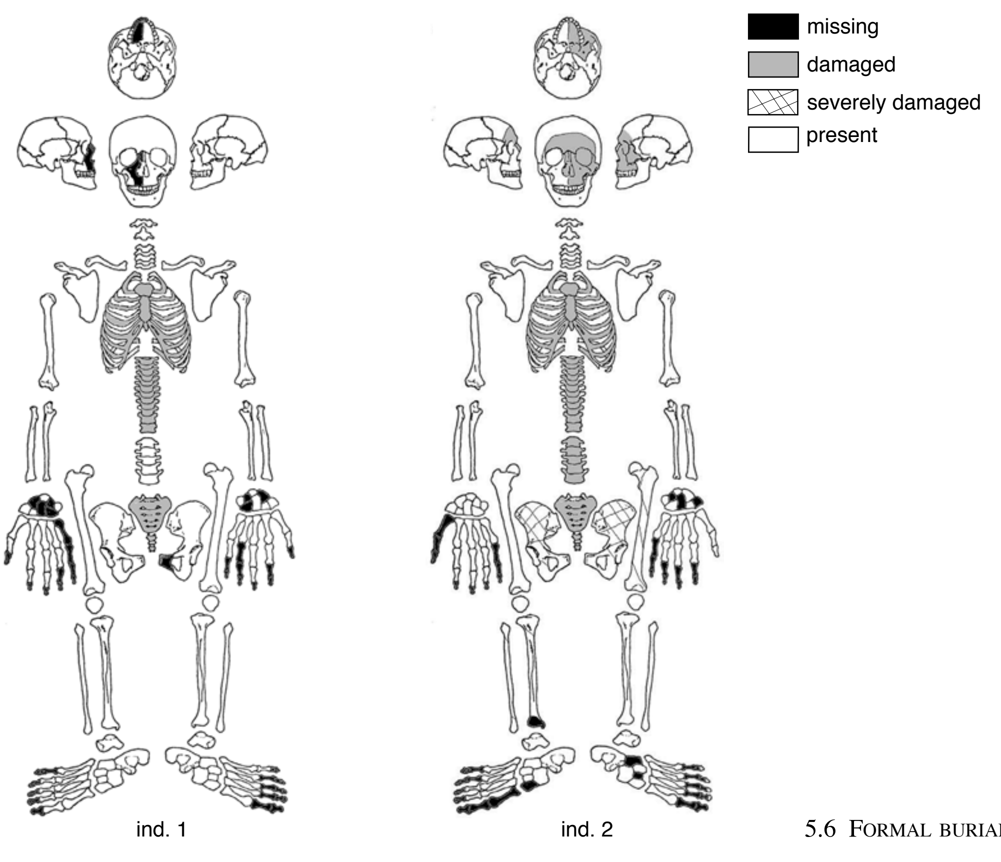
5.3 Measurements of long bones in cm (mean values of left and right sides) and calculated statures of adult individuals.

grave	ind.	L = greatest length	B = greatest width	cranial index (Bx100)/L	cranial index	squatting facet tibia
1	1	19,1	14,3	74,87	dolichocranial	present
1	2	–	–	–	–	present
2	3	19,7	13,5	68,53	dolichocranial	present
3	4	19,2	14,1	73,44	dolichocranial	present

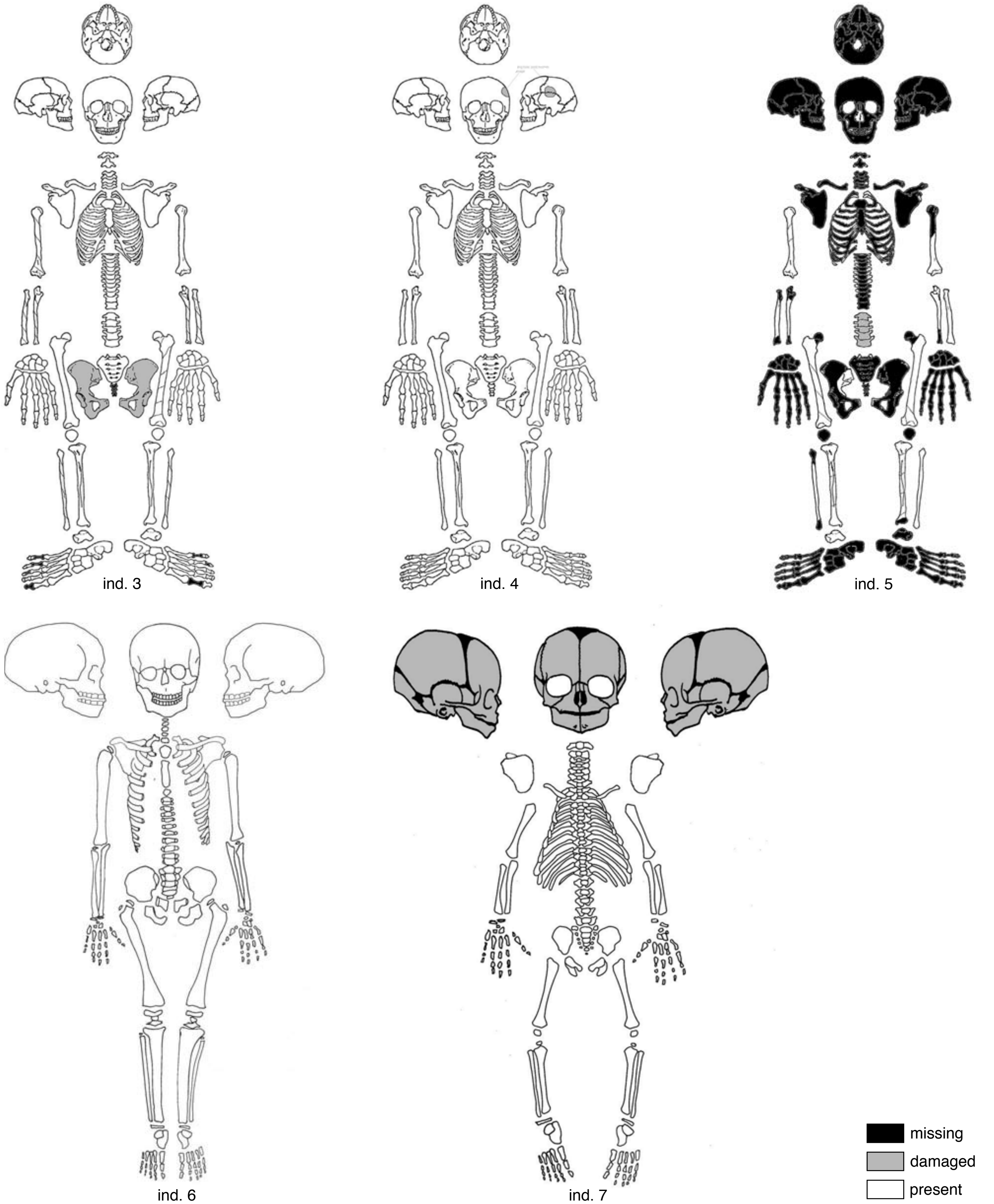
5.4 METRIC AND NON-METRIC TRAITS OF FOUR ADULTS BURIED IN FORMAL BURIALS.

grave	ind.	inspected positions	elements present	ante mortem loss	post mortem loss	caries	agenesis
1	1	27	22	–	7	–	3
1	2	32	30	–	2	–	–
2	3	32	32	–	–	–	–
3	4	32	30	2	–	–	–

5.5 DENTAL OBSERVATIONS ON FOUR ADULTS BURIED IN FORMAL BURIALS.



5.6 FORMAL BURIALS, PRESERVED SKELETAL PARTS.



5.6 Continued

6 The Schipluiden pottery

Daan Raemaekers
Michiel Rooke

The pottery assemblage from Schipluiden is the largest Hazendonk assemblage available. This, and the phasing of the site's occupation, allowed a detailed analysis of the chronological development of the pottery. The analysis showed that there are two Hazendonk 3 wares, distinguishable on the basis of tempering agents, wall thickness and wall decoration. The first, dominant ware is mainly quartz-tempered, relatively thick-walled and often decorated. The second ware is shell-tempered, relatively thin-walled and rarely decorated. Both wares were probably produced locally.

6.1 Introduction

This chapter discusses the objects of fired and burnt clay that were found at the Schipluiden site: ceramics and lumps of daub. First, the question whether the studied sherds may be regarded as representative of the pottery assemblage as a whole will be considered. After that, the pottery's characteristics will be discussed according to the life cycle of production, use and discard. On the basis of the outcome of that discussion a major research question will then be examined, notably whether it is possible to distinguish different wares. The cultural affinities of the inhabitants of Schipluiden will be examined in relation to those of contemporary sites in the micro-region and sites further upstream the Rhine and Meuse. Finally, the chronological trends in the pottery will be examined and viewed in a broader chronological context.

In section 6.5 the pottery from Schipluiden will be classified as Hazendonk pottery. This term refers to the Hazendonk site where a pottery assemblage was found underneath Vlaardingen find layers (Louwe Kooijmans 1974). This pottery was renamed Hazendonk 3 pottery when two more pre-Vlaardingen assemblages where found at the site (Louwe Kooijmans 1976). Re-analysis of this Hazendonk 1 and 2 pottery (Raemaekers 1999) showed that they should be interpreted as Swifterbant assemblages, albeit with a local touch. In this article we will return to the original classification and use the term Hazendonk pottery (*cf.* Louwe Kooijmans in press).

6.2 Data, selection

The collected sherds are not all the sherds encountered at the site. The assemblage is assumed to include all sherds from the sieved segments; in some of the other segments small sherds will probably have been overlooked. This issue was discussed in chapter 4. All sherds weighing more than 10.0 g were most probably recovered. From our perspective we may assume full find recovery.

All the sherds from trenches 10 and 14 with a minimum weight of 5.0 g were described in the first phase of analysis. On the basis of the 769 sherds in question and the total number of ceramic finds (3767 in total) it was concluded that a description of all sherds with a minimum weight of 5.0 g would involve around 8000 sherds. At an assumed rate of description of around a hundred sherds a day, this would have implied an amount of work probably unjustified for the research questions at hand. The sherds considered in the pilot study were used to determine whether a higher minimum weight would lead to the same patterns in sherd characteristics (chronological development and spatial patterns). Table 6.1 and fig. 6.1 present a comparison of the data based on minimum weights of 5.0 and 10.0 g. The table reveals few differences between the two weight categories. One comprehensible difference is a greater frequency of sherds with wall decoration when only the sherds with a minimum weight of 10 g are considered. The same phenomenon was previously noted for sites with similar pottery (Raemaekers 1997, fig. 26; Raemaekers 1999, figs. 3.8, 4.2). Evidently, the larger a pottery fragment, the greater the possibility of determining whether the pot from which it derives was decorated. In other words, at a certain point the percentage of decorated sherds comes to stand for the percentage of decorated pots. The spatial patterns based on minimum sherd weights of 5.0 and 10.0 g are virtually the same (fig. 6.1). It was concluded that a smaller number of described sherds would allow reliable conclusions to be drawn concerning sherd characteristics, chronology and spatial patterning. The minimum weight was set at 10.0 grams, leading to a total of 4557 described sherds. This number will figure as the total score in the remainder of this text.

The fragmentation of the sherds was studied on the basis of the weights of the individual sherds from trenches 10 and 14 because in the case of these trenches, all sherds with weights between 5.0 and 10.0 g were also analysed (fig. 6.2). The number of sherds decreases when the weight increases.

	minimum weight 5.0 grams		minimum weight 10.0 grams	
	N=	%	N=	%
number of sherds	769		441	
wall thickness				
average (mm)	10.0		10.2	
temper				
quartz	381	49.5	228	51.7
grit	69	9.0	49	11.1
grog	29	3.8	20	4.5
plant	32	4.2	16	3.6
shell	264	34.3	143	32.4
construction				
H-joints	319	94.1	202	94.0
N-joints	18	5.3	12	5.6
Z-joints	2	0.6	1	0.5
firing environment*				
ox-ox-ox	52	6.8	26	5.9
ox-ox-re	14	1.8	9	2.0
ox-re-ox	91	11.9	48	10.9
ox-re-re	54	7.1	35	8.0
re-ox-ox	14	1.8	8	1.8
re-ox-re	5	0.6	2	0.5
re-re-ox	108	14.1	68	15.5
re-re-re	409	53.5	233	53.0
indet.	18	2.4	11	2.5
decoration				
wall sherds	686		382	
wall decoration	58	8.5	49	12.8

* From left to right: inner side, centre and outer side.
ox = light (oxydation) colour; re = dark (reduction) colour.

Table 6.1 Pottery, comparison of characteristics of sherds >5.0 grams and >10.0 grams from trenches 10 and 14.[1]

Interestingly, the fragmentation curve is similar to the curves of both Wateringen 4 and the Hazendonk, level Hazendonk 3, two reference sites that will be discussed in section 6.5.1. One would expect that on average the sherds from the Hazendonk would be larger, because they were deposited in peat, suffered little weathering and could relatively easily be joined with other sherds to obtain larger pottery fragments. So, ruling out the effect of fragmentation, the small number of joined sherds from both Wateringen and Schipluiden must be exclusively attributable to the effect of weathering.

6.3 Methods

The analysis was carried out using the descriptive system developed by Raemaekers (1999) as a basis. Where necessary, the system was expanded in order to include attributes first encountered in the Schipluiden ceramics. Individual sherds were described on the basis of a series of attributes relating to the production and use of the pottery (see section 6.4). The use of this system enables a relatively straightforward comparison with pottery from other sites described using the same system (see section 6.5.1).

6.4 Analysis

6.4.1 Production

Clay sources

The diatom analysis showed that all the pots may have been produced locally; there are no diatom spectra suggesting that clay from other natural sources was used (chapter 15). This means that the pots were either produced at the site or were transported to the site from production areas with similar clays elsewhere. Site characteristics such as a large number of features and large amounts of debris (including pottery sherds) suggest intensive occupation; this makes the option of local production the most plausible.

Tempering agents

The selected clay was tempered with various materials: stone (quartz, granite and other types), shell, parts of plants and grog. Most of the sherds (90.8%) are tempered with only one of these agents. The others contain two or more materials. This high percentage suggests that the clay was often purposefully tempered with only one agent.

Quartz was apparently the most preferred temper. Of the quartz-tempered sherds, 85.7% contain no other types of temper. The most common admixture is grit (6.1%). The density and particle size distributions (table 6.2) show a dominance of low density and an average particle size of 2 mm. The unimodal distribution in the table suggests that this particle size and density were what the makers aimed to realize, but a small peak representing a high density of 1-mm particles suggests a second set of quartz-tempered pottery.

The second largest group consists of sherds tempered with types of stone other than quartz (grit). Of these sherds, 73.5% contain no other type of temper. Quartz is the most frequent admixture (15.7%). In most cases it was impossible to determine which type of stone was used. In 93 sherds (red) granite was identified; it may be assumed that the temper in some of the other grit-tempered sherds will also be granite. A second feature peculiar to Schipluiden is the occurrence of mica (1-4 mm) in various sherds. In this study mica was however not considered a tempering agent because it occurs naturally in deposits around the site. The density and particle size distributions of the grit (table 6.2) are similar to those of the quartz-tempered sherds. There is a similar unimodal distribution revealing a focus on a low density of grit particles with an average particle size of 2 mm. The resemblance to the quartz sherds suggests that clay with similar temper characteristics was desired.

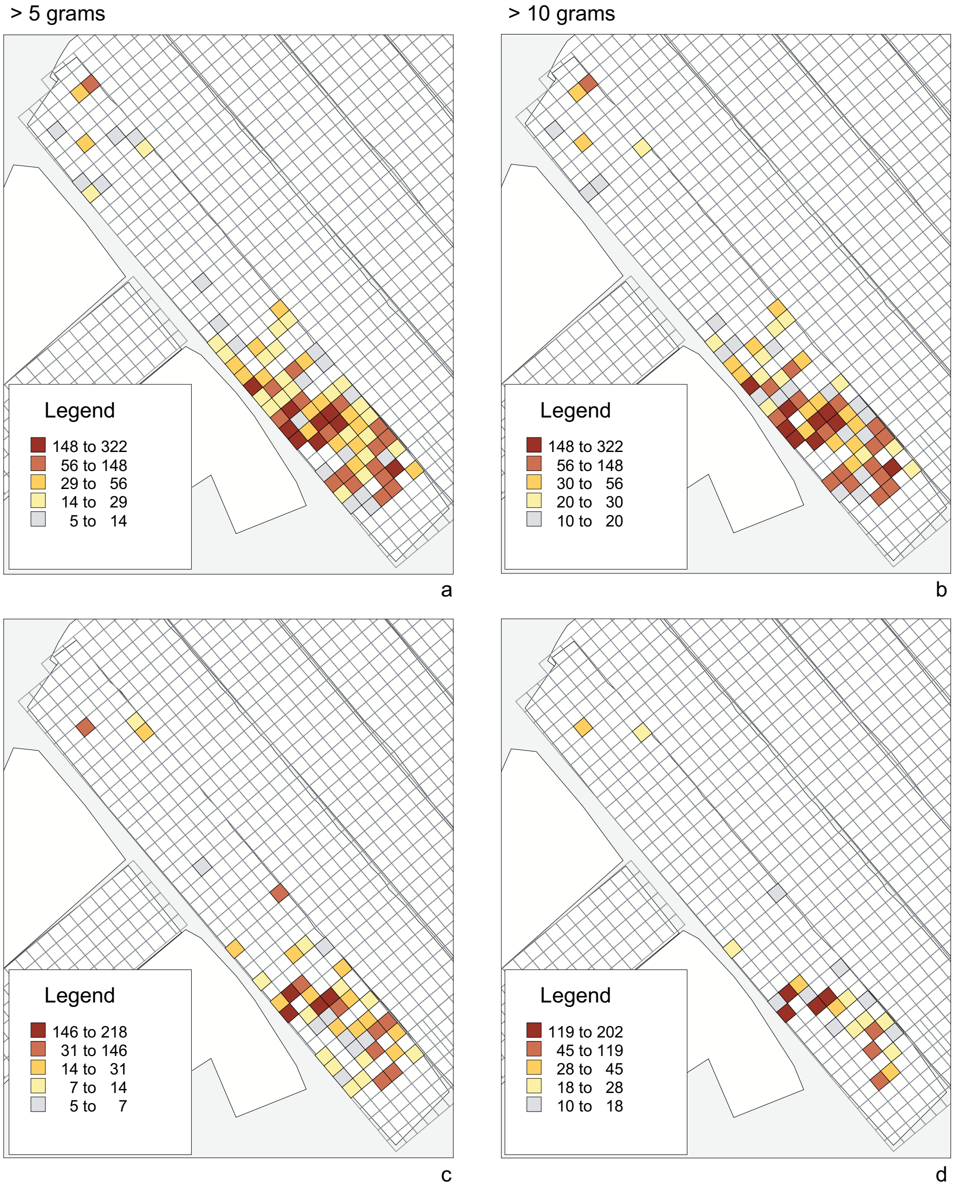


Figure 6.1 Spatial patterns in trench 10 on the basis of minimum sherd weights of 5.0 (left) and 10.0 g (right).
a-b all sherds
c-d shell-tempered sherds.

The third largest tempering agent consists of shell fragments. Of the shell-tempered sherds, 92.6% contain no other types of temper. The main admixture is plant matter (2.9%). Table 6.2 shows a unimodal distribution centring on an average particle size of 2 mm and an average or high density of shell particles. At the start of the analysis, shell-tempered sherds appeared to be difficult to identify. In the first place, shell is an uncommon tempering agent in pottery from this period, so sherds with pores were initially identified as plant-tempered. However, closer analysis of sherds whose temper had not been completely burnt during the firing revealed white crumbs. They were identified as shell fragments on the basis of a thin-section analysis by G. van Oortmerssen (Laboratory of Conservation & Material Sciences, University of Groningen) and microscopic examination by W. Kuijper (Faculty of Archaeology, Leiden University). The crumbs were in two cases identified as deriving from cockle shells, *Cerastoderma* spec.. A handful of sherds showed large identifiable impressions of cockle fragments (fig. 6.3). These positive observations enabled a distinction to be made between plant- and shell-tempered sherds: sherds tempered with ground shell contain small, thick, flake-shaped pores aligned parallel to the wall surface.

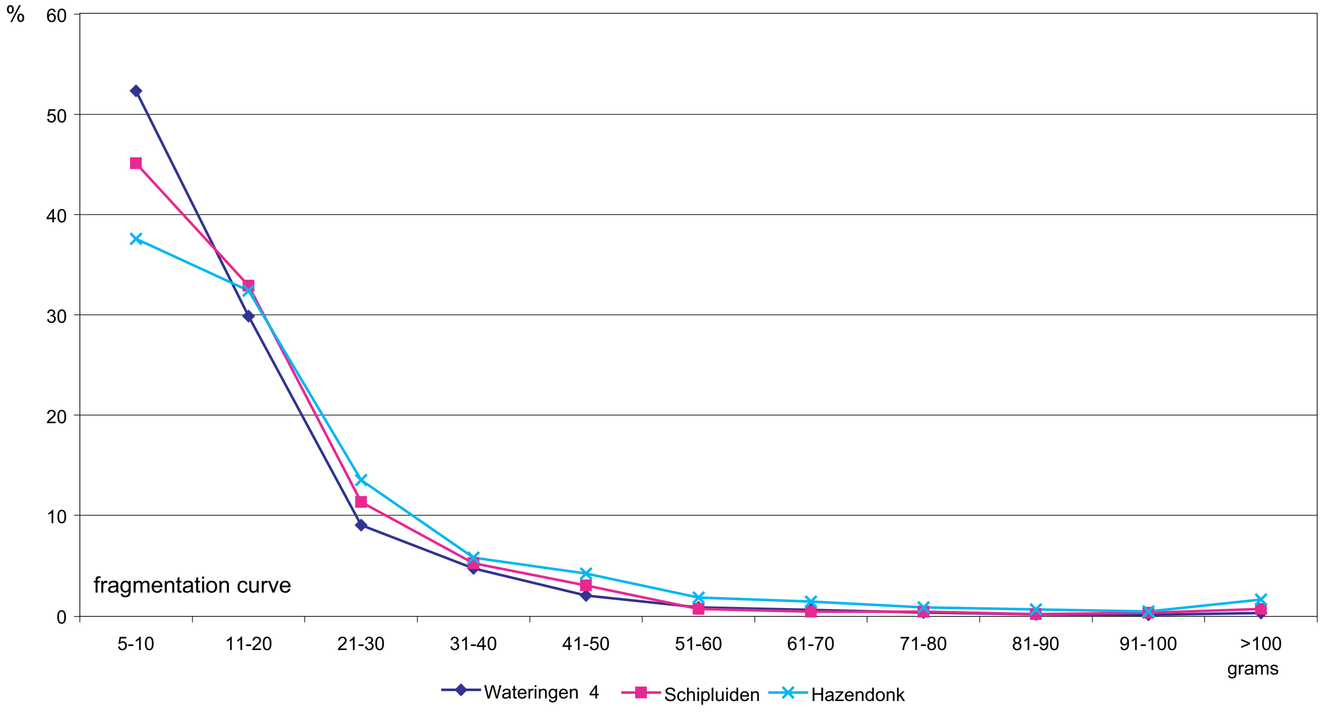


Figure 6.2 Sherd dimensions for Schipluiden, Wateringen 4 and Hazendonk 3.

The fourth tempering agent is plant material. Of the plant-tempered sherds, 73.5% contain no other types of temper. The main admixture is quartz (15.7%). The average particle size was not determined. Plant material was encountered mostly in low or average densities (table 6.2).

The last tempering agent found in the pottery is ground sherd fragments (grog). Only 49.7% of the grog-tempered sherds contain no other types of temper. The most important admixture is quartz (39.8%). The density and particle size distributions (table 6.2) are fairly similar to those of the quartz-tempered sherds. There is again a unimodal distribution with a focus on a low density of grog particles with an average particle size of 2 mm. The close resemblance to the quartz-tempered sherds suggests that clay with similar temper characteristics was desired.

Types of joints
The pottery was built up from coils (fig. 6.4e) that were connected via three types of joints (H, N, Z: Raemaekers 1999, 195). The coiling technique was rather crudely employed, judging from the large proportion of sherds with fractures revealing the type of joints (56.1%). Most joints are fairly straight H-joints. The others are N-joints and Z-joints (table 6.6). There is no relation between the type of joints and the employed tempering agents.

Figure 6.3 Impressions left by burnt shell temper (magnification 5×).

Wall thickness
The average wall thickness is 10.6 mm. The wall thickness appears to be related to the employed tempering agent(s) (see section 6.4.3). Grog-tempered sherds are on average the thinnest (9.5 mm); shell-tempered sherds have the greatest average wall thickness (11.3 mm).

Morphology
Due to the fact that the assemblage concerns settlement debris, information on morphological aspects is rather limited (figs. 6.5-6). The 44 largest rim fragments were all selected to make profile drawings and measure rim diameters. The drawings show that the majority of the sherds derive from open types (buckets, N=16) and closed types (barrels, N=27). One beaker and one vessel with an S-shaped profile were represented. When the sherds are considered in relation to the tempering agents, those tempered with grog, plant material and shell are all found to derive from buckets, but this is a biased conclusion, based on only a small number of observations. Rim diameters could be estimated in the case of 26 rim fragments. They vary from 14 to 28 cm. There appear to be no size groups. The rim diameters seem to be unrelated to the tempering agents (fig. 6.7).

The shapes of the bases vary considerably, with pointed (2), round (17), flat (54), hollow (4) and protruding foot bases (2) being represented. There is no relation between base shapes and tempering agents. The assemblage contains two elongated lugs, one with a horizontal perforation (nos. 6331 and 7855, fig. 6.5).

Surface finish
Finishing techniques were rather simple. Most of the sherds have a smooth, uneven or rough surface. Polishing was observed on only three sherds and brush marks (*Besenstrich*) were found on ten sherds.

Wall decoration
A total of 401 wall sherds are decorated (9.6%). Of these sherds, 270 bear single fingertip impressions; 16 sherds have paired fingertip impressions. Spatula impressions were observed on 103 sherds and grooves on 38 sherds. One sherd was decorated with a hollow spatula and two show a combination of single fingertip and spatula impressions. It is not possible to say what instrument was used to create the decoration on the remaining eight sherds. In general, the wall decoration covers the entire wall surface excluding the rim zone (the top 2 cm), which was in the case of many pots a separate zone characterised by narrowing of the wall thickness and/or a curve outwards. Six sherds derive from pots on which the rim zone was included in the wall decoration (*e.g.* nos. 1358 and 5740, figs. 6.5-6).

quartz					
average particle size (mm)	1	2	3	>3	total
low density	268	**470**	247	73	**1058**
average density	112	229	185	46	572
high density	192	155	139	58	544
total	572	**854**	571	177	2174
grit					
average particle size (mm)	1	2	3	>3	total
low density	123	**217**	110	12	**462**
average density	47	114	54	2	217
high density	53	93	45	17	208
total	223	**424**	209	31	887
grog					
average particle size (mm)	1	2	3	>3	total
low density	12	**53**	24	5	**94**
average density	8	31	17	1	57
high density	2	23	11	0	36
total	22	**107**	51	6	187
shell					
average particle size (mm)	1	2	3	>3	total
low density	20	85	34	6	145
average density	25	**229**	111	5	**370**
high density	39	196	122	8	365
total	84	**510**	267	19	880

plant	
	total
low density	**233**
average density	226
high density	91
total	550

Table 6.2 Pottery, size versus density for various tempering agents. The highest scores are indicated in **bold**.

This general picture can be given more detail by relating it to the tempering agents. This reveals first of all a striking similarity in the proportions of the aforementioned types of decoration (table 6.3). The proportions of decorated wall sherds reveal major differences, with 15.6% of the quartz-tempered sherds and only 1.1% of the shell-tempered sherds being decorated (see section 6.4.3).

Rim decoration
In total, 418 rim fragments were described. Rim decoration was recorded for seven sherds, six of which are sherds on which the wall decoration included the rim zone (see above); this should therefore not be interpreted as rim decoration *per se*. One sherd has a rim perforation. So the overall conclusion must be that rim decoration is absent.

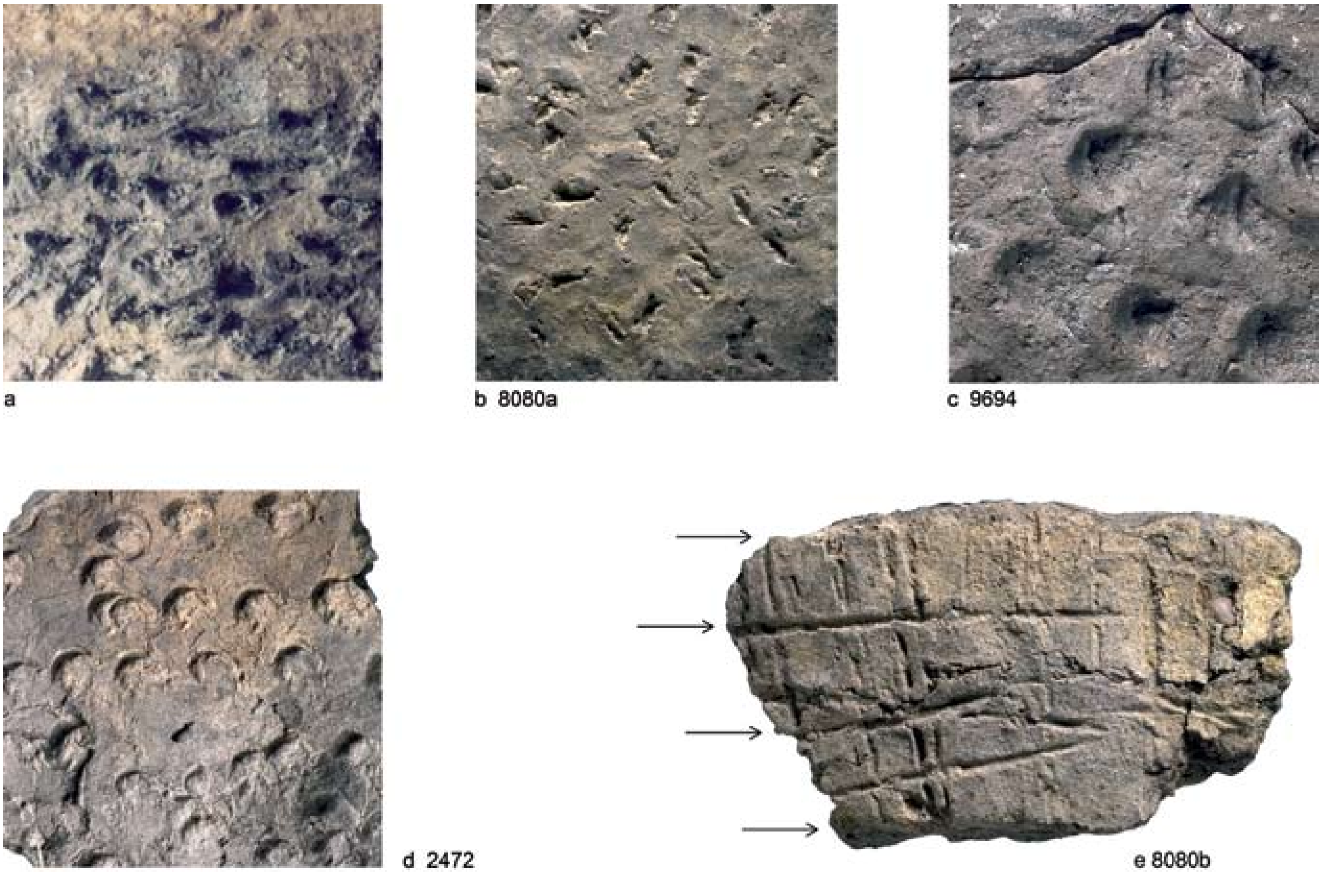


Figure 6.4 Typical aspects of the Schipluiden pottery (scale 1:1).
a, b, d spatula impressions
c fingertip impressions
e vertical lines, horizontal fractures reflecting joints of coils

Firing

The last step in the production process was firing. The absence of kiln remains and the poor quality of the pottery suggest that the pots were fired in an open fire. The colour of the pots could be influenced by controlling the influx of oxygen. Plenty of oxygen leads to a light-grey to yellow-red fabric; reducing the influx of oxygen by covering the fire with sods leads to a dark-grey to black fabric. The atmo-sphere in which the pots were fired was analysed on the basis of the colour of the cross-section of the sherds. As a rule of thumb, the colour of the central part is taken to be indicative of the first stage of firing; the colours of the exterior and interior surfaces are assumed to indicate the firing conditions in the last stage. Most sherds have a dark cross-section all through; sherds of which only the exterior is light-coloured may have been fired in a hot oxygen-rich atmosphere (for use as a cooking vessel). Other sherds have a dark centre and a lighter exterior and interior, suggesting a low oxygen concentration in the first firing phase and a high oxygen concentration in the second phase. The other sherds have cross-sections comprising other colours. The percentages suggest that firing in an atmosphere with a low oxygen content was preferred: the dark colour results from deliberate influencing of the influx of oxygen. There is no relation between the firing atmosphere and the tempering agents.

6.4.2 Use

Food remains / soot

746 sherds were found to be encrusted with food remains or soot, suggesting that many, if not all of the pots were used as cooking vessels. Analysis of food remains found on seven sherds showed that porridge was made (see chapter 20). Remains were found encrusted on interior surfaces (387 sherds), exterior surfaces (280) and both surfaces (79).

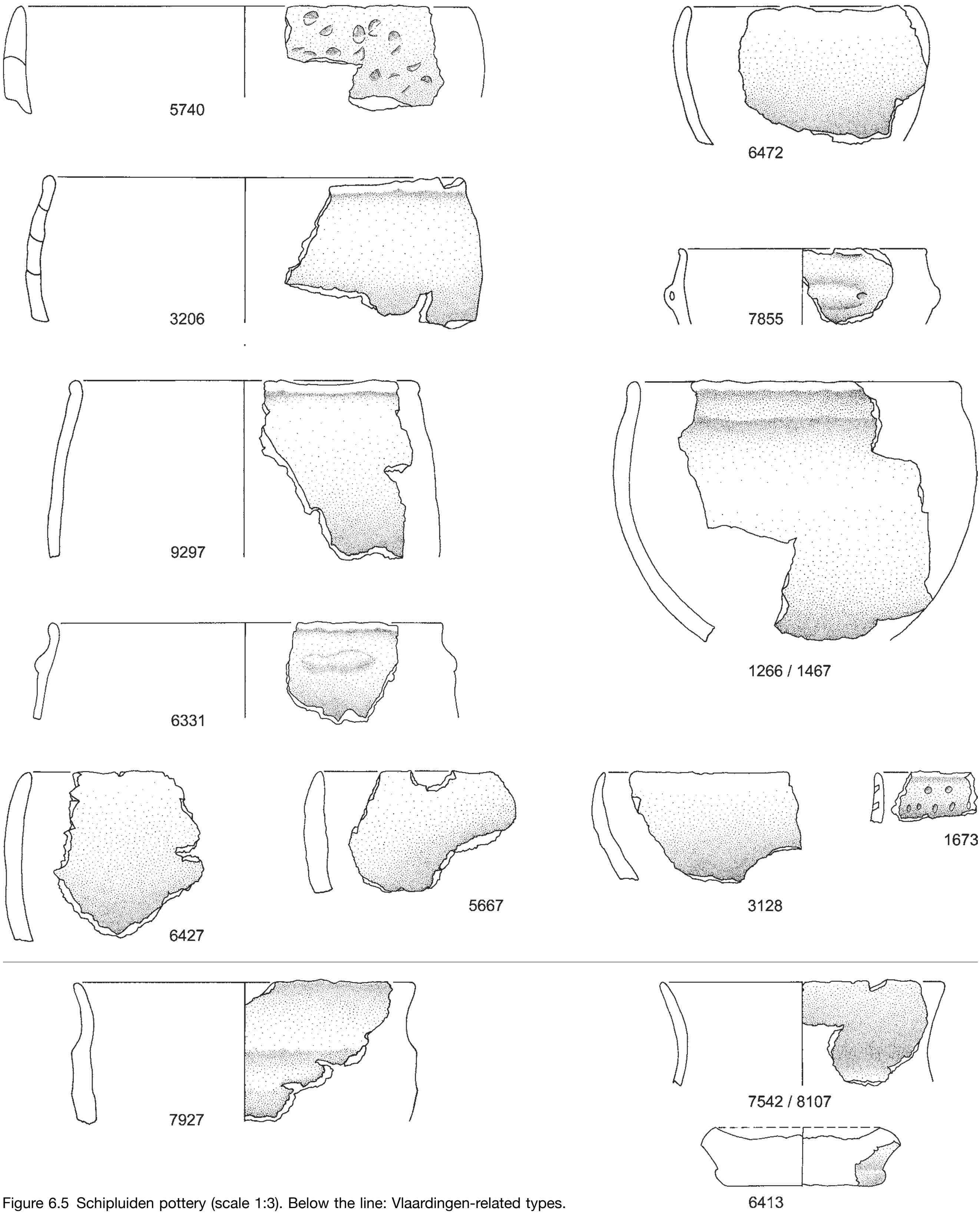


Figure 6.5 Schipluiden pottery (scale 1:3). Below the line: Vlaardingen-related types.

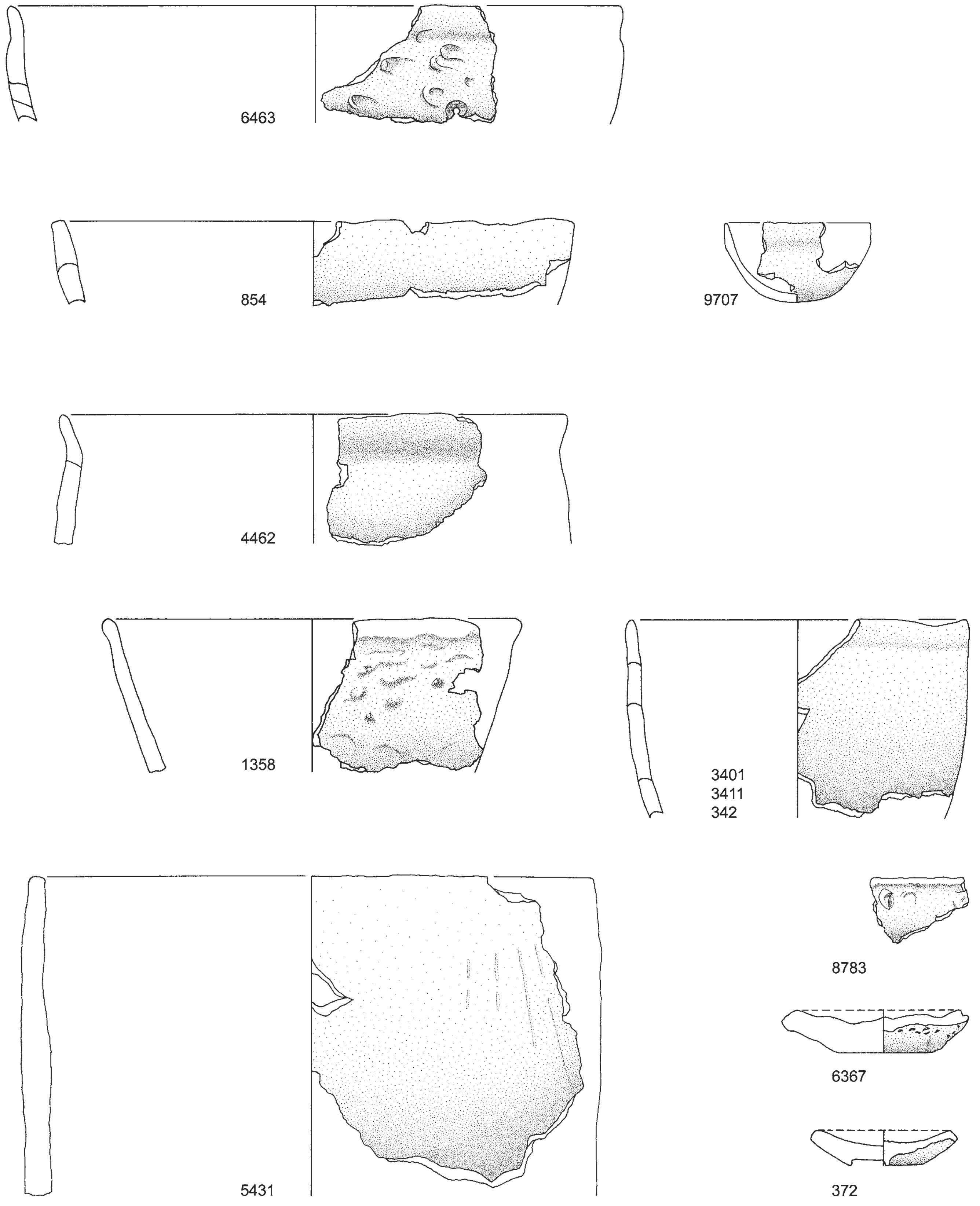


Figure 6.6 Schipluiden pottery (scale 1:3).

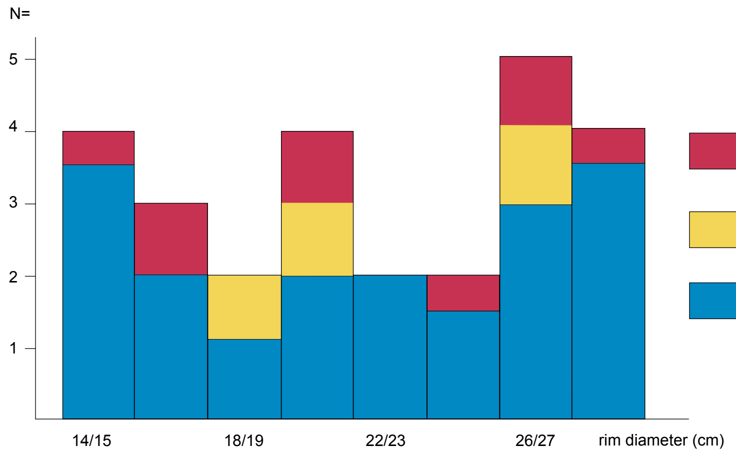


Figure 6.7 Tempering agents in relation to rim diameters.

temper	quartz	grit	grog	plant	shell	all
N=	1881	754	165	477	745	3922
wall decoration %	15.5	8	10.3	5	1.1	10.2
single fingertip	62.7	55	82.4	66.7	75	63.6
paired fingertip	3.8	5	–	4.2	–	3.7
single fingertip + spatula	0.7	–	–	–	–	0.5
spatula	27.4	8.3	17.6	20.8	–	23.4
hollow spatula	0	0	–	4.2	–	0.2
groove lines	4.5	30	–	4.2	12.5	7.5
indet.	1	1.7	–	–	12.5	1
Totals	*100*	*100*	*100*	*100*	*100*	*100*
av. wall-thickness (mm)	10.2	10.6	9.5	11.1	11.3	10.6

Table 6.3 Pottery, wall decoration and average wall thickness versus tempering agents.[1]

Repair holes
Holes with a typical hourglass cross-section were found in 24 sherds (*e.g.* no. 6463, fig. 6.6). The holes were produced after firing, probably to repair fractures. Small fracture lines – resulting from thermal stress after repeated use of a cooking vessel – will have been repaired by making holes on either side of the fracture and tying the parts together with a cord or a leather thong. This way, a cooking vessel could be given a new lease of life as a storage vessel.

6.4.3 *Chaîne opératoire or chaînes opératoires?*

The concept of *chaîne opératoire* proposed by Lemonnier (1986) is often used to describe the technological framework in which artefacts were produced. The concept is gradually becoming a common tool in the study of flint assemblages, but it also holds promise in the study of pottery. In the case of pottery, it entails considering described attributes in the sequence in which a pot was produced and used. The various production stages will be considered below, except for the final discard stage, which will be discussed in a separate section (section 6.4.4).

The Schipluiden pottery was produced from locally available clays. The clay was tempered with mostly low densities of various tempering agents and formed into bucket- and barrel-shaped pots with diameters of between 14 and 30 cm using the coiling technique. In some instances the pottery was subse-quently decorated with fingertip or spatula impressions applied to the wall surface. The rim zone (approx. 2 cm) was left undecorated. Pots were fired in an open fire in which the influx of oxygen was to some extent controlled, resulting in a dark
fabric. The pots were used as cooking vessels and storage vessels. Their life ended as sherd debris in and around the settlement. A few sherds saw rebirth as grog temper in new pots.

With this general description as a starting point, the question arises whether other attributes were predetermined in the second stage of the production process, the tempering of the clay. A positive answer to this question would imply that we are dealing with wares with specific characteristics, and not with a single large group of pottery, in other words, that there were several *chaînes opératoires*. In the case of most attributes no relation to the tempering agents was observable. Below, the attributes that seem relevant to the discussion will be considered one by one.

First of all, the selection of tempering agents is noteworthy. There was apparently a cultural preference for quartz and other types of stone that were not locally available that was so strong that they were deliberately imported. The quartz, grit and grog tempers were processed in more or less the same way, leading to relatively homogeneous fabrics containing low densities of tempering agent(s) with an average particle size of 2 mm. Quartz was evidently the most preferred tempering agent; it was replaced with grit (and grog) if not available. Shell temper is uncommon in the Netherlands, but was frequently encountered in the Schipluiden pottery. The divergent characteristics in terms of temper density suggest that the shell-tempered pottery represents a second type of ware at this site. On average, shell temper was found in a higher density than quartz temper. Perhaps their white colour made shell fragments a suitable replacement for quartz. It should however be borne in mind that shell temper will have been burnt away from the surface during firing, leaving no visual reminder of the employed tempering agent. When this division between pottery tempered with quartz/grit/grog and shell-tempered pottery is followed through it is found that the choice of temper admixtures follows similar lines (fig. 6.8). Quartz and grit were evidently mutually replaceable favourite admixtures, while shell temper is generally encountered without admixtures.

Secondly, this division is also observable in the average wall thickness. The sherds tempered with quartz, grit or grog have an average wall thickness of 10.3 mm; the average wall thickness of shell-tempered sherds is 11.3 mm. A third attribute in which this contrast is observable is the presence of wall decoration. Wall decoration is relatively abundant (13.2%) on sherds tempered with quartz/grit/grog whereas shell-tempered sherds are rarely decorated (1.1%).

The patterns outlined above are based on the assemblage as a whole; a subdivision according to the three occupation phases would be preferable. Such a subdivision is presented in table 6.4. It shows that the aforementioned differences between quartz-tempered and shell-tempered sherds in terms of average wall thickness and wall decoration percentage are observable in pottery from all the occupation phases (see also section 6.5.2). This is a strong argument in favour of the existence of two wares, and hence two *chaînes opératoires*, the first ware being relatively thick, shell-tempered and virtually undecorated and the second (usually) quartz-tempered, thinner and more frequently decorated.

phase	1	2a	2b	3 Unit 10	3 Unit 11
av.wall thickness (mm)					
quartz	11.6	10.4	10.1	10.1	9.8
shell	12.8	11.6	10.8	11.1	10.6
wall decoration %					
quartz	15.0	14.8	16.2	20.0	13.7
shell	1.0	1.1	4.0	–	4.0

Table 6.4 Pottery, average wall thickness and percentage of wall decoration for sherds tempered with quartz and shell per occupation phase.[1]

6.4.4 *Discard*

After some time, the Schipluiden pots were discarded. Fitting sherds were found at maximum distances of 10 m. The small number of refits (ten) suggests that pots were generally not discarded in one go.[2] When a pot broke beyond repair, some fragments were discarded while other, larger ones were used for storage purposes (see above) or perhaps as bowls or spoons (although there is no evidence to support the latter forms of secondary use). In other words, pots were discarded over a period of time and their remains ended up scattered across the site – and probably also beyond. Some pots are easily identifiable among the sherds. Many of the sherds concerned do not form part of the assemblage. They were destroyed by weathering or trampling, discarded (just) outside the excavated area or taken away on trips outside the site. A few sherds were ground to obtain grog for tempering new pots.

The discard patterns are illustrated in figs. 6.9-10. The general pattern (fig. 6.9) is that of a dense spread on the southeastern slope and a thinner spread on the northwestern slope. It should be borne in mind that erosion resulted in the almost complete absence of finds on the central part of the dune (chapters 2 and 4). A breakdown of this general pattern into phases 1, 2a, 2b and 3 yields no new information (figs. 6.10a-d). No discrete patterns of, for example, types of decoration are observable within these general patterns. The fact that subsets of sherds based on temper or decoration all reveal similar patterns suggests that the whole site was occupied throughout the entire period of occupation. There are no small-scale spatial patterns suggesting shifting occupation or households with individual pottery characteristics.

The second group of burnt clay objects consists of lumps of daub. Only 22 of such lumps were recovered, evenly distributed over the excavation area and the various units.

6.5 Conclusion

6.5.1 *General*

The locally available clay was mixed with different types of temper and formed into bucket- and barrel-shaped pots with diameters of between 14 and 28 cm with the aid of the coiling technique. The pots were decorated with fingertip or spatula impressions applied to the wall surface. When the clay had dried, the pots were fired in an open fire in which

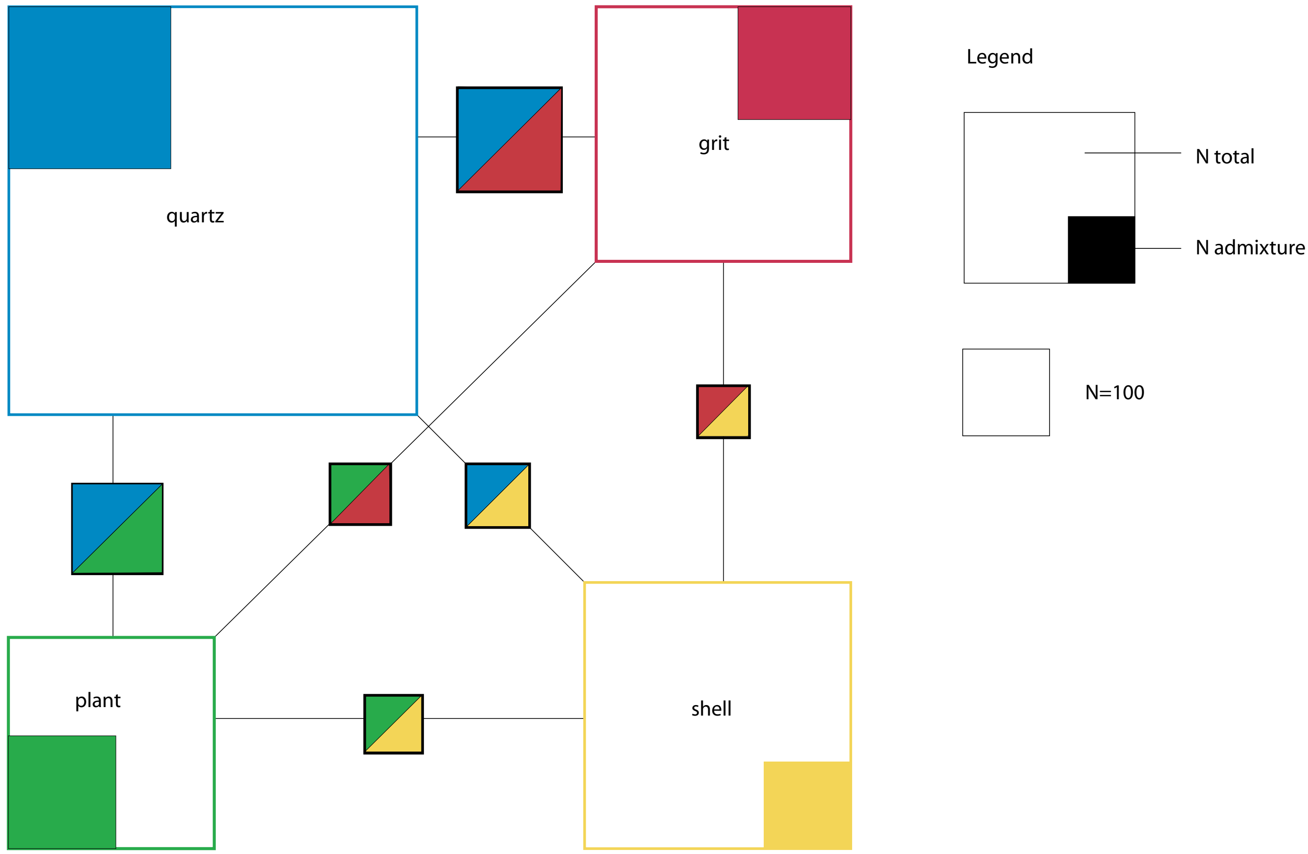


Figure 6.8 Admixtures of tempering agents. Open squares: total number of sherds containing a specific tempering agent. Colour: sherds with admixtures.

the influx of oxygen was to some extent controlled. The pots were used as cooking vessels and storage vessels.

All characteristics suggest that the Schipluiden pottery is to be classified as belonging to the Hazendonk pottery group. This is further supported by the ^{14}C dates obtained for the site. A recent overview of the sites of this group can be found in Raemaekers 1999. In this section, the Schipluiden pottery will be compared with two major assemblages from the same region, notably those of Ypenburg (Koot/Van der Have 2002; Raemaekers unpublished report) and Wateringen 4 (Raemaekers 1997), and the eponymous assemblage from the Hazendonk site, further upstream (Louwe Kooijmans 1974; Raemaekers 1999).

The Schipluiden assemblage is the largest set of Hazendonk 3 pottery available for study. More important is that this assemblage has for the first time made it possible to subdivide the Hazendonk 3 pottery into three phases (see section 6.5.2). A key question is whether these three phases are of relevance to the Schipluiden site only, or allow more precise dating of the other Hazendonk 3 assemblages, too. This question is rather difficult to answer due to the possibility of differences between assemblages being attributable not only to chronological changes in style, but also to regional or local preferences for, for example, specific tempering agents or types of decoration.

Some of the sherd characteristics of the four sites are given in table 6.5. Two distinct patterns emerge from this table. First, there seems to be a major difference between Schipluiden and Ypenburg on the one hand and Wateringen 4 and the Hazendonk on the other. The pottery from the first two sites shows a correlation between tempering agents, average wall thickness and percentage of wall decoration not observable in the earthenware from the other two sites. Secondly, there is a distinct difference in the frequency of different types of decoration between the pottery of the three sites on the coastal dunes and that of the Hazendonk river-dune site. Grooves were a popular form of decoration at Hazendonk but are much less frequently observed on the pottery from the coastal area. So there is a considerable degree of variation in terms of tempering agents and

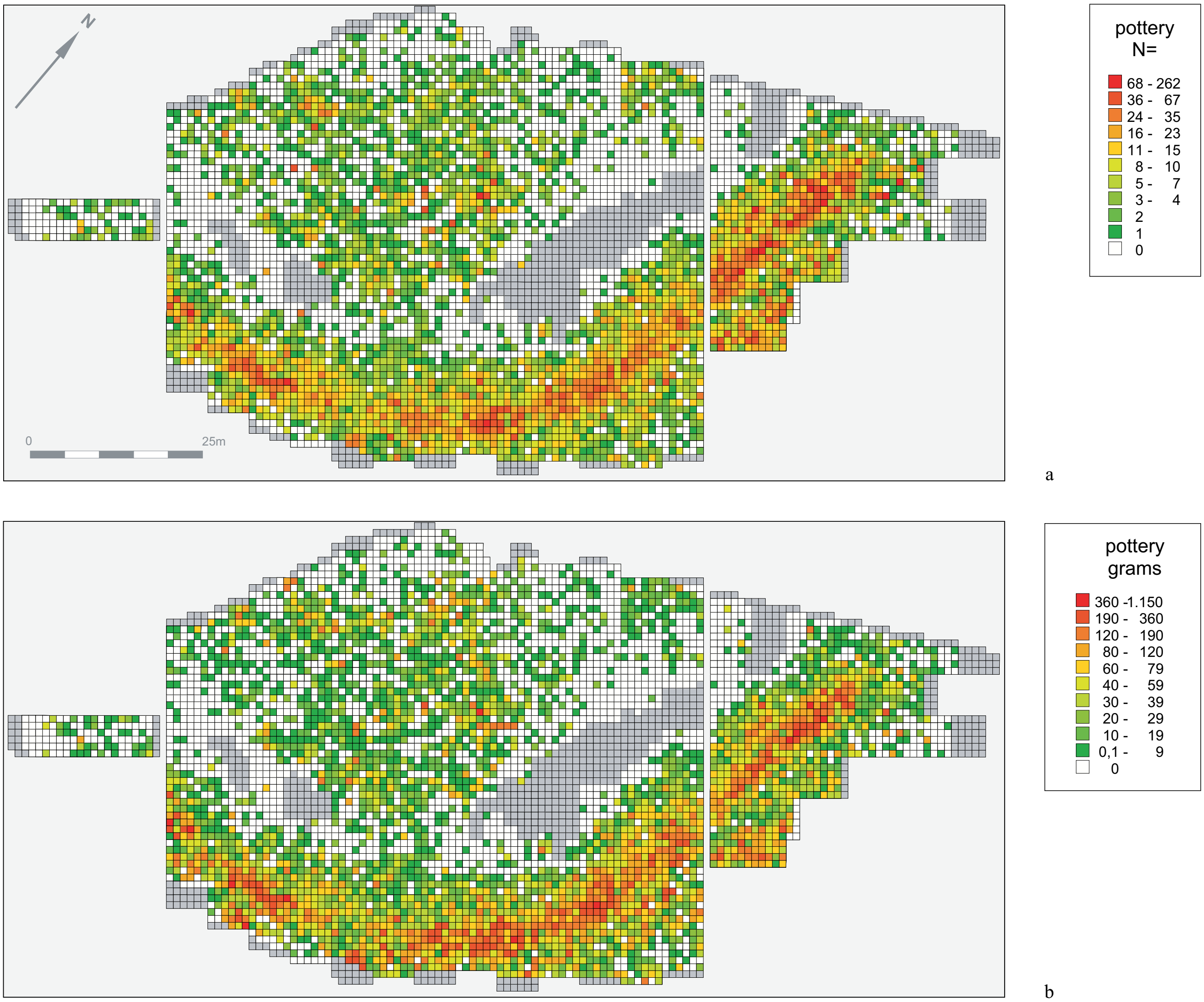


Figure 6.9 Distribution patterns of manually collected pottery per square metre; number of finds (a) and total weight (b).

decoration within the relatively well-defined Hazendonk pottery group. This variation occurs within a group with strong morphological and technological coherence and a common vocabulary of decoration types and themes (covering the entire wall surface except for the top 2 cm). The correlation between tempering agents, average wall thickness and frequency of decoration is also observable in the pottery from Ypenburg, but not in that from Wateringen 4 and the Hazendonk. This difference could be associated with differences in the length of occupation. Schipluiden and Ypenburg were both occupied for several centuries, whereas Wateringen was probably occupied for only one or a few generations. The Hazendonk 3 find layer at the Hazendonk site was probably produced in an even shorter period.

The pottery of two important Hazendonk group sites further upstream is more difficult to relate to that of Schipluiden. The sites in question are Gassel (Verhart/Louwe Kooijmans 1989) and Het Vormer (Louwe Kooijmans 1980), both near Nijmegen. The pottery from these sites was analysed using a different descriptive system. This prohibits a quantitative comparison. A qualitative comparison shows that in terms of morphology, technology (tempering agents, coils) and decoration, the pottery from these sites is definitely to be classified as belonging to the Hazendonk

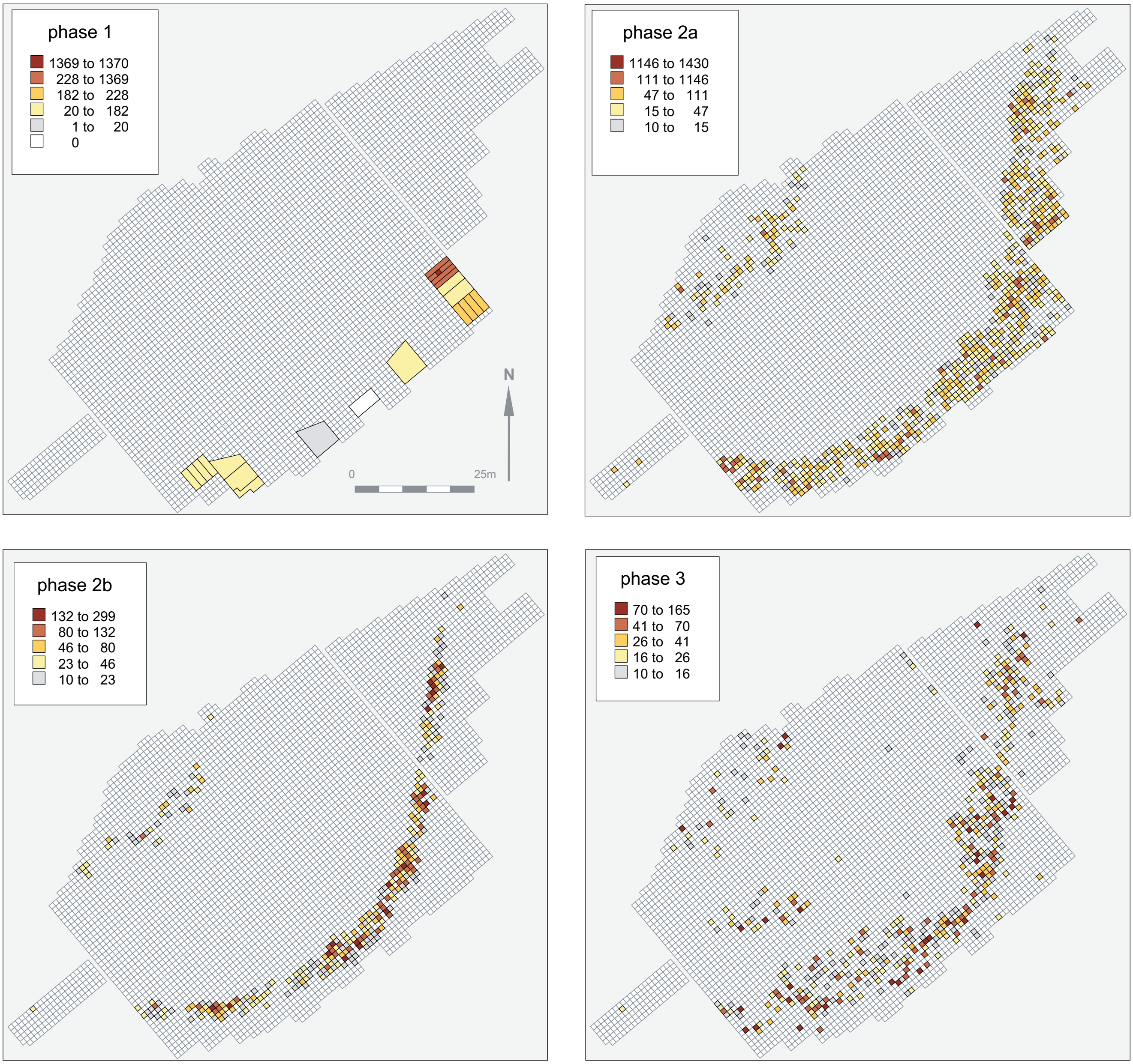


Figure 6.10 Distribution patterns of pottery from phases 1, 2a, 2b and 3.

group. The morphological system developed by Louwe Kooijmans for the pottery of Het Vormer comprises three basic types: bowls (I), beakers (II) and barrels (III). The beakers and barrels are represented in all Hazendonk assemblages; the bowls are absent from some.

The youngest ^{14}C date obtained for Schipluiden is younger than the oldest date obtained for the Vlaardingen group, the successor of the Hazendonk group in large parts of the western and southern Netherlands (Lanting/Van der Plicht 1999/2000, 68). Although it could be argued that Hazendonk and Vlaardingen were to some extent contemporary, it is preferable to use the calibration curve to pinpoint the transition from the Hazendonk group to the Vlaardingen group. The calibration curve has a large plateau around 4500 BP, spanning the period *c.* 3250-3125 cal BC (Stuiver *et al.* 1998, fig. A14). The available dates for Schipluiden

	Schipluiden	Ypenburg	Wateringen 4	Hazendonk
N=	4557	646	1474	363
tempering agents (%)				
quartz	47.7	43.0	87.1	92.3
grit	19.5	–	20.8	–
grog	4.1	9.4	48.5	19.3
plant	12.1	49.4	73.7	73.8
shell	19.3	6.2	–	–
average wall-thickness (mm)	10.6	8.7	9.9	9.2
quartz-tempered	10.2	7.2	9.7	9.3
grit-tempered	10.6	–	9.8	–
grog-tempered	9.5	8.8	9.6	8.5
plant-tempered	11.1	9.9	9.8	9.2
shell-tempered	11.3	11.6	–	–
wall decoration (%)	9.6	15.9	29.3	28.4
quartz-tempered	15.5	30.0	31.7	26.0
grit-tempered	8.0	–	26.1	–
grog-tempered	10.3	50.8	29.9	25.7
plant-tempered	5.0	6.6	28.5	26.1
shell-tempered	1.1	0	–	–
wall decoration types (%)				
single fingertip	61.6	66	56.0	35.0
double fingertip	3.7	3	9.2	–
single fingertip + spatula	0.5	2	–	–
spatula	23.5	31	24.5	27.2
hollow spatula	0.2	–	5.3	4.9
groove lines	8.7	1	–	32.7
indet.	1.8	–	4.9	–

Table 6.5 Comparison of the Schipluiden pottery with pottery from Ypenburg (Raemaekers unpublished), Wateringen 4 (Raemaekers 1997) and Hazendonk, level Hazendonk 3 (Raemaekers 1999). N.B. All data are based on a minimum sherd weight of 10.0 gr.[1]

(chapter 2) and the one Vlaardingen 1a date (obtained for a tree trunk) make a date of around 3200 most plausible for the Hazendonk/Vlaardingen transition. This would make the Schipluiden pottery from occupation phase 3 the youngest Hazendonk pottery so far known.

The question is whether the transition from Hazendonk to Vlaardingen is observable in the Schipluiden pottery. It would for example be nice to observe a gradual decrease in the percentage of wall decoration, ending in the virtually undecorated Vlaardingen pottery. Unfortunately, this is not the case: the youngest Schipluiden pottery shows the highest percentage of decoration. Nevertheless, there are a few elements in the Schipluiden pottery that are reminiscent of Vlaardingen pottery (fig. 6.5). These elements are three fragments of S-shaped pots (one from phase 3, nos.7927, 7542/8107), one pot with an elongated rim (no. 1059/1060, not illustrated), two protruding foot bases (phase 2) and one sherd with a rim perforation (phase 2).[3] All in all, this is not very strong supporting evidence, but, with the other Hazendonk sites having yielded no evidence whatsoever, it is at least something to go on.

6.5.2 Trends

The sequence of the clay and peat deposited around the dune theoretically allows a detailed analysis of the development of pottery characteristics during the occupation period. The majority of the sherds could however not be used for such an analysis because they were recovered from units containing remains that may derive from different phases. So only sherds recovered from the southeastern slope of the dune were used. Phase 1 comprises the sherds from Unit 19, phase 2a the sherds from Units 17 and 18 and phase 3 the sherds from Unit 10. The limited amount of material from phases 1 and 3 prohibits major conclusions. Table 6.6 presents the sherd characteristics of the three phases. There are no clear-cut present/absent differences between the phases, but a number of trends are nevertheless observable in the characteristics. First of all, the sherds from phase 2a are on average thinner, less often tempered with shell and more frequently decorated than those from phase 1. Compared with the sherds from phase 2a, the phase 3 sherds are more often tempered with quartz and grit than with shell, and show a higher percentage of decoration. The proportion of sherds with dark cross-sections shows a decrease. A development in pottery morphology cannot be proposed on the basis of the limited number of large pottery fragments that can be ascribed to one of the three phases (see figs. 6.5-6).

On the basis of this framework, characteristics of sherds from Units 15/16 (phase 2b, but possibly with some admixture of older remains) and Unit 11 (phase 3, again possibly with some admixture of older remains) were included in the diachronic analysis (table 6.6). The analysis showed that the characteristics of the sherds from Units 15/16 are strikingly intermediate between those of phase 2a (Units 17/18) and phase 3 (Unit 10). This suggests that the remains from Units 15/16 are also intermediate in age, with comparatively little admixture from the earlier phases 1+2a.[4] The characteristics of the sherds from Unit 11 are most comparable with those of the sherds from Unit 10, suggesting limited admixture of older remains in Unit 11.

Table 6.4 shows that the characteristics of the pottery from Wateringen 4 and Hazendonk have most in common with those of the sherds from phase 3, which would place the pottery from those sites relatively late in the chronology of the Hazendonk group.[5] The shared characteristics are no/little shell temper and a relatively high frequency of

	N=						%					
phase	1	2a	2b	3	3	total	1	2a	2b	3	3	total
Units				10	11					10	11	
number of sherds	153	1466	739	88	565	4557						
wall-thickness												
average (mm)	12.1	10.8	10.4	10.3	10	10.6						
temper												
quartz	33	559	383	46	363	2174	21.6	38.1	51.8	52	64.2	47.7
grit	29	275	151	32	90	887	18.9	18.7	20.4	36	15.9	19.5
grog	0	30	61	5	45	187	0	2.0	8.2	6	8.0	4.1
plant	12	185	83	10	60	550	7.8	12.6	11.2	11	10.6	12.1
shell	72	357	83	9	55	880	47	24.3	11.2	10	9.7	19.3
construction												
H-joins	80	713	391	41	268	2316	90	88.7	90.3	87	89.6	90.6
N-joins	9	90	41	5	28	230	10	11.2	9.5	11	9.4	9.0
Z-joins	0	1	1	1	3	9	0	0.1	0.2	2	1.0	0.3
total visible joints	89	804	433	47	299	2555	58.2	54.8	58.6	53	52.9	56.1
firing environment*												
ox-ox-ox	2	91	65	8	53	325	1.3	6.3	8.9	9	9.5	7.2
ox-ox-re	0	4	4	0	2	24	0	0.3	0.5	0	0.4	0.5
ox-re-ox	12	105	67	4	77	450	7.9	7.3	9.2	5	13.9	10.0
ox-re-re	3	26	43	8	46	224	2	1.8	5.9	9	8.3	5.0
re-ox-ox	2	17	5	0	6	50	1.3	1.2	0.7	0	1.1	1.1
re-ox-re	0	4	0	2	0	8	0	0.3	0	2	0	0.2
re-re-ox	12	182	107	12	102	664	7.9	12.6	14.7	14	18.4	14.8
re-re-re	121	1017	438	53	269	2755	80.1	70.3	60.1	61	48.5	61.2
wall decoration	8	128	83	13	60	438	5.8	9.5	11.2	15	10.6	9.6
single fingertip	5	87	54	3	34	270	62	68.0	65	23	57	61.6
paired fingertips	0	4	0	0	3	16	0	3.1	0	0	5	3.7
fingertip + spatula	1	0	0	0	1	2	12	0	0	0	2	0.5
spatula	0	24	20	7	13	103	12	18.7	24	54	22	23.5
hollow spatula	1	1	0	0	0	1	0	0.8	0	0	0	0.2
groove lines	0	10	8	3	9	38	12	7.8	10	23	15	8.7
indet.	0	2	1	0	0	8	0	1.6	1	0	0	1.8

* From left to right: inner side, centre and outer side.
ox = light (oxydation) colour; re = dark (reduction) colour.

Table 6.6 Pottery, detailed characteristics per phase.[1]

wall decoration. The similarities in the aforementioned characteristics suggest that the Ypenburg site, whose results have not yet been published, has a chronological range similar to that of Schipluiden.

notes

1 The total number of sherds in the tables is often smaller than the sum of the temper groups because sherds containing two or more tempering agents were counted more than once.

2 The small number of fits is partly attributable to the large number of sherds. The fits were found during the description of the sherds. In an analysis in which refitting is the main objective, such sherd descriptions could be used to assemble subsets of material with similar descriptions and carry out refit analysis.

3 Also known from Ypenburg (Raemaekers unpublished report)

4 These intermediate characteristics cannot be attributable to mixing of older and younger remains. By the time when the remains in Units 15/16 were deposited, occupation phase 3 had not yet begun.

5 The ^{14}C dates obtained for Wateringen 4 and Hazendonk however predate the Schipluiden phase 3 dates by some 200 years and coincide with the dates obtained for phases 1 and 2.

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7 Flint, procurement and use

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The flint from Schipluiden consists of a small amount of high-quality imported material, including some typical Michelsberg tool types, and a large component of rolled pebbles. The source of these pebbles is unknown, but must have been relatively well accessible. The tools formed part of various tool kits geared to such activities as hide scraping, the manufacture of ornaments, cereal harvesting and fire making. The range of activities suggests that complete households once occupied the dune.

7.1 Introduction

Flint artefacts constitute one of the largest find categories at Schipluiden. No flint is to be found in the dune's surroundings, which means that all the material had to be imported. Identifying the flint sources was therefore an important aspect of the study whose results are reported here. Knowledge of the flint-procurement sites tells us whether the Schipluiden people maintained exchange contacts or whether they obtained their flint in the context of their mobility patterns.

A second objective of this study was to gain insight into the activities carried out at the site by doing a wear-trace analysis of a selection of the material. Such a functional analysis can provide additional information regarding subsistence activities and craft activities such as woodworking, bead production and tasks like basketry or rope-making, whose products are often not preserved. The range of activities, combined with other information such as that obtained in palaeobotanical and archaeozoological analyses, gives an indication of the character of the site, for example whether it was a permanent settlement or a special activity site. It may also tell us something about the composition of the social group residing at or using the site.

Finally, a technological and morphological study of the flint assemblage enables comparison with other sites of the Hazendonk group, especially the nearby sites of Wateringen 4 and Ypenburg (within the micro-region). Such a study also provides insight into diachronic developments in flint use by the region's Neolithic wetland communities.

7.2 The material

Schipluiden has yielded a total of over 15,000 flint artefacts, mostly small fragments. The majority of the objects were collected by hand as part of the standard excavation strategy, and consist of artefacts measuring 2 cm and more (chapter 4). The small fraction was recovered mainly from the 4-mm sieve.

As a pilot, all the flint from trench 10 was described, including all the fragments from the sieve (N=1182). This was repeated for the flint from trench 18 (N=1615). The results of these two trenches were used to assess the representativeness of the sample studied. It was decided to analyse all the retouched implements, even those bearing only the slightest signs of retouch (commonly known as 'use retouch'), as well as all the blades, cores, core-preparation and core-rejuvenation pieces. In total, 5106 pieces were described, 1123 of which were modified artefacts. However, in order to obtain a homogeneous sample in terms of selection strategies, all the flint from the sieve – except 14 special pieces – and all the unmodified flint from trenches 10 and 18 were removed from the final operating file used for the calculations, resulting in a total of 2666 manually collected modified or technologically significant implements (table 7.1).

In order to check whether this procedure was justified, the frequencies of raw material and type were compared for the total number of artefacts described (N=5106), the total of trenches 10 and 18 (N=2797) and the total of our operating file (N=2666). As far as the raw material used for the implements' manufacture is concerned, the frequency of rolled pebbles, and especially unidentified material, is much higher amongst the sieved material (table 7.1). This is to be expected, as the sieved flint contains large quantities of splinters, whose raw material is almost impossible to identify. Apart from the larger amount of unidentified raw material, the manually collected flint is therefore representative. The same holds for the operating file from which all flint from the sieve was removed. The relative percentages of the various tool types show no differences that could be attributable to differences in the collection strategy. The same holds for the degree of burning. The operating file of 2666 artefacts can therefore be considered representative for answering most questions.

The flint artefacts comprise a number of tool types typical of this period such as triangular bifacially retouched points

%	all coded artefacts (N=5106)			trenches 10 and 18 (N=2797)			operating file (N=2666)		
	hand-collected		4 mm	hand-collected		4 mm	hand-collected		4 mm
flint variety	Units	pit fills	Units	Units	pit fills	Units	Units	pit fills	Units
rolled pebbles	57.6	53.9	12.9	55.9	49.2	11.3	58.1	55.6	7.1
Cap Blanc Nez	1.8	2.4	–	1.2	1.5	–	2.3	2.6	–
Obourg	1.2	3.6	0.1	0.6	3.1	0.1	1.6	5.1	–
black, homogeneous	0.4	1.2	0.2	0.3	1.5	–	0.6	1.7	–
light grey Belgian	0.5	0.6	–	0.8	–	–	0.6	0.9	–
various Belgian	1.6	1.8	0.3	0.3	–	0.2	2.2	2.6	7.1
Spiennes/Rijckholt	0.2	–	–	0.1	–	–	0.2	–	–
northern flint	0.2	0.6	–	0.5	1.5	–	0.1	–	–
indet.	36.3	35.8	86.5	40.3	43.1	88.5	34.2	31.6	85.7
Totals	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
N=	3668	165	1273	1535	65	1197	2535	117	14

Table 7.1 Composition of various flint sub-assemblages per flint variety, recovery technique and context (features or units).

and some pointed blades. Additionally, a surprising number of strike-a-lights were found, a tool type that is not commonly encountered in contemporary assemblages. The raw materials used are similar to those employed at Wateringen 4. Rolled pebbles, possibly from the chalk deposits of northern France, predominate, supplemented by a few types of Belgian flint, including Obourg flint.

7.3 Methodology

7.3.1 Morphological study

All the implements were described in terms of their metrical attributes, the raw material they are made of, tool typology, primary classification (*i.e.* flake, core, blade, *etc*.), kind and extent of cortex, patination, degree of burning, fragmentation and modification (*e.g.* axe flakes). They were described according to the database of the Laboratory for Artefact Studies at Leiden University.[1]

7.3.2 Technological study

During the analysis, artefacts displaying technological indications were kept aside for the technological study. The selection thus obtained included cores, core-preparation and rejuvenation pieces, flakes and blades. This selection was made randomly across the trenches, by taking some pieces from each bag of finds. We continued to describe artefacts until the relative percentages of the attributes remained constant. This resulted in a total of 432 artefacts that were described in terms of their technological features. Those features include such variables as the type and length of the platform, dorsal face preparation, striking angle, type of impact point, the pronouncement of the bulb of percussion and the state of the distal end. The study of these technological characteristics provides evidence of the reduction strategies, the way cores were prepared prior to flaking (planning) and possibly also the level of expertise of the flint knappers.

7.3.3 Functional analysis

The selection for use-wear analysis was made on the basis of typology. We took a comparative proportion from the various typological categories. An exception was made for blades made of imported flint, which were all included in the analysis. In total, 373 implements were studied for traces of use. In order to assess the validity of our selection, we examined all the implements from trench 10 for 'possibly used edges' (PUAs), they are edges with (use-) retouch, a point or a straight edge of more than 1 cm viewed in cross-section (Van Gijn 1990). This resulted in a total of 351 PUAs on 204 artefacts, all of which were examined by microscope (reported in Wentink 2004). The relative percentages of the represented tool types and the inferred activities of this sample correspond to the results of the total analysis, indicating that the selection provided a representative view.

The use-wear analysis was performed using an incident light microscope with magnifications in the range of 10-560 × (equipped with DIC) and a stereoscopic microscope (10-160 ×). The latter was used to locate possible residue and to obtain a general survey of the tool. Some types of wear traces, such as those formed in striking pyrite, are better studied by stereomicroscope, as the traces are macro-scopic rather than microscopic. Photographs were taken with a Nikon DXM1200 digital camera. Some of the tools were cleaned in distilled water in an ultrasonic cleaning tank in order to remove adhering dirt, but the majority of the tools were just wiped clean with alcohol to remove finger grease. Chemical cleaning was not necessary.

7.4 Taphonomy

Many artefacts seem to have been found in a secondary position, having been discarded in the dump zones along the southeastern edge of the dune (fig. 7.1). However, unlike bone, antler and to a lesser extent ceramics, flint had also survived on top of the dune. Some of the flint artefacts found on top of the dune may have been in a primary position, but it is impossible to distinguish them from the rest of the scatter (chapter 3). Only three tools were found in a primary context: the strike-a-lights were found in the hand of the skeleton of grave 2, held against the deceased's mouth (fig. 5.3).

The number of burned pieces is high: 731 of the 2666 implements (27.4%) show signs of burning. This is however a much smaller number than at Wateringen 4, where 39% of the implements were burned to various degrees. No figures have yet been published for Ypenburg. It is unlikely that flint was intentionally burned. There is no evidence of heat treatment (such treatment has indeed never been demonstrated for comparable assemblages), so the signs of burning cannot be attributed to accidents during heat treatment. It is more likely that the burning is due to intensive human occupation of the dune, causing previously abandoned flint to be accidentally burned.

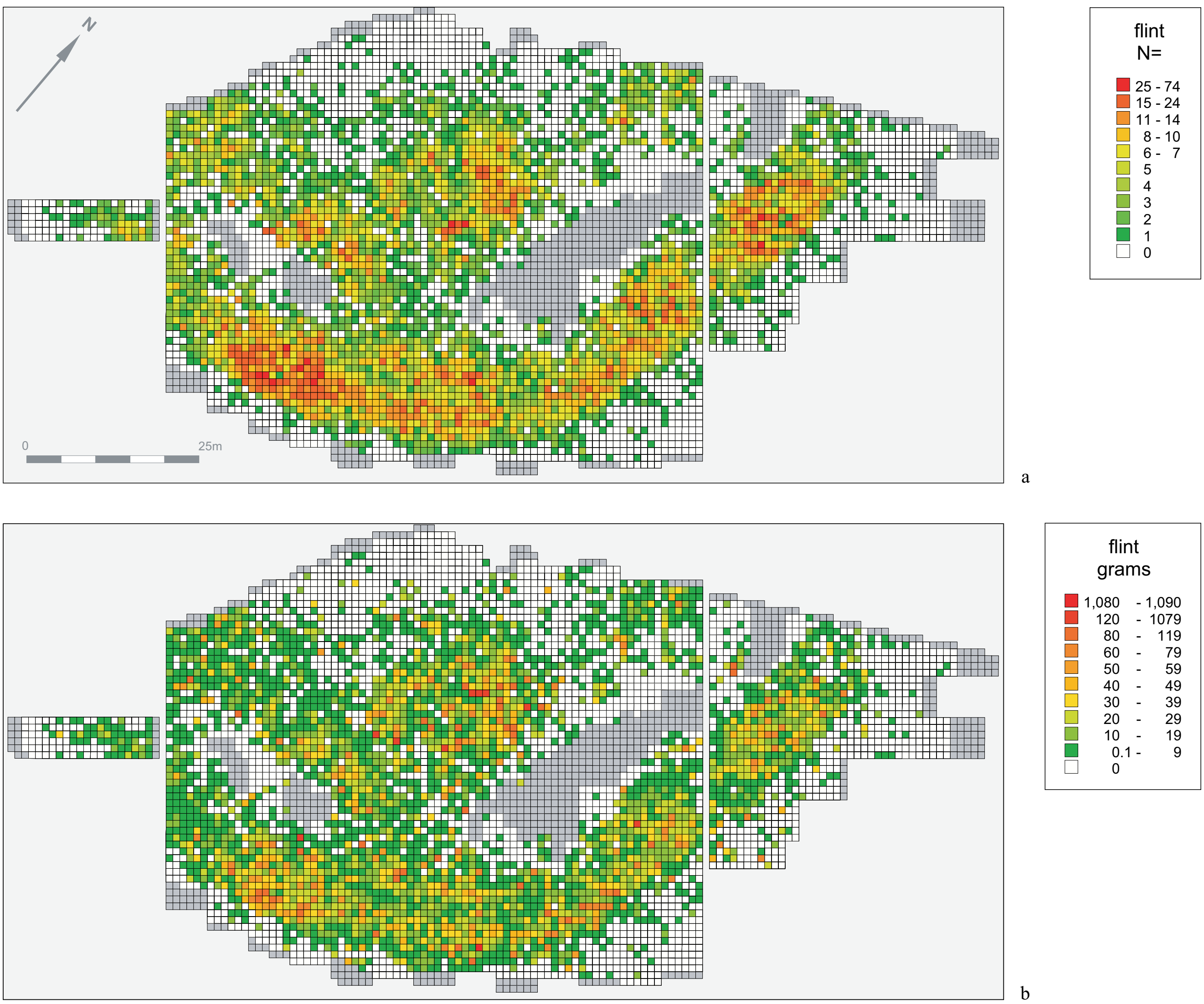


Figure 7.1 Distribution patterns of all manually collected flint artefacts per square metre; number of finds (a) and total weight (b).

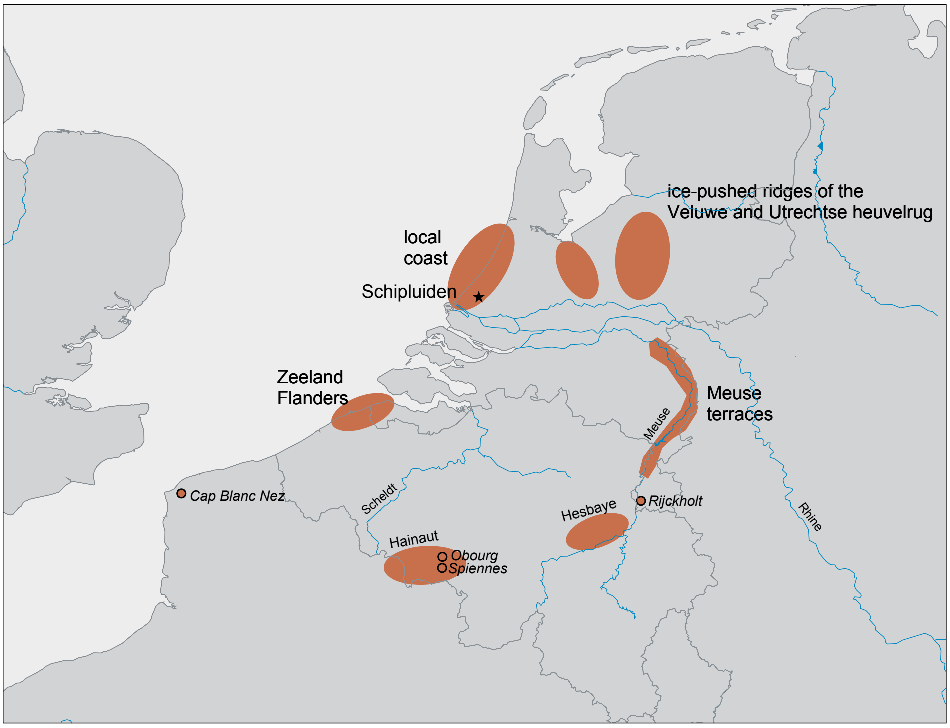


Figure 7.2 Possible sources of the flint used at Schipluiden.

Fragmentation is not frequent: 79.2% of the artefacts are complete. The number of proximal, medial and distal fragments is relatively small (5.8% in total). Fragmentation could not be established for some of the modified implements due to extensive (bifacial) retouch. The absence of fragmentation can be attributed to the fact that the employed technology was predominantly a flake technology, involving only a small number of blades. Intentional fragmentation is usually linked with a blade technology. At first sight the artefacts seem to be in mint condition, and 97% of the implements were described as not patinated. However, the black colour of most artefacts seems to be at least partially due to patination in the humic deposits in which the artefacts were buried. Other forms of patina were observed on very few tools: colour patina was noted on only four implements and gloss patina on 17 artefacts, while 38 artefacts display white patination to various degrees. Some of these implements are probably fairly old implements that were scavenged elsewhere and re-used.

Although the artefacts were somewhat reflective when examined under the microscope, the use polishes were still clearly visible and interpretable. The edges and ridges were not affected by gloss patina and were still sharp.

7.5 Raw materials

Flint was brought to the site in different forms: as nodules, axes and macrolithic blades. All flint must have been brought to the site (fig. 7.2). The nodules, most of which were rolled pebbles, were flaked locally. The axes are made of a variety of southern types of imported flint. After they had been broken they were considered a source of good-quality flint and were used as cores for the production of flakes. The blades were brought to the site as blanks or as finished tools, a distinction that could not be made without refitting the small debitage.

7.5.1 Rolled pebbles

The greater part of the flint consists of a specific type of rolled pebbles (table 7.2). The pebbles are very rounded and generally ovoid in form. The outer surface shows a lighter, bluish or greyish rough texture, probably caused by rolling in an intertidal zone (fig. 7.3a). The flint itself has a blackish to dark grey colour, frequently somewhat mottled with lighter inclusions. It is fine-grained, in some cases even translucent at the edges. The source of this type of flint is difficult to trace. The flint bears some similarity to the material found at Cap Blanc Nez near Calais, northern France, where flint nodules are still eroded from the chalk cliffs by the sea today. The cortex on these nodules is rough due to frequent rolling in the waves, and is composed of a multitude of pounding marks. It lacks the characteristic 'hard' cortex indicative of river-rolled pebbles. Some of the raw material of the rolled pebbles from Schipluiden

primary classification / flint variety	N= rolled pebbles	Cap Blanc Nez	Obourg	black, homogeneous	light grey Begian	various Belgian	Spiennes / Rijckholt	northern flint	indet.	totals	% rolled pebbles	Cap Blanc Nez	Obourg	black, homogeneous	light grey Begian	various Belgian	Spiennes / Rijckholt	northern flint	indet.	totals
flake	748	32	17	5	10	38	–	1	552	1403	49	53	37	29	59	62	–	33	60	53
blade	35	7	9	5	2	4	3	–	35	100	2	12	20	29	12	7	60	–	4	4
core	433	10	3	1	3	6	–	2	67	525	28	16	7	6	18	10	–	67	7	20
waste	96	6	15	5	1	12	2	–	165	304	6	10	33	29	6	20	40	–	18	12
splinter	2	–	–	–	–	–	–	–	1	3	+	–	–	–	–	–	–	–	+	+
core fragment	6	1	1	–	–	–	–	–	5	13	+	2	2	–	–	–	–	–	1	1
block	36	1	–	–	–	–	–	–	9	46	2	2	–	–	–	–	–	–	1	2
rejuv. platf. tabul., facet.	3	–	–	–	–	–	–	–	3	6	+	–	–	–	–	–	–	–	+	+
idem, not facetted	2	1	–	1	–	–	–	–	3	7	+	2	–	6	–	–	–	–	+	+
rejuv. core face, parallel	20	–	–	–	–	–	–	–	4	24	1	–	–	–	–	–	–	–	+	1
idem, perpendicular	20	–	–	–	–	–	–	–	3	23	1	–	–	–	–	–	–	–	+	1
core prep., crested blade	2	–	–	–	–	–	–	–	–	2	+	–	–	–	–	–	–	–	–	+
idem, decort. flake	112	2	–	–	–	–	–	–	13	127	7	3	–	–	–	–	–	–	1	5
idem, decort. blade	2	–	–	–	–	–	–	–	1	3	+	–	–	–	–	–	–	–	+	+
pebble	1	–	–	–	–	–	–	–	–	1	+	–	–	–	–	–	–	–	–	+
indet.	19	1	1	–	1	1	–	–	56	79	1	2	2	–	6	2	–	–	6	3
Totals	*1537*	*61*	*46*	*17*	*17*	*61*	*5*	*3*	*917*	*2666*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Table 7.2 Flint, primary classification versus flint variety.

indeed bears sufficient similarity to our reference material from Cap Blanc Nez to be identified as such (fig. 7.3b), so the material classified as rolled pebbles may as a whole originally also have come from this source. The strong northbound currents in the North Sea may have carried flint nodules from Cap Blanc Nez in a northerly direction. Such nodules may have been deposited as far north as the Belgian province of Zeeland (P. Cleveringa, pers. comm.). Similar flint has been found at Neolithic sites around Antwerp, for example at Doel (Crombé *et al*. 2000). It has not been found further inland in Belgium and seems to be confined to coastal sites in that country (P. Crombé, pers. comm.). The inhabitants of Schipluiden may have travelled to the Belgian province of Zeeland to collect flint. The problem is that there are no data on the presence of flint in the western part of the Dutch province of Noord-Brabant. Detailed research is evidently needed before we can identify the source of this characteristic dark, fine-grained 'sea flint'.

Another possibility is that the rolled pebbles were collected further north, closer to the Schipluiden site. Van der Valk (in prep.) notes that gravel, including small flint nodules, may have been obtained at the coast close to Schipluiden. According to Van der Valk, there are three possibilities. In the first place, estuarine gullies may have cut into the Pleistocene gravel deposits at the base of the river Oude Rijn. Other gravel deposits that may have been eroded by the sea are those of the ice-pushed ridge of Rhine-Meuse deposits in the subsoil of Haarlem-Vogelenzang. Another possibility, finally, is that the Oude Rijn carried gravel from the hinterland. If so, those gravel deposits must also have contained small nodules of flint, because the rivers transported Tertiary flint from the uplands of Noord-Brabant (Van der Valk in prep.).

The possibility of rolled pebbles of flint having been obtained close by on the beach is in agreement with the observation that flint was brought into the site in considerable quantities. The entire reduction sequence is represented at the site, from unmodified rolled pebbles via core-preparation and rejuvenation pieces to finished tools (see below). Flint was evidently not in short supply. The rolled pebbles are therefore considered to be local flint, and will be referred to as such below.

7.5.2 *Imported flint: blades and axes*

There is also a small quantity (5.2%) of non-local, 'exotic' flint types, deriving directly from the south Belgian

a 10775

b 3427

c 8345

d 4731

e 8561

f 2857

Cretaceous zone. The artefacts concerned are predominantly finished products of a size larger than the rolled pebbles (fig. 7.4), and include no cores, core-preparation or rejuvenation pieces (table 7.2). Some of this material may have been imported in the form of polished axes. Several varieties of Belgian flint could be distinguished:

1) first of all there is the well-known light-grey flint from central Belgium, more specifically perhaps Hesbaye. This is a light grey, mottled, fine-grained flint;
2) a larger group consists of a fine-grained, mottled flint of darker shades of grey, probably from the same general region (fig. 7.3c). One of the axes from Schipluiden, a burned fragment of a large Buren axe, is made of this type of flint. It may actually be a variety of the same light grey Belgian flint;
3) a third variety of greyish flint also has a medium grey colour, but, instead of being mottled, it has very well defined inclusions of lighter flint against a darker background (fig. 7.3d). It is translucent and has a waxy feel to it;
4) there are also two varieties of homogeneous black flint: an almost translucent, very fine-grained variety and a somewhat coarser one. The translucent variety bears a close resemblance to the material found at Obourg in the Belgian province of Hainaut. It sometimes has a faint reddish colour when viewed through thin edges, a feature deemed highly characteristic of Obourg flint. Smaller nodules of a similar black flint are sometimes classified as Zevenwegen flint. A few artefacts found at the contemporary site of Wateringen 4 were indeed classified as such (Van Gijn 1997). The slightly coarser grained black variety of flint shows very fine light coloured specks (fig. 7.3e). It is sometimes found in coastal assemblages in the region of Antwerp, for example at Doel (P. Crombé, pers. comm.), but no source is known for this type of flint.

A last type of southern flint is represented by a group of five artefacts of a mottled dark grey, almost black flint of a fine-grained, but not translucent variety. This material bears resemblances to both Rijckholt and Spiennes flint, but is not entirely characteristic of either (fig. 7.3f).[2] It is not so strange that the Rijckholt and Spiennes flints should look so very alike, because they both come from the same chalk layer of Lanaye. It was indeed long believed that the two types could not be distinguished (M.E.Th. de Grooth, pers. comm.). It can be argued that Spiennes is most likely to have been the source of the Schipluiden flint, considering that very few flint artefacts point to a source near the Meuse. On the other hand, however, the hard stone found at the site, most notably the quartz, does derive from Meuse deposits (chapter 8), and the small amount of Rijckholt/Spiennes-like material may have been collected in the context of search parties or exchange relationships whose primary aim was the procurement of hard stone.

Finally, a few pieces (N=3) with a possible northern origin were encountered. They have characteristic glossy, patinated surfaces typical of flint from boulder clay deposits. No flint with Bryozoa inclusions, characteristic of erratic sources, was however identified.

Flint procurement

Unfortunately, the greater part of the flint cannot be sourced. The flint concerned consists of smallish flakes without cortex or distinctive features. Obviously the percentage of unidentifiable flint among the flint from the 4-mm sieve is much higher than that among the manually collected material because the former consists of splinters that are too small to show distinctive features such as cortex, mottling and the like.

To conclude, even though it has not been possible to determine the origin of the raw material, the general area from which the inhabitants of Schipluiden procured their raw material is evident: a source at the coast near Schipluiden or further south towards the Belgian province of Zeeland for the dark rolled pebbles, and the south Belgian Cretaceous zone, from Hainaut to (possibly) Hesbaye, for the imported material. This implies contacts in a direction different from that inferred for the hard stone, namely south instead of east or southeast.

7.6 Technology and typology

7.6.1 Technology

The predominant type of raw material consists of rolled pebbles of small dimensions (3.5-6 cm in diameter). These pebbles were brought to the site and worked locally, as

◂ Figure. 7.3 The most important flint varieties represented in the assemblage (magnification 2×).
a rolled pebble
b Cap Blanc Nez
c Belgian flint probably from the Hesbaye
d mottled greyish flint, probably Belgian, with waxy texture
e relatively coarse-grained black flint
f grey flint from Spiennes or possibly Rijckholt

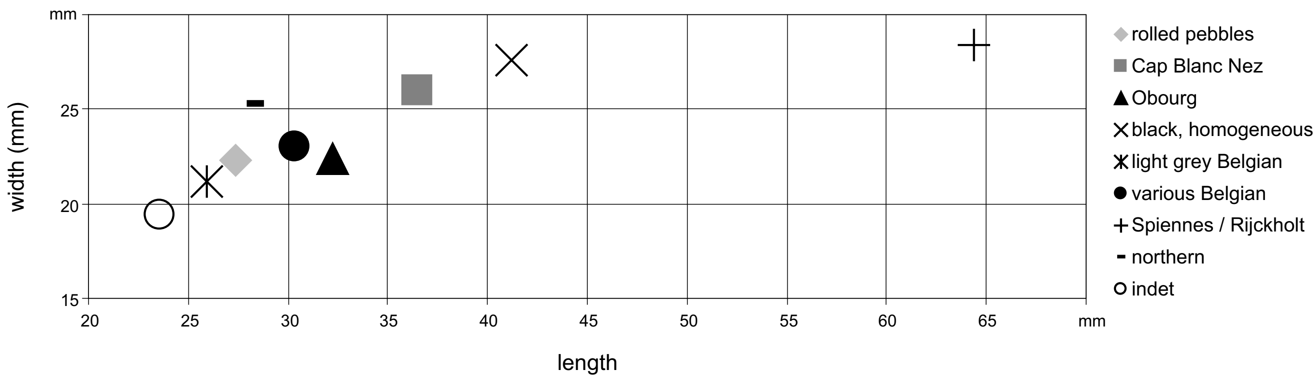


Figure. 7.4 Mean dimensions of the various flint varieties. The relatively small number of larger blade implements has only a modest effect on the mean values, with the exception of the Spiennes/Rijckholt material.

demonstrated by the presence of decortification flakes, core-preparation and core-rejuvenation pieces (table 7.2, fig. 7.5). The small amount of debitage of other types of flint is probably attributable to the import of polished axes that were secondarily used as cores after breaking. This would explain the incidental presence of cores of Belgian, Obourg and homogeneous black flint. Cores of Spiennes/Rijckholt-like flint are however absent. The secondary use of broken axes as cores also explains the low frequency of cortical pieces of Belgian flint. The larger blades of Belgian flint were most likely imported as finished products, since no debitage associated with their production has been found.

The more or less complete absence of cortex on the imported material is another indication that this flint was only incidentally flaked at Schipluiden. None of the artefacts made of the light grey Belgian material shows cortex. Implements of Belgian flint, Obourg and black homogeneous flint have cortex in only 10-25% of the cases. This contrasts with the rolled pebbles and the Cap Blanc Nez material, 65-70% of which shows a weathered outer surface.

As already mentioned above, broken polished flint axes were also employed as cores (fig. 7.6). When an axe breaks in half (for example as a result of a shock fracture from impact), two perfectly prepared platforms result. A considerable number of polished axe flakes were found (N=548), most of which are of unknown flint (N=514), but Belgian (N=18), light grey Belgian (N=12), Obourg (N=3) and Cap Blanc Nez (N=2) flint were also identified. Their average size is relatively small (average length is 2.2 cm), but they do show well-developed bulbs of percussion indicating that they were struck purposefully. These polished axe flakes can be considered decortification flakes, removed in order to prepare a proper core. The great majority of the polished flakes in the assemblage (71.6%) are unmodified flakes, but some flakes were modified into tools or used without further modification (fig. 7.7). The small number of cores of imported material may therefore actually be the exhausted remnants of polished axes, granted a second life as a core. In fact, 45 flake cores display a polished facet. Some of the tools of unknown or imported flint must have been made from such 'axe cores'. Those cores cannot have been very large, as most of the recovered axes are of small dimensions**.** Attempts to refit the polished axe fragments were not successful (Wentink 2004).

As the reduction sequence was basically directed at the production of flakes, blades are a rare occurrence. Most blades were made from rolled pebbles and are of small dimensions. They are probably not intentional products of the reduction sequence. The larger blades are invariably made on imported, Belgian flint. They must have been brought to the site as finished products, as no evidence of large blade cores or flaking waste from imported flint has been found. Something similar was also observed at for instance Kraaienberg (Louwe Kooijmans/Verhart 1990), and is in agreement with the evidence obtained at other Middle Neolithic sites.

Evidence of both hard and soft hammer percussion has been found. Platform preparation was not evident in the case of more than half of the examined pieces. Incidentally, the platform was abraded or displayed micro-retouch. The type of platform varied. The largest category was formed by platforms with cortex, which is not surprising considering the fact that most of the flaked material consisted of rolled pebbles. Other platforms include facetted, pointed and linear shapes. The platforms of a number of tools, made of exotic materials had disappeared through retouch, so nothing remained to indicate the shape of the original platform.
The widths of the platforms are 3-5 mm, with only a few

larger specimens. The angle of percussion varied between 90 and 130 degrees, with an average at 110-120 degrees (189 implements). The impact point usually displays a cone of percussion, sometimes the cone extends into the platform.

As stated above, rolled pebbles of small dimensions constitute the largest category of locally knapped flint. They measured on average 3.5 by 6.0 cm. Some of the pebbles display one or two flake negatives, suggesting that they were only tested. It is likely that a bipolar technique was used to open the pebbles, for, being small and rounded, they afforded no primary striking points. Flakes with evidence of bipolar flaking were found (N=71). Several hammer stones were found, some of which may have been used for hard hammer percussion, but only one anvil was encountered (chapter 8). Once the pebbles had been opened up, normal hard hammer percussion seems to have been practised. Well-developed bulbs of percussion prevail, but evidence of soft hammer percussion was also found. Broken axes were secondarily deployed as cores, using the same technology. The tools made on the imported flint were frequently retouched, indeed to such an extent as to result in the removal of technological features. The absence of a pronounced bulb of percussion on many of these tools points to removal by soft hammer percussion.

The flint technology shows close similarities to that practised at neighbouring sites. At Wateringen 4 rolled pebbles were likewise knapped locally, while imported flint rarely displays cortex and must therefore have been brought to the site in the form of finished products. There, too, a considerable number of axe flakes were encountered (Van Gijn 1997). Bipolar reduction was observed at Ypenburg (Koot/Van der Have 2001, 111). At all three sites flake technology predominated and the average size of the artefacts is small. The dichotomy between the rather wasteful reduction strategies of local flint and the import of small amounts of high-quality implements observed at Schipluiden is also in agreement with the evidence provided by contemporary Michelsberg sites further east and in Belgium (*e.g.* Kraaienberg, Louwe Kooijmans/Verhart 1990) and the site of Spiere in the Scheldt basin (Vanmontfoort *et al.* 2001/2002).

7.6.2 Tool typology

The range of tool types represented at Schipluiden agrees with that encountered at Hazendonk sites (table 7.3). The triangular point is the most noteworthy, being a typical Michelsberg type of point. This artefact was found in substantial numbers. Most had a straight, slightly convex or concave base and an asymetrical cross-section (fig.7.8). They show surface retouch, which does not always cover the entire ventral surface. Interestingly, unfinished points are relatively numerous, suggesting that this tool type was also manufactured locally. This is corroborated by the fact that quite a few of them are made on local flint. A few were produced on Belgian and Obourg flint (table 7.3). Other point types such as geometric points and leaf-shaped points were encountered in small numbers.

Another tool type typical of the Hazendonk period is the pointed blade. Only a relatively small number of pointed blades 'proper' were found at the site (fig. 7.9). The other blades that were classified as such are less typical.

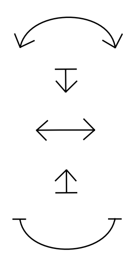
A small number of point-butted axes were found, all of them with an oval cross section and usually of quite small dimensions, approx. 5 cm in length (fig. 7.6). One axe is made of local flint, the others are of unknown flint types. The flint of most of these axes resembles the (light grey) Belgian flint. Only three axes are complete; the other

Legende of codes in figures of chapters 7 and 10

contact material/activity

BR	burning
CE	cereals
HA	hafting
HI	hide
HI/SIPL	hide/silicious plants
JE	jet
MI	mineral
PL	(soft) plant
PO	pottery
SH	shooting
SIPL	silicious plants
SOMA	soft material
ST	stone
UN	unknown
WO	wood

motion



drilling/boring
'impact'
cutting/sawing
transverse/scraping
hafting

degree of use

•	heavily developed traces
•	medium developed traces
·	lightly developed traces
x x x	traces of tar from hafting
+ + +	friction glass from hafting
* * *	handling traces

technical information

▲	bulb of percussion present
△	bulb of percussion absent but direction of percussion clear

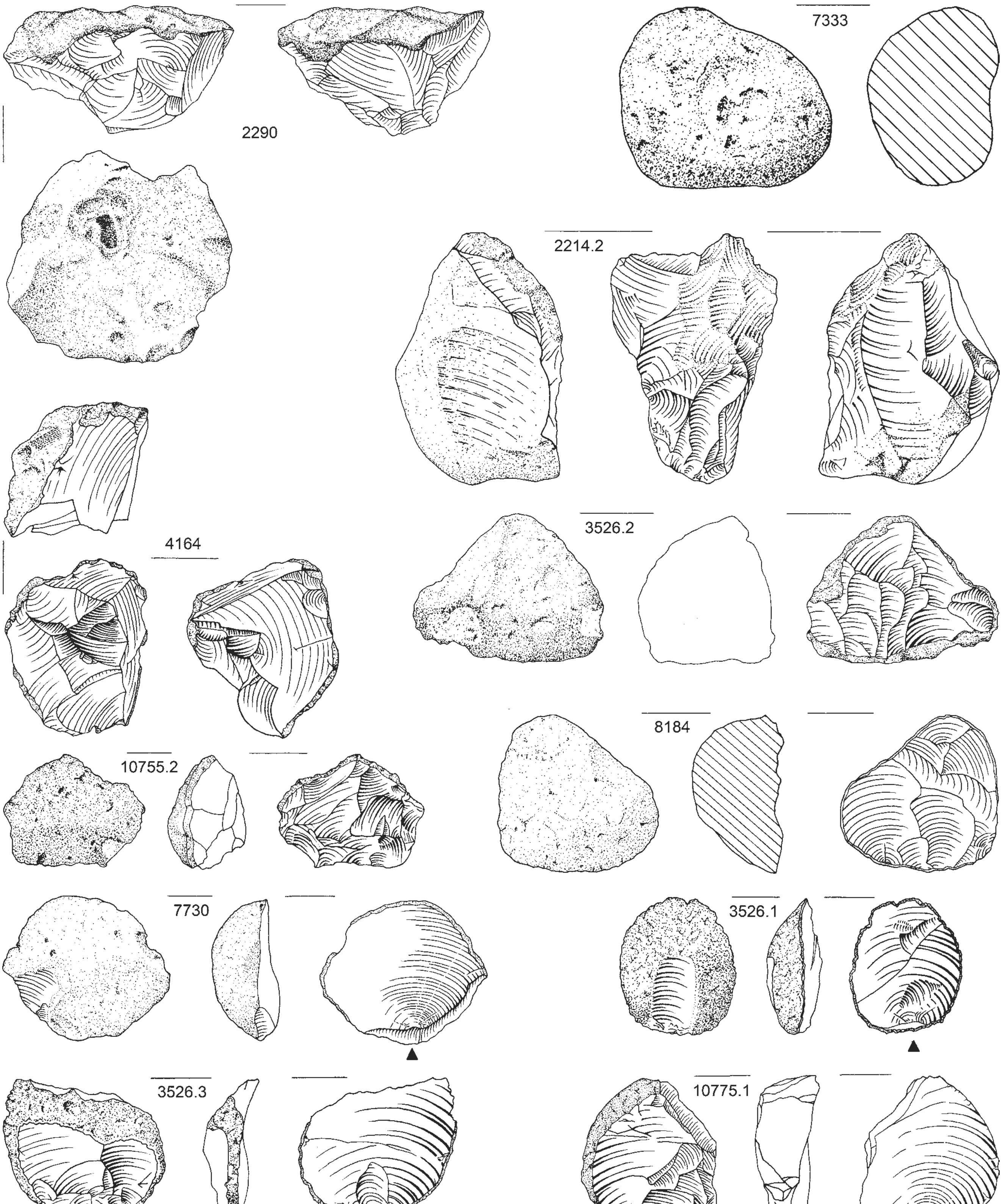


Figure 7.5 Cores and core-preparation flakes (scale 1:1).

pebble	7333
cores	2290, 2214.2, 4164, 3526.2 and 10755.2
core caps	8184, 7730 and 3526.1
core preparation flakes	3526.3 and 10775.1

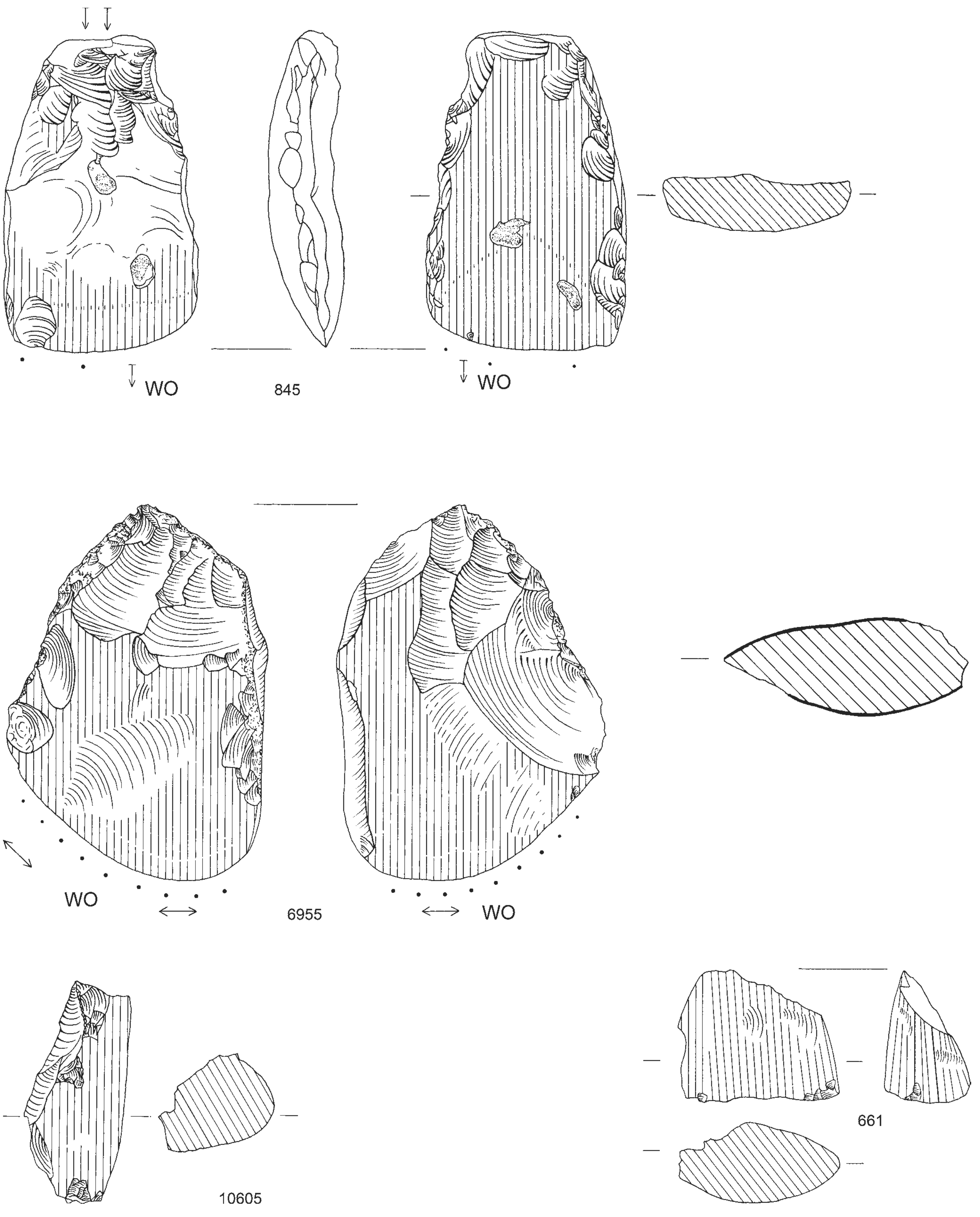
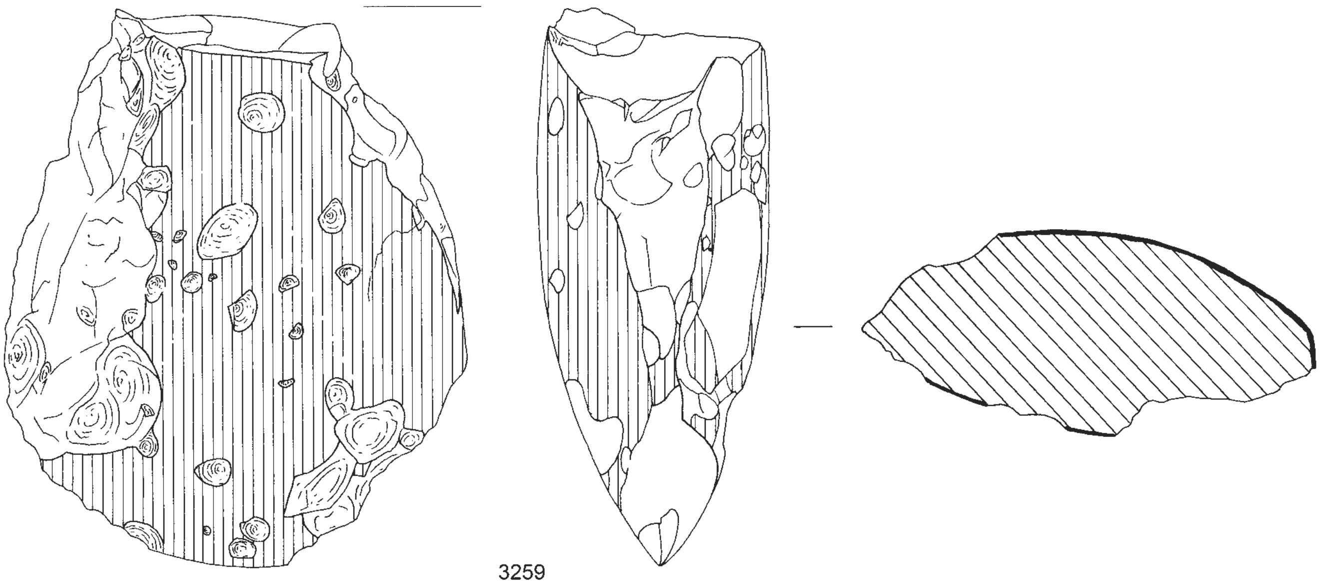


Figure 7.6 Axes and axe fragments (scale 1:1).



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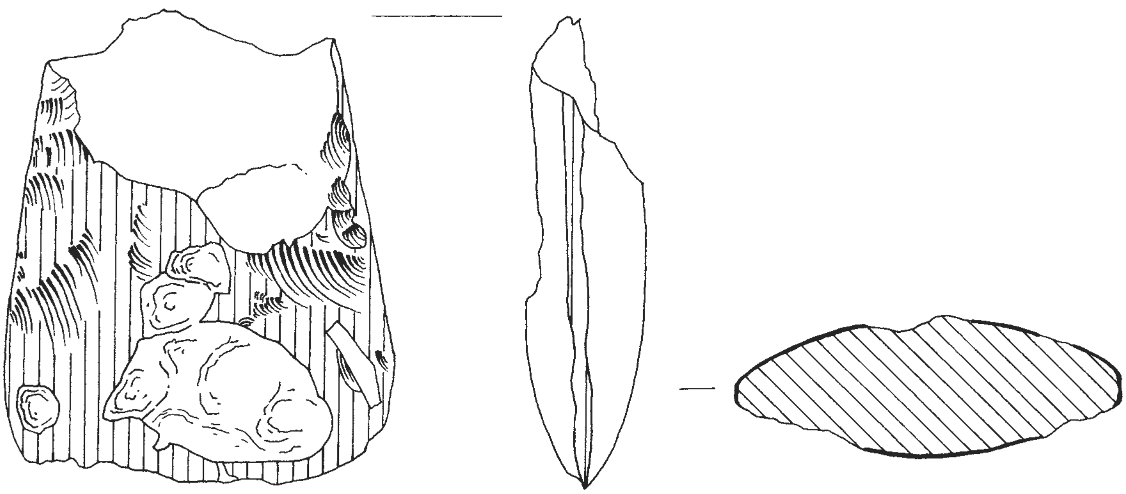

9515

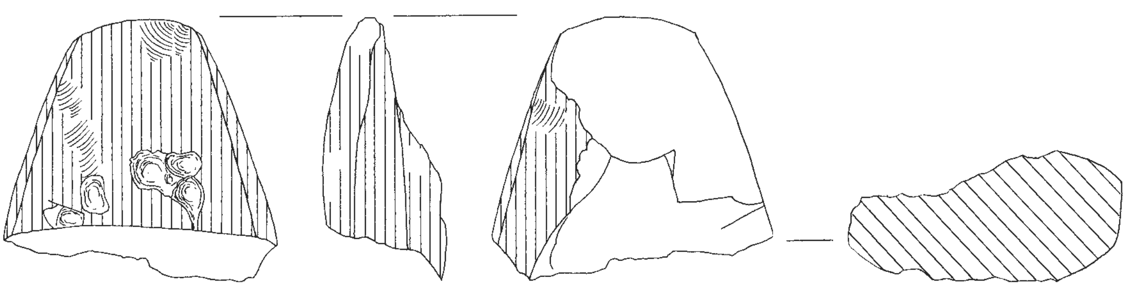

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Figure 7.6 *(cont.)* Axes and axe fragments (scale 1:1).

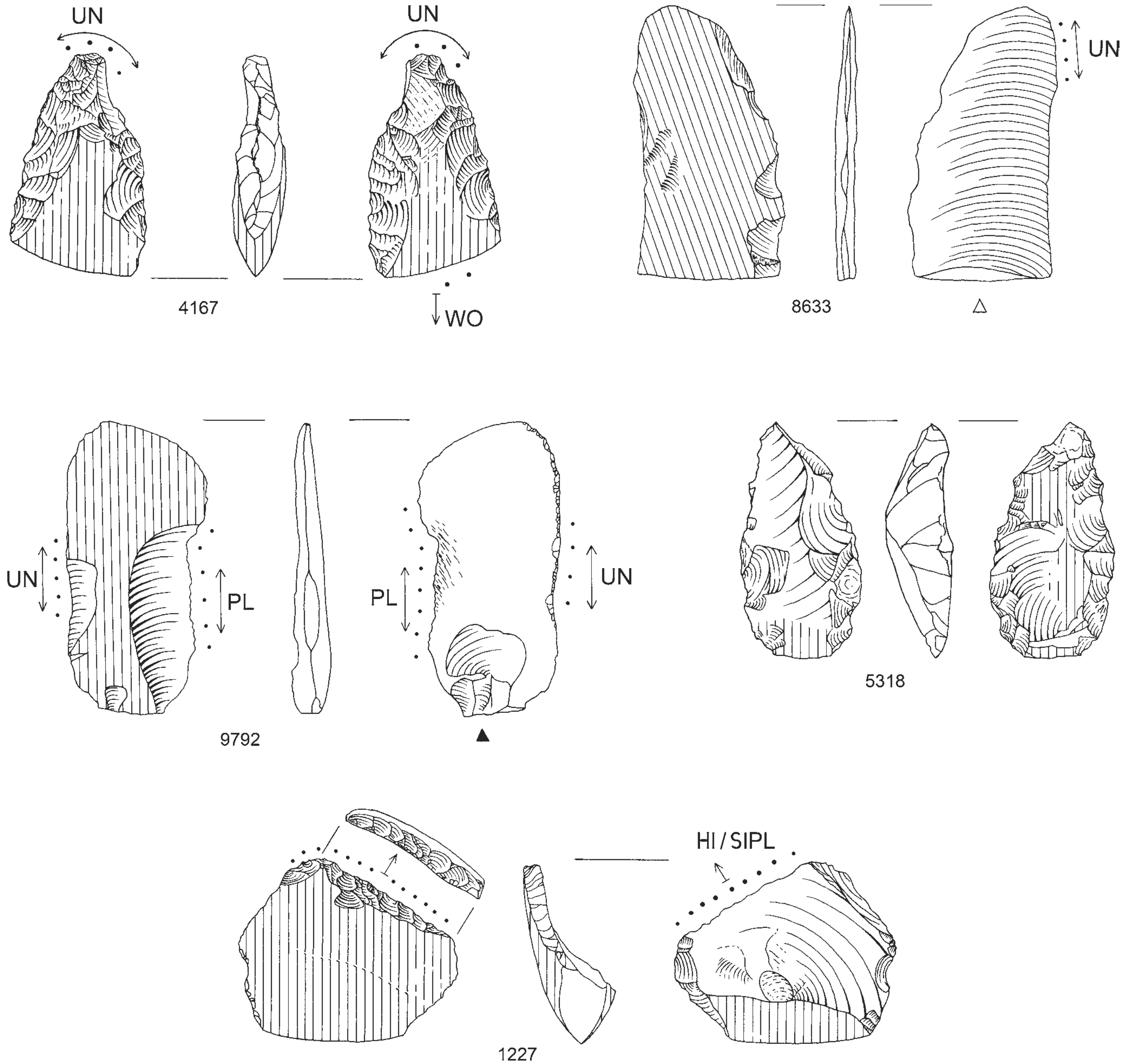


Figure 7.7 Retouched or used axe flakes and fragments (scale 1:1).

artefacts are large parts of axes. One burnt distal end, still displaying part of the cutting edge can probably considered part of a Buren axe (fig. 7.6, no. 3259).[3] The axes have a highly polished cutting edge, the remaining surface being only (partially) ground. This may be because the removal of the deep depressions of the flake negatives was very time-consuming, but it may also be indicative of recycling and rejuvenating damaged axes. Complete axes are indeed also rare in the assemblages of the neighbouring Michelsberg sites. No complete axes were found at Wateringen 4 (Raemaekers *et al*. 1997), nor at Gassel (Verhart/Louwe Kooijmans 1989), while only one was encountered at Kraaienberg (Louwe Kooijmans/Verhart 1990). Only one atypical specimen was found at Maastricht Klinkers

artefact type / flint variety	rolled pebbles	Cap Blanc Nez	Obourg	black, homogenous	light grey Belgian	various Belgian	Rijckholt / Spiennes	northern flint	indet.	totals
geometric microlithic point	3	1	–	–	–	–	–	–	2	6
triangular point	37	2	10	3	–	9	1	–	26	88
leaf-shaped point	3	–	–	–	–	–	–	–	2	5
halfproduct point	24	4	2	–	–	1	–	–	10	41
point indetermined	3	–	–	1	–	1	–	–	9	14
borer	12	3	1	–	–	5	–	–	4	25
burin	2	–	–	–	–	2	–	–	–	4
scraper	21	4	3	2	1	2	2	–	17	52
combination tool	–	1	–	–	–	2	–	–	–	3
axe	1	–	–	–	–	–	–	–	13	14
pointed blade	12	2	2	2	–	3	1	–	9	31
strike a light	10	2	5	3	–	1	–	–	13	34
retouched blade	14	2	1	1	2	3	1	–	10	34
retouched flake	438	23	15	4	2	20	–	–	213	715
retouched core	9	3	2	–	1	–	–	–	2	17
retouched block	1	1	–	–	–	–	–	–	–	2
retouched type unknown	12	2	1	–	–	1	–	–	21	37
notched flake	1	–	–	–	–	–	–	–	–	1
not modified	936	11	4	1	11	11	–	3	566	1543
Totals	*1539*	*61*	*46*	*17*	*17*	*61*	*5*	*3*	*917*	*2666*

Table 7.3 Flint, artefact type versus flint variety.

(Schreurs 1992, 139). Complete axes were also relatively rare at Spiere in the Scheldt basin (Vanmontfort *et al.* 2001/2002). Wateringen 4 yielded only four fairly large parts of axes, but many polished axe fragments (7.3%, Van Gijn 1997, 173). Flake axes were absent at Schipluiden.

Other tool types are less specific of the Hazendonk flint repertoire. Scrapers constitute an important tool type. Their sizes and exact shapes vary, many being somewhat irregularly shaped (fig. 7.10). Most of the scrapers were classified as short end scrapers with a single scraping head. They were predominantly made on rolled pebble flakes and were produced locally as the need arose. Three very finely shaped scrapers were classified as tanged scrapers (fig. 7.11, nos.1255, 9381, 815). The almost lamellar retouch must have been applied by either soft percussion or, more likely, pressure flaking, as it covers a large part of the tool's surface. Two were made on Spiennes/ Rijckholt flint, one on homogeneous black flint; they were probably imported as finished tools. Scrapers of this kind were not found at Wateringen 4, nor at other Hazendonk sites.

Quite a few borers were found, ranging from a very heavy reamer made of mottled Belgian flint to a tiny awl with a long, finely retouched tip (fig. 7.11). Although some borers were clearly imported, such as the large reamer (no. 8345), the majority are much smaller and were made locally on flakes of rolled pebbles.

Strike-a-lights form an interesting category. They are characterised by an elongated shape and a rounded point at one or both ends (fig. 7.12). Their general shape may vary somewhat, so tools vaguely resembling a scraper may initially have been classified as such, and have been identified as strike-alights only after microscopic examination. No tools have previously been identified as strike-a-lights in Hazendonk assemblages. Those assemblages may however have included strike-a-lights that were classified as reamers (*e.g.* Louwe Kooijmans/Verhart 1990, fig. 30, tool N26). Three strike-a-lights were found in grave 2, in or close by the hand of the buried man (fig. 5.4).

Retouched blades are relatively rare (fig. 7.13). A few were made from rolled pebbles and have small dimensions. They are probably not the result of intentional blade production. Other blades, like no. 10,419 (fig. 7.13), are much larger, regularly shaped, made of imported or unknown materials

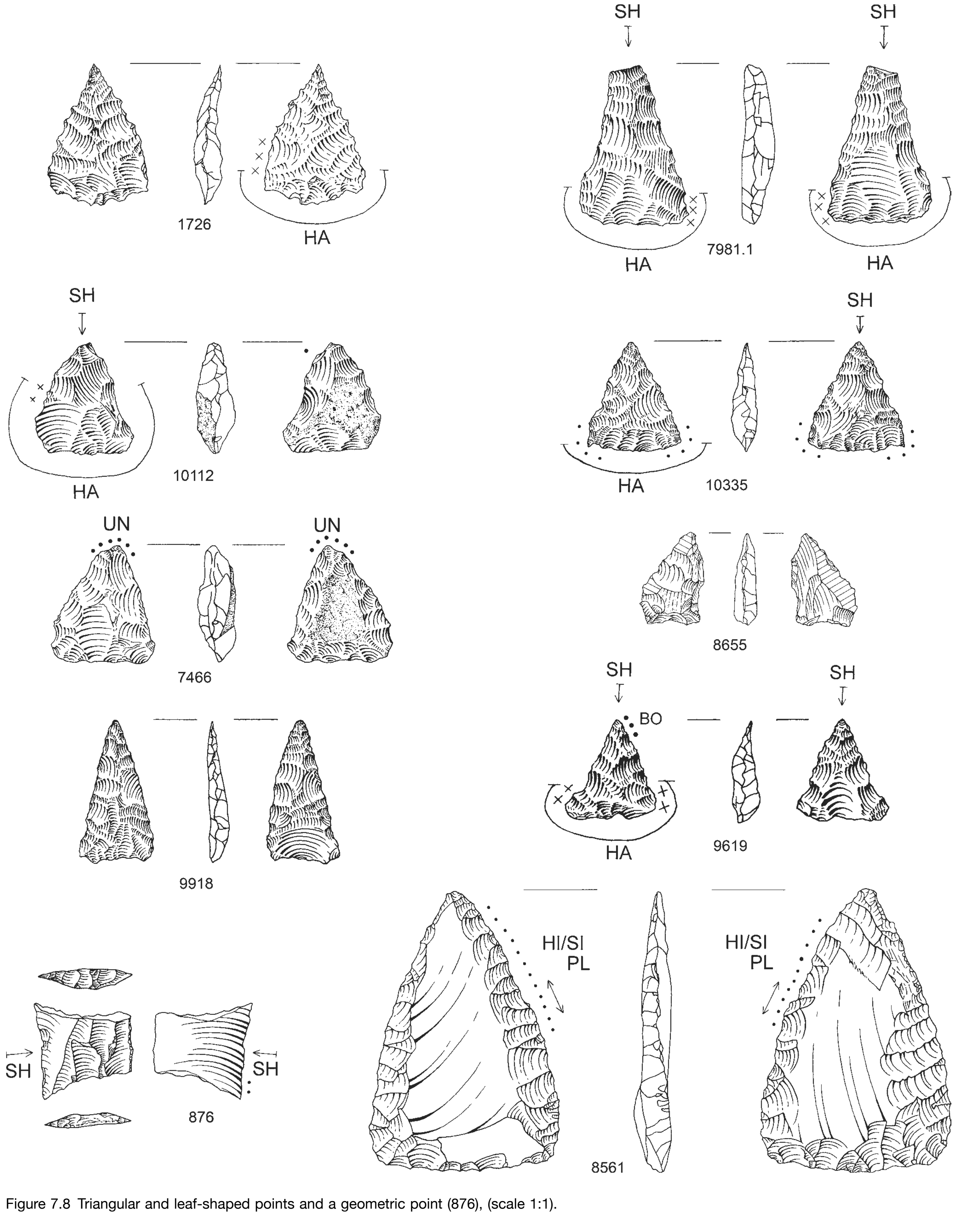


Figure 7.8 Triangular and leaf-shaped points and a geometric point (876), (scale 1:1).

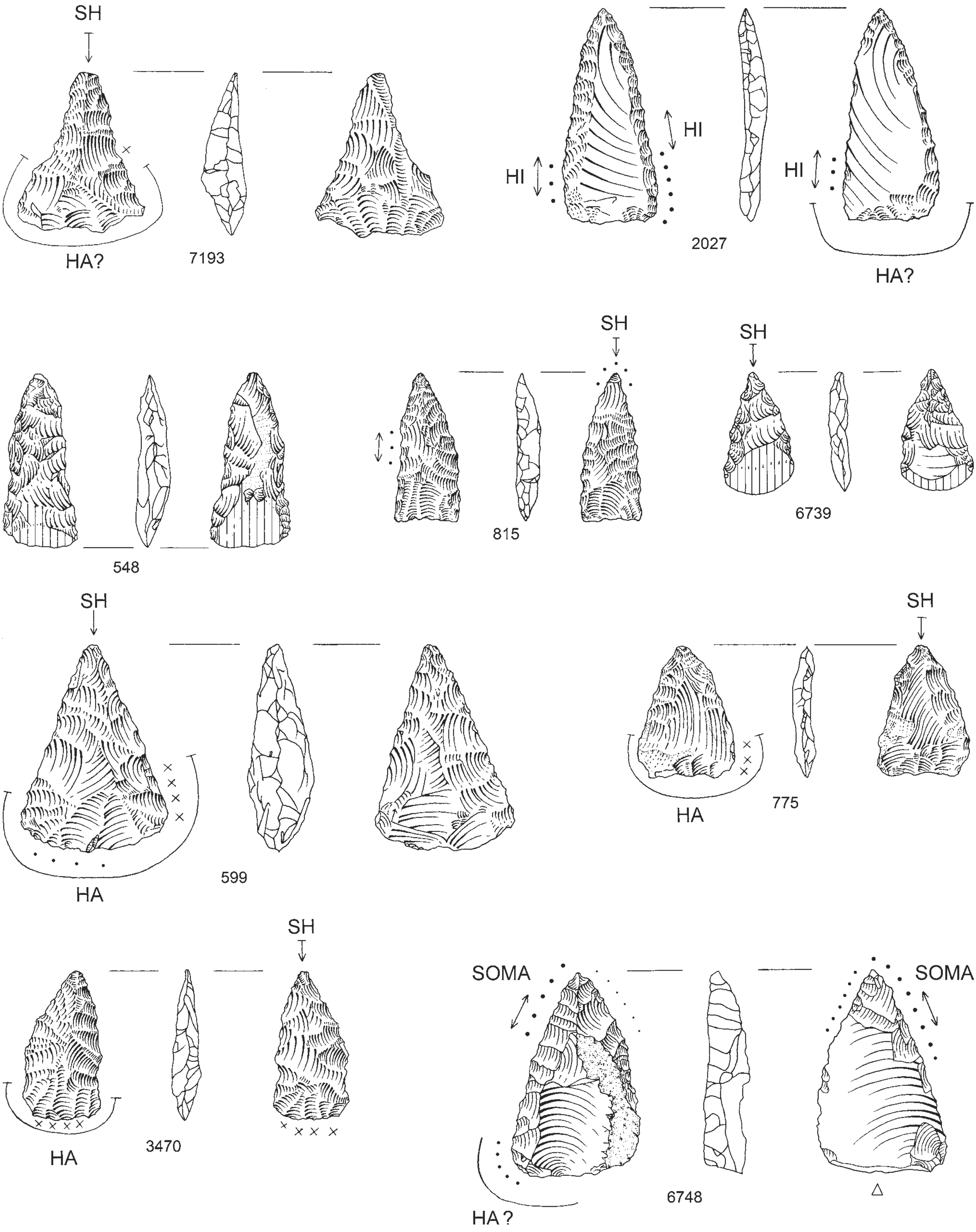


Figure 7.8 *(cont.)* Triangular and leaf-shaped points (scale 1:1).

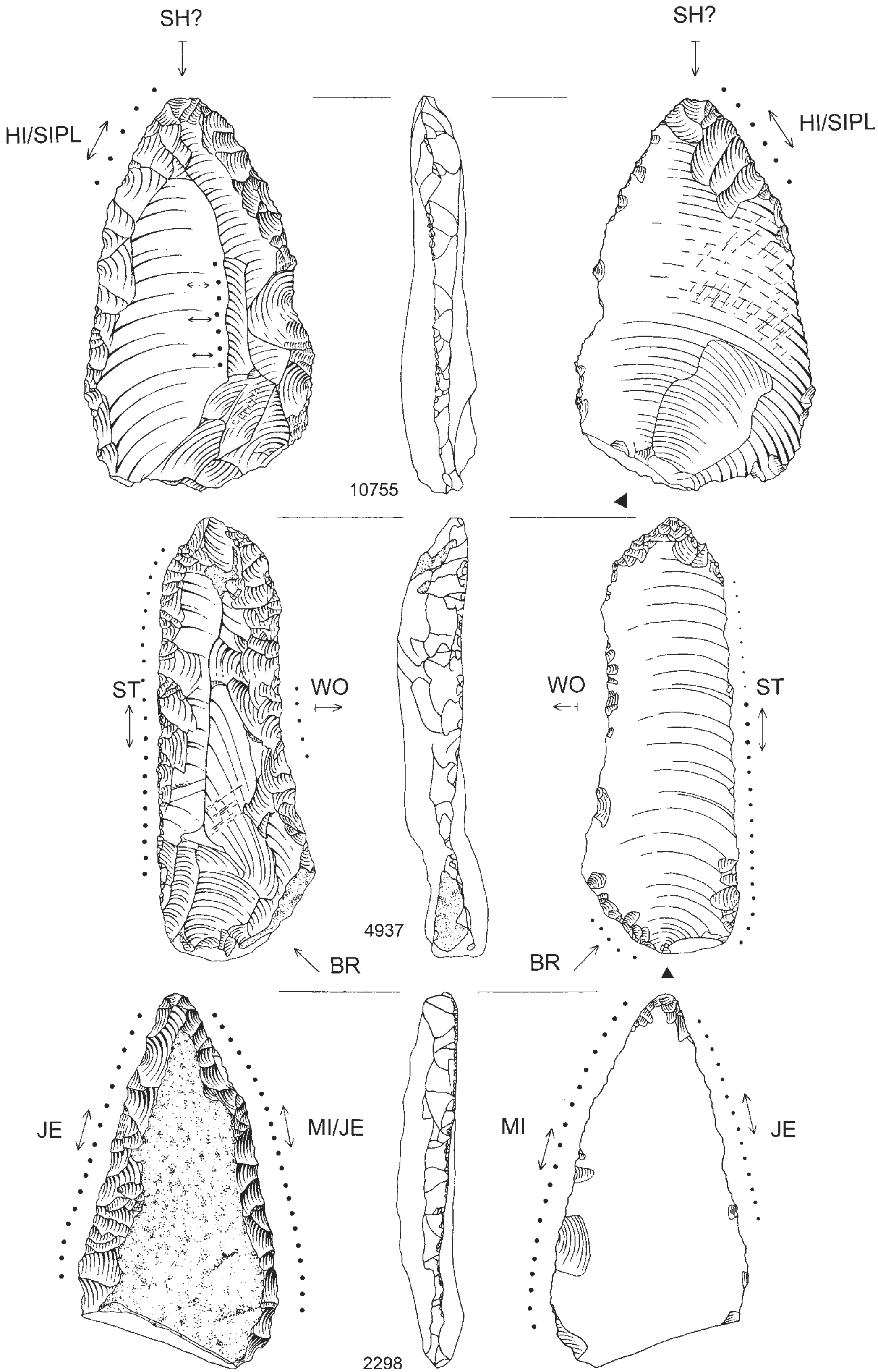


Figure 7.9 Pointed blades of imported flint (scale 1:1).

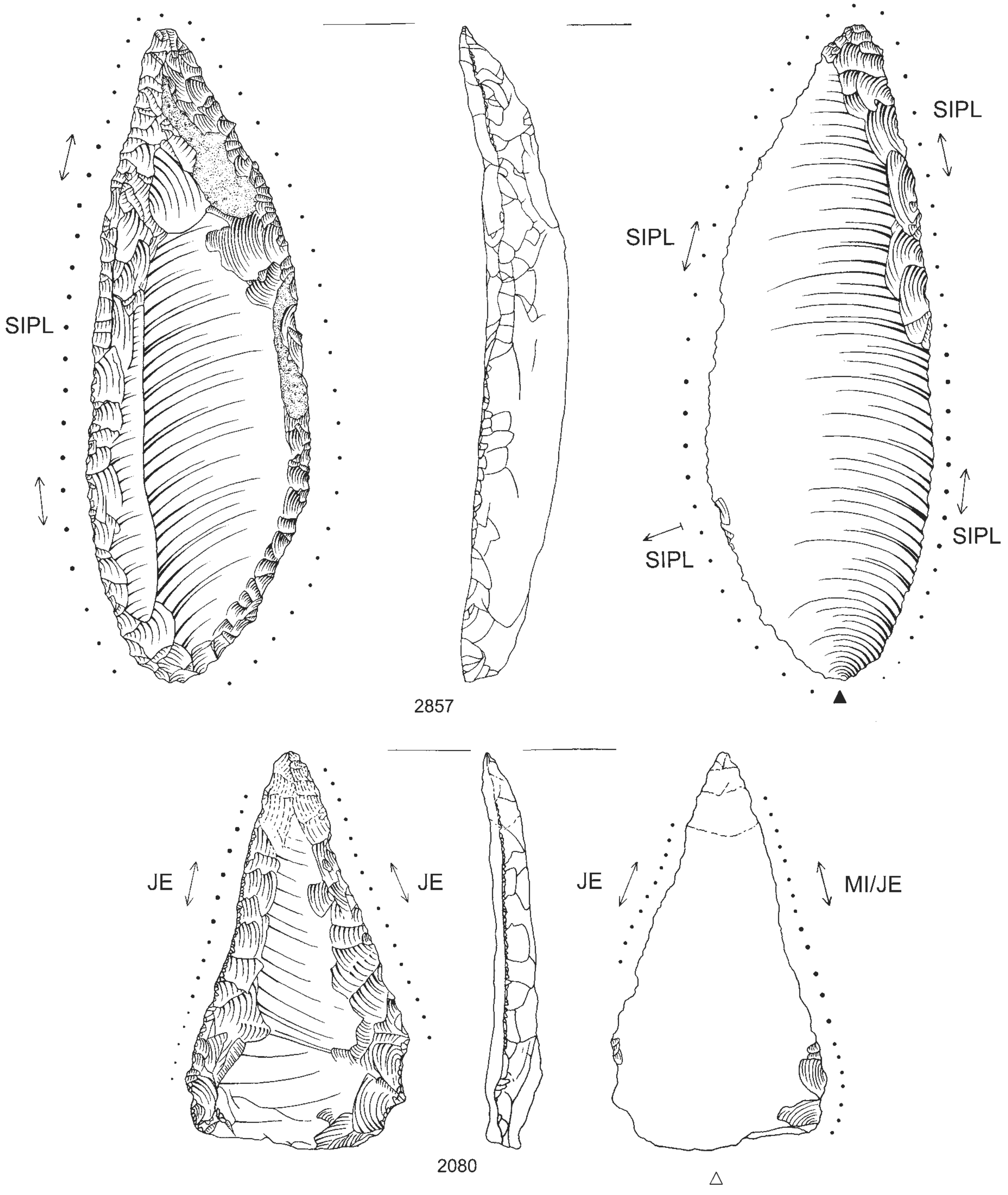


Figure 7.9 *(cont.)* Pointed blades of imported flint (scale 1:1).

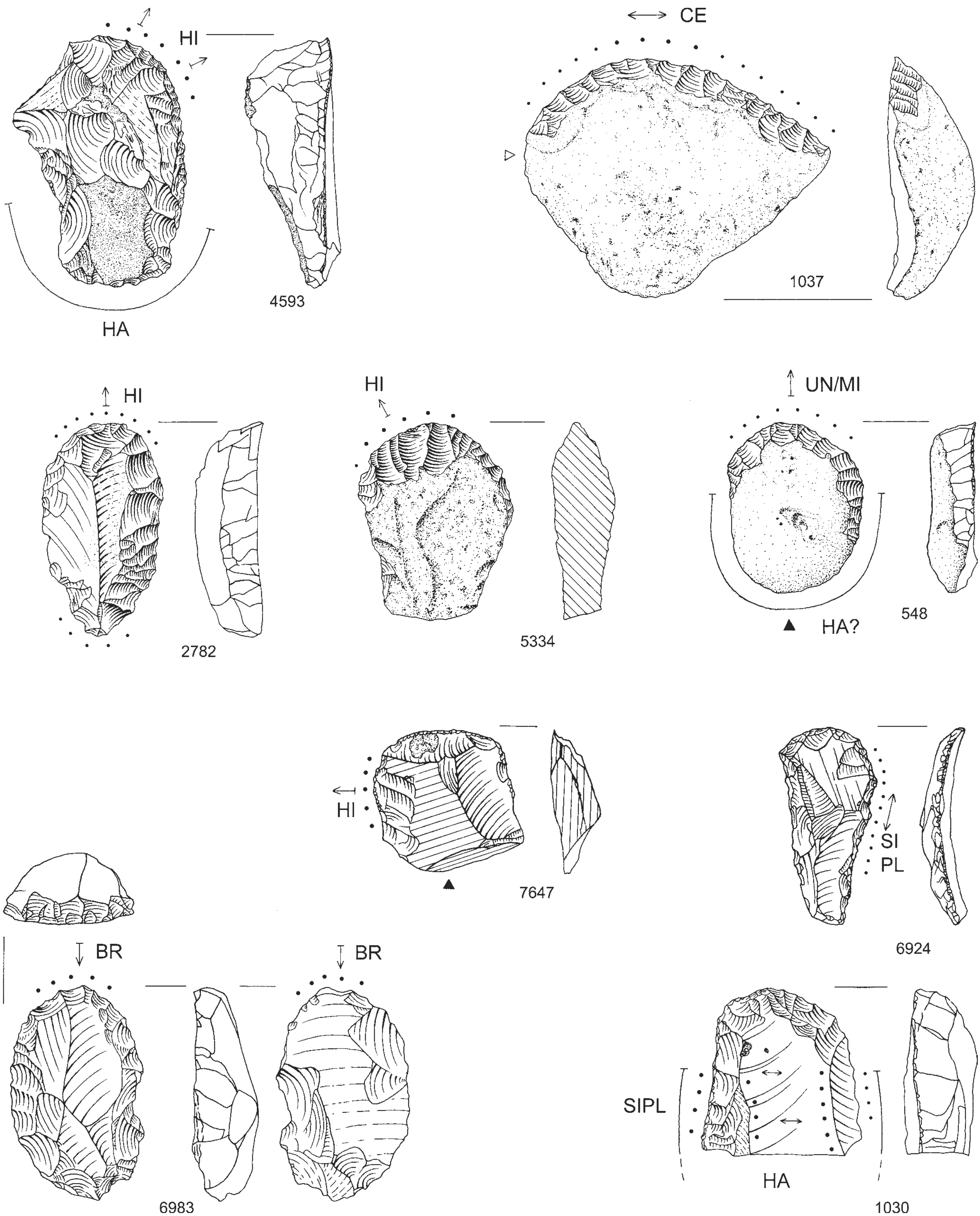


Figure 7.10 Various end and side scrapers (scale 1:1).

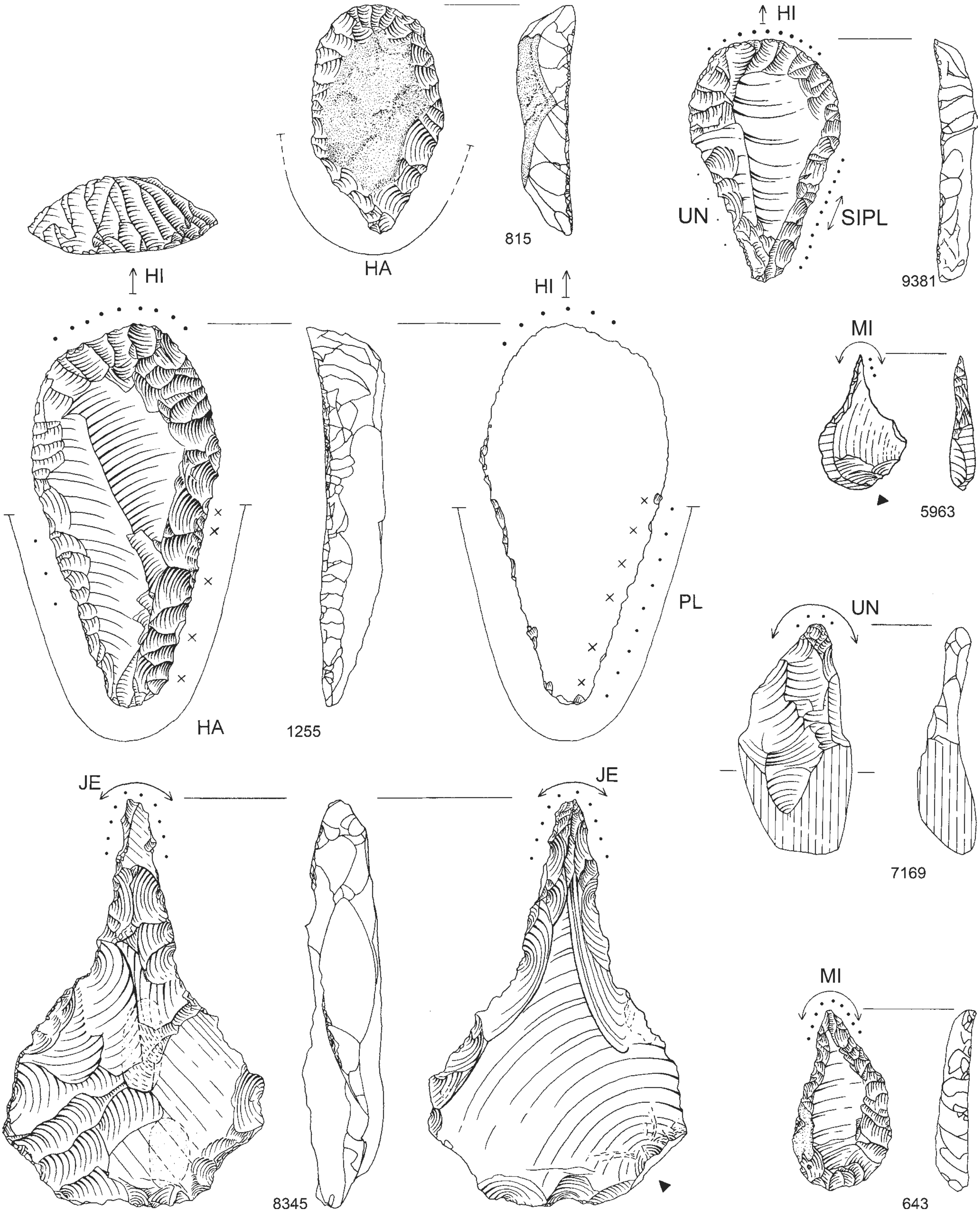


Figure 7.11 Tanged scrapers and borers (scale 1:1).

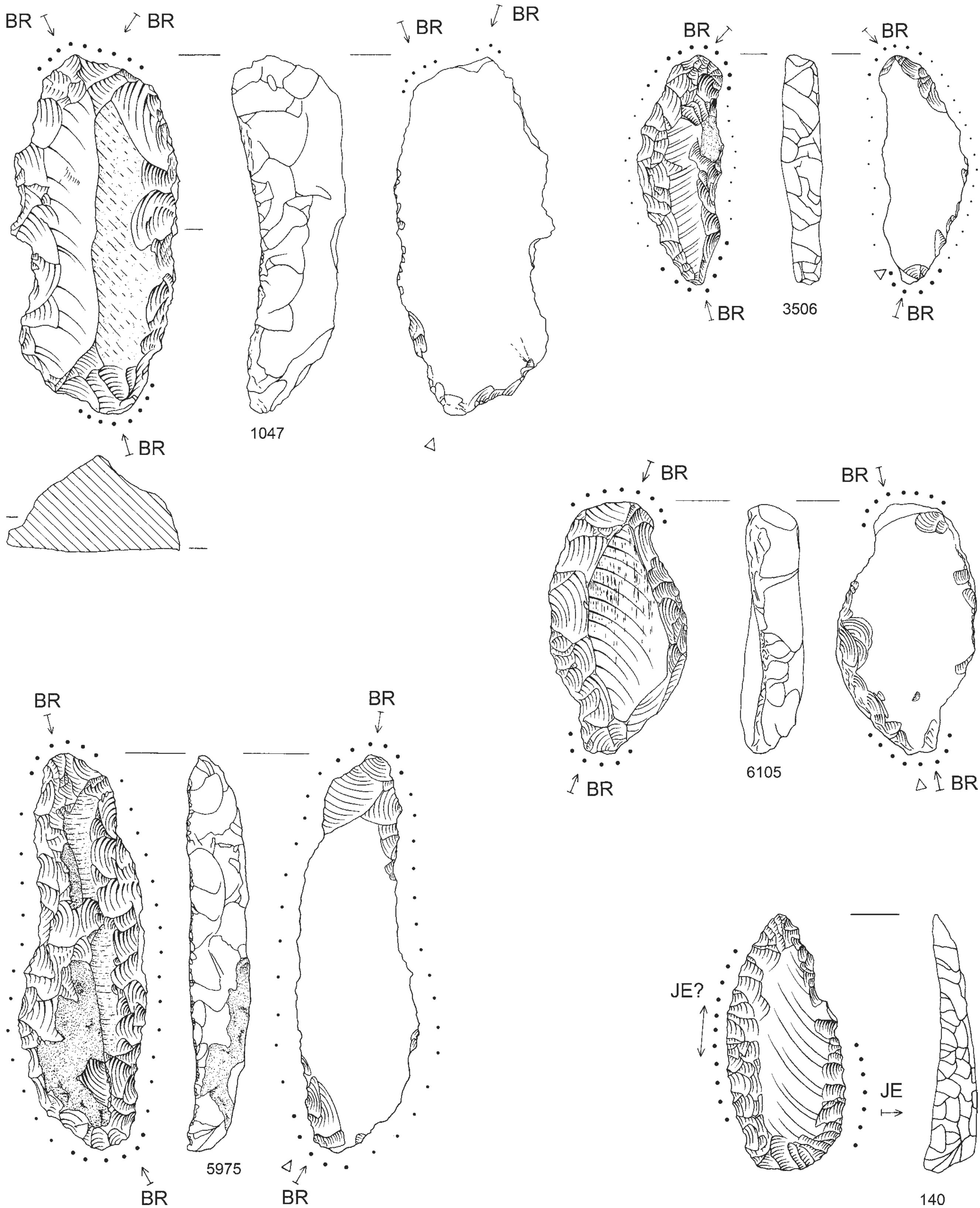


Figure 7.12 Strike-a-lights, two from grave 2. Retouched blade (no. 140). (scale 1:1).

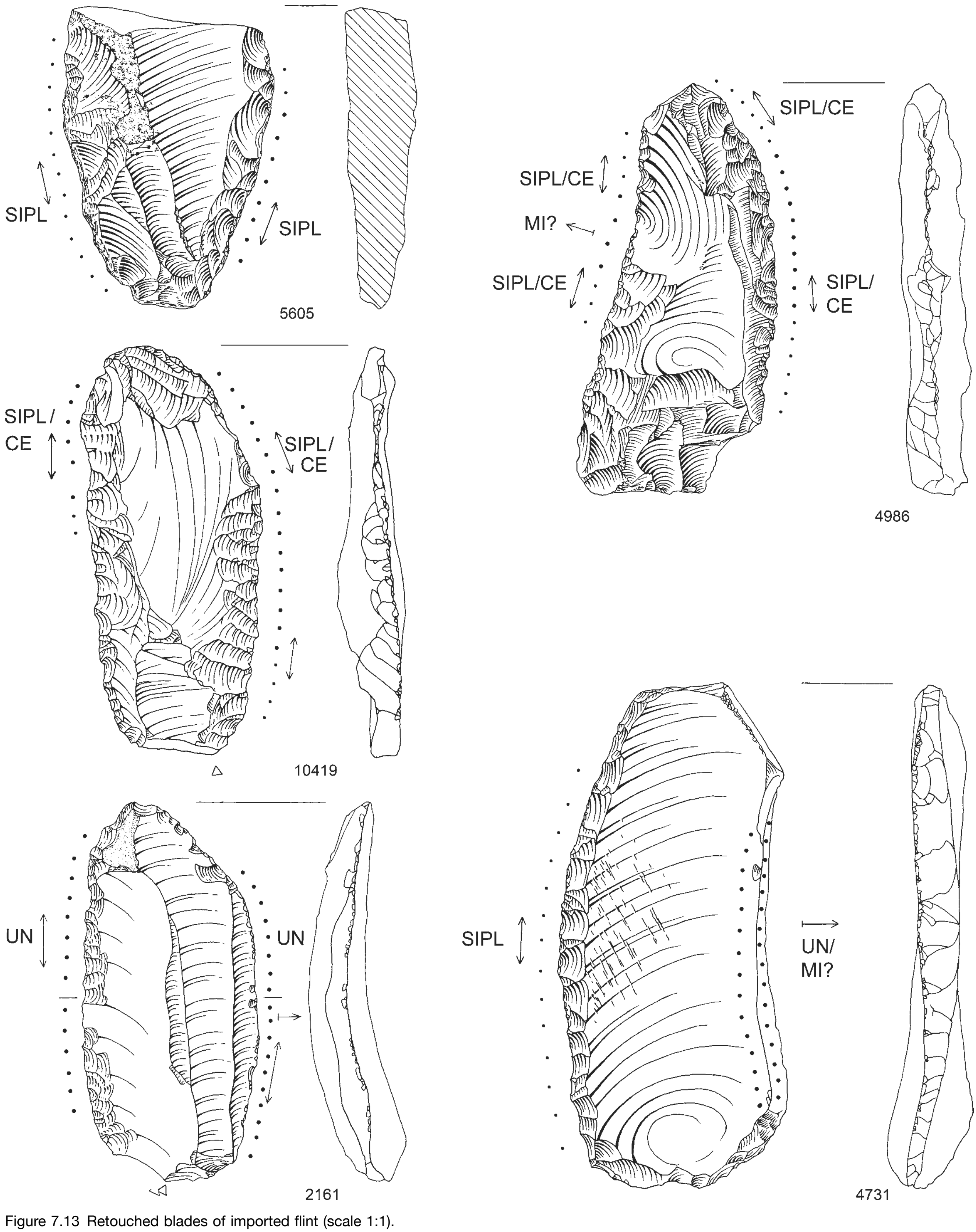


Figure 7.13 Retouched blades of imported flint (scale 1:1).

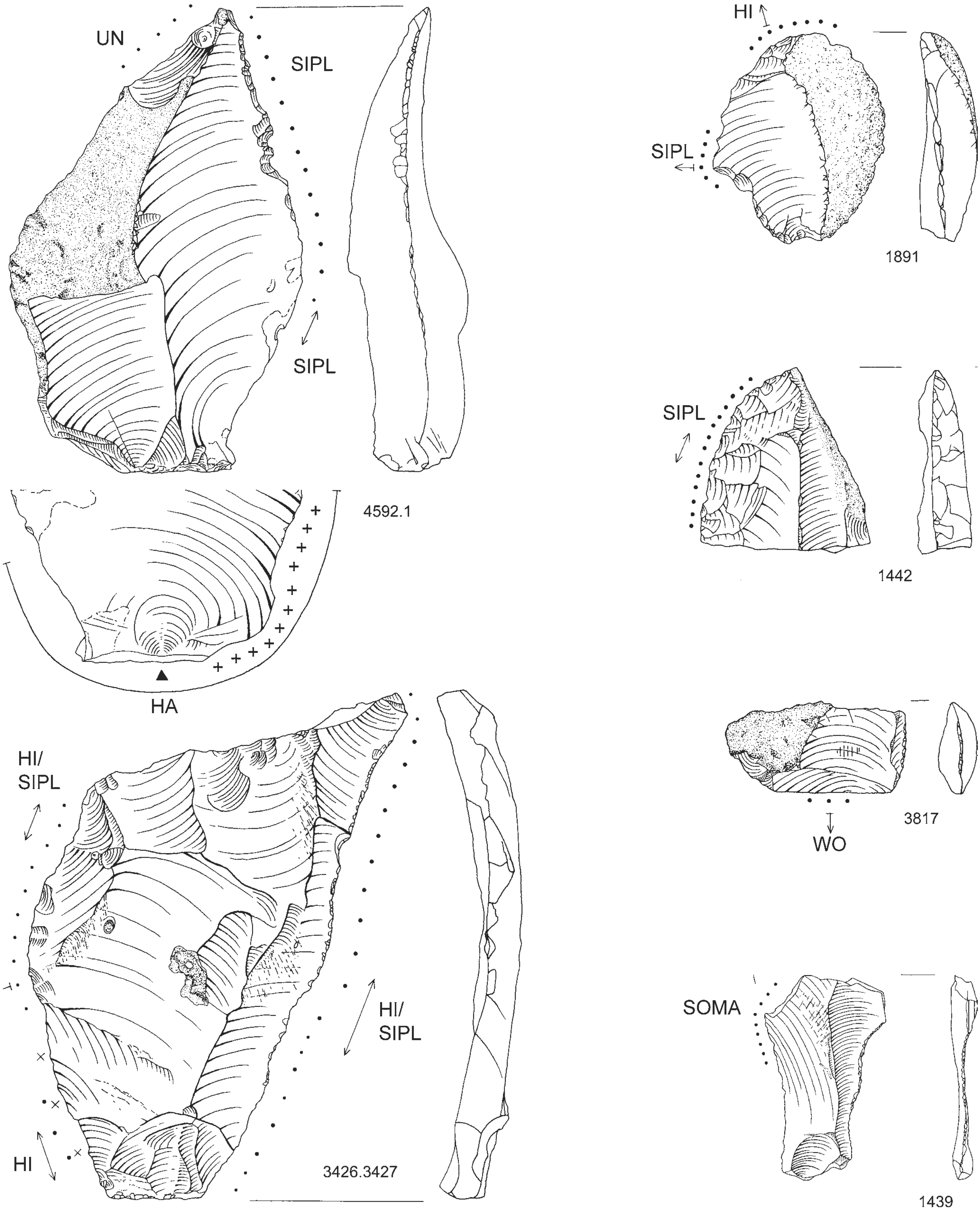


Figure 7.14 Retouched flakes (scale 1:1).

contact material \ motion	longitudinal	transverse	boring	diagonal	pounding	shooting	transverse / longitudinal	hafting	hafting with tar	indet.	totals
plant											
plant unspec.	–	–	–	–	–	–	–	2	–	–	2
soft vegetal	1	–	–	–	–	–	–	–	–	–	1
siliceous plant	17	8	–	–	–	–	1	–	–	3	29
reeds	1	–	–	–	–	–	–	–	–	–	1
cereals	3	–	–	–	–	–	–	–	–	–	3
wood	2	3	–	–	–	–	–	–	–	1	6
animal											
bone	–	1	–	–	–	–	–	–	–	–	1
hide	1	14	–	–	–	–	1	–	–	–	16
fresh hide	–	2	–	–	–	–	–	–	–	–	2
soft animal	2	1	–	–	–	1	–	–	–	1	5
mineral											
mineral unspec.	1	7	6	1	–	–	–	–	–	–	15
soft stone	1	–	–	–	–	–	–	–	–	–	1
pyrite	–	–	–	–	32	–	–	–	–	–	32
jet	3	–	–	–	–	–	1	–	–	–	4
uncertain material											
bone / wood	2	1	1	–	–	–	–	–	–	–	4
hide / siliceous plant	4	1	–	–	–	–	2	–	–	–	7
soft material unspec.	1	2	1	–	–	–	–	–	–	1	5
unknown use	9	8	3	–	–	2	1	2	–	4	29
hafting											
with tar	–	–	–	–	–	–	–	–	9	–	9
material indet.	–	–	–	–	–	–	–	8	–	–	8
indet.	–	–	–	–	–	14	–	–	–	6	20
Totals	*48*	*48*	*11*	*1*	*32*	*17*	*6*	*12*	*9*	*16*	*200*

Table 7.4 The results of micro-wear analysis of 147 artefacts with 200 AUA's (actually used areas); contact material versus motion. The figures represent actually used edges and not individual tools, as one artefact may display more than one used zone.

and were probably produced elsewhere. The retouch is regular and more invasive.

At 63.7%, retouched flakes constitute by far the largest category of modified tools (fig. 7.14). Most were made from rolled pebbles, but there are also several large flakes of Cap Blanc Nez, Obourg and homogeneous black flint, which must have been brought to the site as such. One flake is notched.

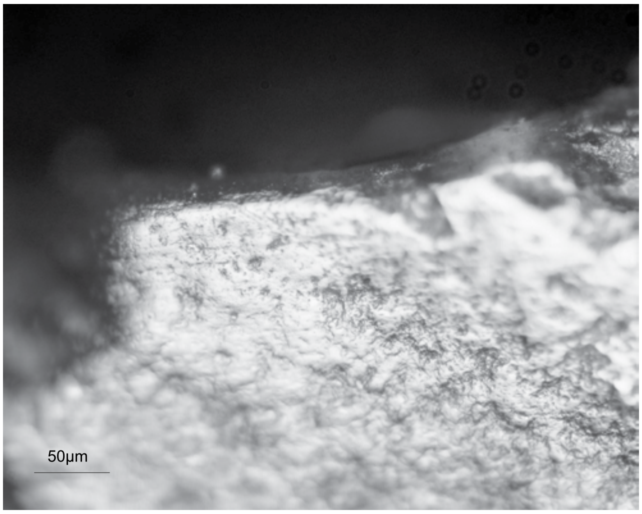
The remaining tool categories include several cores with retouch and some retouched pieces for which the primary classification could not be specified.

7.7 Artefact use

7.7.1 Introduction

A total of 373 artefacts were examined for traces of use. This sample included 204 implements from trench 10. The

Figure 7.15 Use-wear traces formed in contact with silicious plants, cereals, wood and hide. ▸
- a-c various varieties of bright polishes interpreted as resulting from contact with silicious plants (200×)
- d polish showing resemblance to that obtained by harvesting cereals (200×)
- e possible wood working traces (100×)
- f rounding and matt polish formed in hide scraping (200×)



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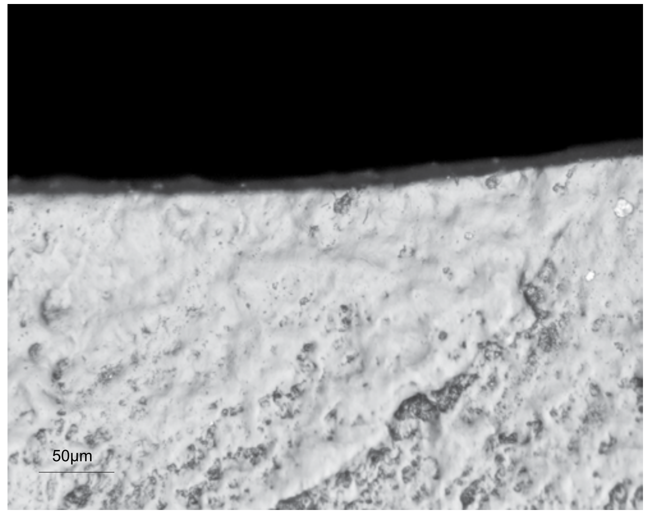

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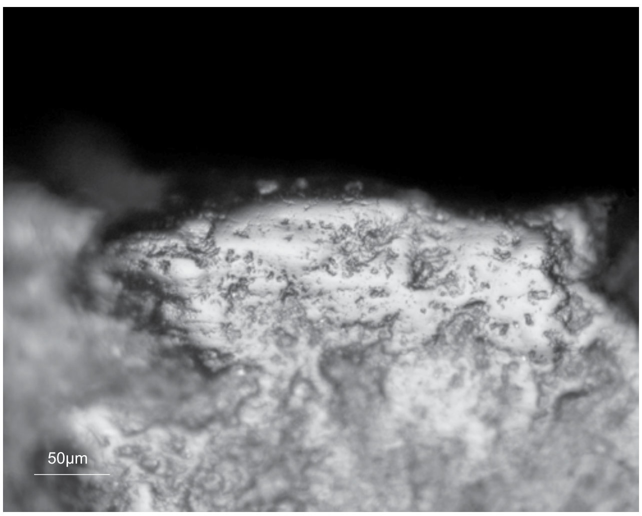

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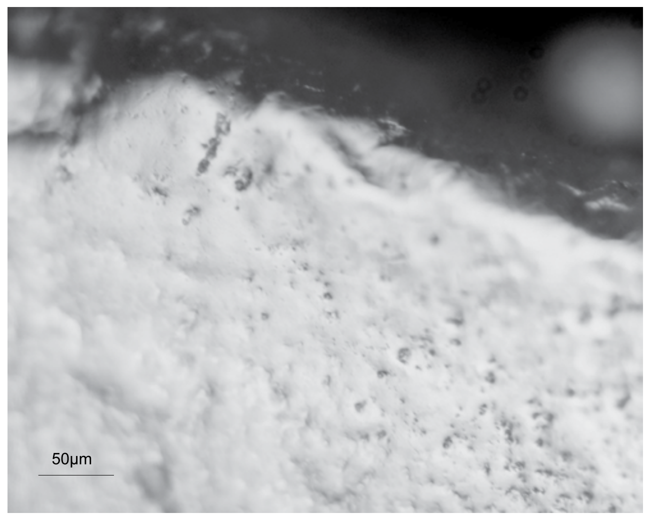

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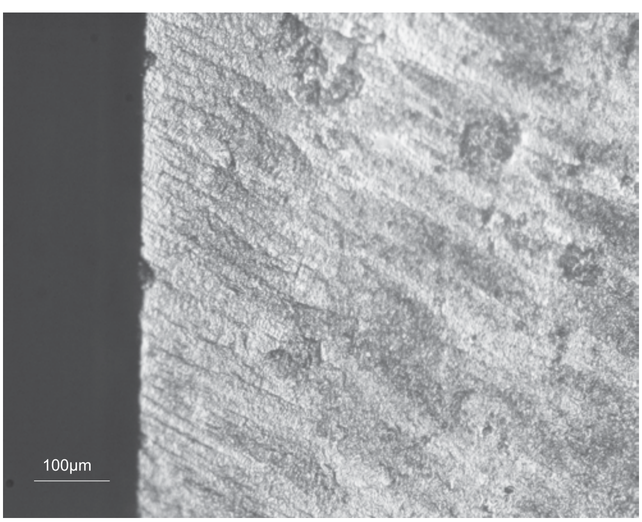

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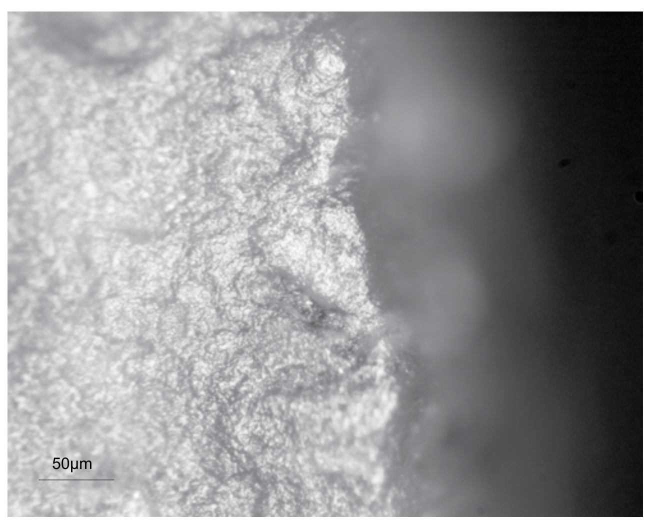

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rest of the material from trench 10 was either very small or very irregularly shaped, and was not studied microscopically. The results of the use-wear analysis of the material from trench 10 were used to assess the representativeness of the sample taken from the other trenches, consisting of 169 artefacts, selected from each typological category. Blades were given preferential treatment because it is known from experience that this tool type was used frequently and for a variety of purposes. This meant that there was a higher chance of spotting rare contact materials that would otherwise not have been noted.

A total of 200 actually used areas (AUAs) were distinguished on 147 artefacts. This implies that 39.4% of the artefacts examined, displayed traces of use. Several tools had more than one used edge: 41 tools had two AUAs, 10 tools were used on three edges, and two implements had four AUAs. Triangular points, scrapers, pointed blades, strike-a-lights and retouched blades most frequently showed more than one actually used area. The tools were found to have been used for a variety of activities (table 7.4).

7.7.2 Plant processing and woodworking

Silicious plants were the most frequently inferred contact material (table 7.4, figs. 7.15 a-c). In the majority of these cases the category of plant could not be identified due to the absence of characteristic features. One AUA displayed the fluid, very bright polish indicative of reed working. Most tools however showed a plant polish that could not be differentiated. Many of the tools concerned were used in a longitudinal (cutting) motion. Transverse motions indicative of processing activities, were less frequently observed. This is in sharp contrast with the Late Mesolithic Hardinxveld sites and also the Swifterbant sites S2 and S3 and Brandwijk (Van Gijn *et al*. 1998, 2001a, b, pers. observation; Bienenfeld 1985, 1988). These tools are assumed to have played a role in the preparation of reeds and other silicious plant material for further use in plaiting or basketry activities. Some such tools were found at Wateringen 4, but none displayed the smooth polish that was so prominent on the Late Mesolithic and Early Neolithic blades. Interestingly, these traces were not observed on Vlaardingen flint tools either. This implies a change in activity pattern somewhere during the early Middle Neolithic, most probably in basketry and plaiting techniques. It is difficult to ascertain whether this was related to a shift in subsistence.[4]

Tools showing traces of woodworking were rare, certainly considering the amount of wood that was chopped and chiselled near the site. Two axes display a smooth, domed gloss, characteristic of contact with wood, in their use retouch. One was clearly used in a transverse, chopping motion, the other oddly enough seems to have been used to cut wood, as the motion is indisputably longitudinal (fig. 7.15e). Other woodworking tools should be viewed in connection with the few examples of fine woodworking found at the site (chapter 11). They include a pointed blade used to shave wood. This implement, made on Obourg flint, is remarkable in that it displays three zones of use, each entirely different in character (fig. 7.9, no. 4937). Two flakes, one of which is unmodified, were also used on wood. One point, made on the cutting edge of a polished axe flake, displays traces of wood chiselling, but this probably relates to the axe to which this flake belonged before it was modified into a point (fig. 7.7, no. 4167).

In comparison with other contemporary assemblages the percentage of woodworking tools is surprisingly low: only 3% of the used zones relate to woodworking, versus 8.1% at Wateringen 4 (Van Gijn 1997). At Gassel, 18 of the 30 artefacts examined (60%) displayed wear traces formed in woodworking (Bienenfeld 1989). Traces of contact with wood however often resemble various post-depositional traces, so the figure obtained for Gassel may not be entirely representative. At Schipluiden, woodworking traces observable on the hard stone and bone tools compensate for the small number of flint woodworking tools (see chapters 8 and 9).

7.7.3 Cereal harvesting

A few of the implements show traces formed in cutting silicious plants that look very much like the traces observed on our experimental sickles. Three zones on two implements (one on a scraper (fig. 7.10, no. 1037) and two on a retouched blade (no. 4986) display a smooth, bright, highly linked polish (figs. 7.15d). The band of polish is however not as wide as that on the experimental sickles used to cut stems. The traces on the tools bear a closer resemblance to traces on implements that were used to snap and cut off ears. Some of the tools that were interpreted as having been used on silicious plants may actually have been sickles. This holds especially for a large pointed blade (fig. 7.9, no. 2857) and two retouched blades (fig. 7.13, no. 10,419 and no. 4731), which show this very bright polish suggestive of use as a sickle.

Five tools, all displaying silicious plant polish, were sampled for phytolith analysis (see chapter 8). Only one sample, from tool no. 10,419, revealed a small dendriform shape with papilles. No phytoliths were observed on the other four implements. The presence of sickles comes as a bit of a surprise as no sickles were encountered in the Wateringen 4 assemblage. The presence of sickles does however agree with the results of the analysis of the botanical macro-remains (chapter 19) and with the presence of grinding stones (chapter 8). Sickles may have had a special significance for the inhabitants as one of them (no. 4986) displays some patches of a reddish residue that may be ochre. A similar residue has been observed on three sickles from Ypenburg (Van Gijn, pers. observ.).

Figure 7.16 A selection of strike-a-lights together with a piece of radial pyrite.

7.7.4 Making fire

One of the surprises of Schipluiden was a large number of strike-a-lights (fig. 7.16), three of which were found in the hand of the skeleton in grave 2 accompanied by a nodule of pyrite (fig. 5.3; fig. 7.12). They may originally have been contained in a small pouch.

A total of 32 zones, on 27 tools, displayed traces associated with a use as strike-a-light. The traces are very characteristic, comprising a very rounded protrusion showing a multitude of small impact fractures. The fractures could be clearly made out under the stereomicroscope (fig. 7.17c). Other characteristic features are linear traces of a matt, rough polish (figs. 7.17b). Most of these strike-a-lights have a very glossy appearance, probably due to the release of fine pyrite powder that acted as an abrasive on the tool's surface (fig. 7.17a). Almost all the strike-a-lights were severely worn and they were also more frequently used on two sides than other types of tools. This will have been facilitated by their shape, generally elongated, usually with one or two pointed ends. The strike-a-lights seem to have been curated tools, used for a considerable time. Our experimental implements did not come close to the prehistoric tools in terms of the extent of wear, even after several hours of use, and never displayed the characteristic glossy surface.

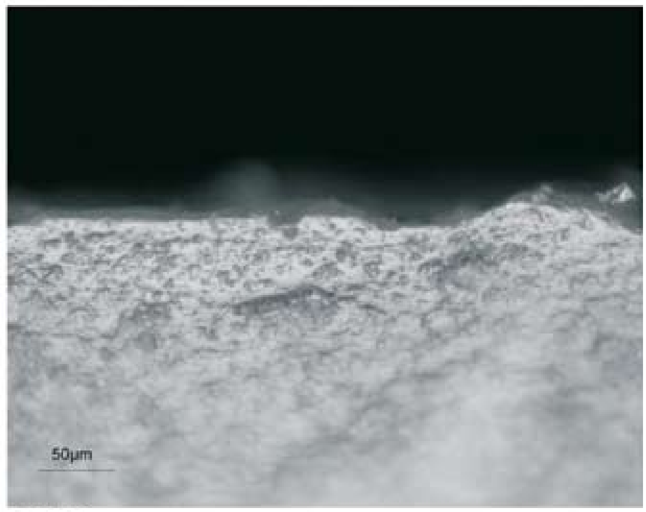
Until recently, strike-a-lights were not differentiated typologically. Only after use-wear analysis has it become clear that many large borers or reamers with rounded tips actually had nothing to do with boring or drilling, but were involved in fire making. Strike-a-lights have been found in the Netherlands in various chronological contexts, notably in Upper Palaeolithic (Oldeholtwolde, Stapert/Johansen 1999), Late Mesolithic (Hardinxveld-Giessendam Polderweg, Van Gijn *et al*. 2001a) Late Neolithic funnel-beaker (Van Gijn, pers. observ.) and Bronze Age (Van Gijn/Niekus 2001) contexts. At Wateringen 4 no tools were identified as strike-a-lights at the time of the analysis (1994/'95), but on hindsight some of the artefacts identified as tools for drilling mineral substances were most probably actually strike-a-lights (Van Gijn 1997, fig. 32f). This may also apply to a heavily worn tool bearing traces formed in boring soft stone that was classified as a borer at Hekelingen III (Van Gijn 1990, fig. 67c): this tool may likewise have to be reinterpreted as a strike-a-light.

Strike-a-lights must have been significant for the inhabitants of Schipluiden, not in the least because they were considered sufficiently worthwhile to accompany the deceased as grave goods. The fact that they were used for

a 4246

b 6983

c 5975



d 2080

e 4731

f 7466

a very long period (years rather than hours) also points to a special meaning of these implements. This is further corroborated by the raw material chosen for their production: although half of them were made on rolled pebbles, a considerable number were made on imported flint, notably Obourg flint or flint that could not be specified.

7.7.5 Hide working

Hide working seems to have been an important activity at the site. Most tools employed in this task are scrapers, used in a transverse motion (figs. 7.10 and 7.15f). Only two tools showed traces pointing to the cutting of hide. This indicates that the flint implements were used in the cleaning, preservation and currying of the hides, rather than in their processing into for instance items of clothing, an activity in which we assume cutting implements played a role. The variation visible in the character of the hide-working traces reflects at least two general stages of hide-working: the cleaning of fresh hides and the currying of dried or tanned hides. Some tools display a greasy-looking band of polish suggestive of contact with fresh hide, others have a heavily abraded edge with a dull, rough polish more indicative of the currying stage of the hide-working sequence.

A total of seven edges display a polish that is reminiscent of contact with both silicious plants and hide (referred to as HI/SIPL in the figures). The polish is quite bright and reflective, with a smooth texture, but extensive rounding is visible, and the band of polish follows every minor protrusion along the edge, just like typical 'hide-polish'. We have no experimental equivalence of this particular type of polish. It bears a close resemblance to the elusive 'polish 10'. 'Polish 10' was first encountered at the Michelsberg site of Maastricht-Klinkers (Schreurs 1992), but has not been reproduced experimentally. It was also found at Brandwijk (Van Gijn 1998) and Wateringen 4 (Van Gijn 1997). At the latter two sites it was only observed on imported tools. It bears similarities to both the polishes produced by silicious plants and hides. The contact material responsible for this polish is not yet known. One explanation for this type of wear may be that the tools were employed to cut finished hides into strips and smaller pieces.

Hide-working traces were encountered predominantly on scrapers: 12 of the 29 scrapers examined displayed traces interpreted as resulting from contact with hide. They include two beautiful tanged scrapers with adhering specks of tar and other indications of hafting, such as friction gloss (fig. 7.11, nos. 1255 and 9381). The polish on one of the implements suggests contact with fresh hide, whereas the rounding of the edge of the other (no. 9381) suggests a use in the currying phase of hide processing. The latter tool had first been used to cut silicious plants before it was retouched into a scraper (fig. 7. 11). Both scrapers were resharpened before being discarded. One blade of homogeneous black imported flint was used to cut hide on both lateral sides.

7.7.6 Working mineral substances: making ornaments from soft stone

A surprisingly large number of artefacts turned out to have been used on mineral substances. Excluding the implements used to strike pyrite, a total of 20 AUAs display traces formed in cutting, scraping, drilling and carving mineral material (figs. 7.17d, e). The majority of the mineral-working traces could not be linked to a specific contact material. The motions include predominantly drilling, followed by cutting and incidentally scraping. The borers may very well have been used in the production of beads and pendants of amber, jet and quartzite. Three tools display the very bright, smooth polish that was also obtained in jet-cutting experiments (fig. 7.17d). Two of them have two used edges. Such traces should not come as a surprise, considering the number of semi-finished jet beads found at Schipluiden (chapter 8), but it is interesting to note the types of tools selected for this activity: all three tools were 'special': a pointed blade, a carefully retouched blade that looked rather like a tanged scraper and a huge borer of highly mottled Belgian flint.

Wateringen 4 also yielded several tools bearing traces of mineral working, including a few borers (Van Gijn 1997, 178). Mineral working has only rarely been demonstrated for Michelsberg assemblages. For example, only one stone-working tool was found at Maastricht-Klinkers (Schreurs 1992). The absence of such traces may however also be partially attributable to a lack of experimental reference pieces in some of the earlier microwear analyses, and it is very likely that stone-working activities played a more prominent part in the Neolithic than so far assumed.

◀ Figure 7.17 Use-wear traces formed by working on various flint varieties.
a-c strike-a-lights (a: 100×; b: 200×; c: 50×)
d traces from contact with jet (200×)
e traces from unknown mineral substance (100×)
f traces from unknown material (100×)

7.7.7 *Bone working*

Only a few bone-working traces were observed: one implement displays traces closely matching those found on experimental bone-working tools and four other tools were used on either bone or wood.

It is very strange that tools for working bone and antler are so rare or even absent, because waste of bone and antler indicates that these materials were indeed locally processed into tools and objects. There is evidence of the manufacturing of awls from red deer metapodia (chapter 10). Implements were also made from antler, as testified by the presence of waste from the groove-and-splinter technique (chapter 10). This strange anomaly was previously also noted at the two Late Mesolithic sites of Hardinxveld-Giessendam where, as at Schipluiden, the number of flint artefacts with traces produced by bone and antler was surprisingly small in comparison with the numerous waste products of bone and antler tool production (Van Gijn *et al.* 2001a, b). This is difficult to explain because flint, with its sharp cutting edges, is essential for the manufacture of bone and antler objects. Moreover, cut marks have been found on a number of bone and antler artefacts whose morphological attributes indicate that they are flint knives (chapter 10). For some reason bone- and antler-working tools are missing from the sample selected for use-wear analysis. This can probably not be attributed to chance. It is more likely that we used the wrong selection criteria. We have of course studied only a very small number of artefacts microscopically, and we must have missed the tools used for this activity. At the later Vlaardingen sites many unmodified tools with a protrusion or a sturdy edge display traces of bone/antler working (Van Gijn 1990). Apparently the occupants of Schipluiden chose a different kind of edge for the manufacture of bone and antler implements, a type of edge that is evidently not represented in our sample. However, it may also simply mean that the manufacture of bone and antler tools was not a frequently occurring activity, especially bearing in mind the relatively small amount of worked bone and antler relative to the long occupation of the dune.

7.7.8 *Shooting*

Quite a large number of triangular points were found at Schipluiden. A total of 41 points were selected for use-wear analysis, 17 of which were found to display traces of impact, sometimes associated with linear traces of polish.[5] Such traces are commonly associated with shooting. Thirteen of the points display traces of hafting. Eight of those points also bear remnants of birch bark tar (fig. 7.8). The presence of used arrowheads indicates that retooling took place at the site and that hunting was practised at Schipluiden.

7.7.9 *Unknown contact materials*

This category actually comprises two types of tools: tools showing well-defined types of polish for which we just do not (yet) have experimental counterparts (listed as unknown use in table 7.4) and tools with more ambiguous traces, usually not developed sufficiently to have resulted in distinctive features in the polish (listed as indet. in table 7.4). The first category includes a total of 29 AUAs, with a wide variety of represented motions. Examples of unspecified soft contact materials are meat and green plants not containing silica – even after an hour of contact – those two materials leave only minor traces, which are hard to interpret archaeologically.

7.7.10 *Hafting traces*

Hafting traces are notoriously elusive but can definitely be distinguished (Rots 2002). Nine implements bore tiny fragments of a black substance interpreted as tar (fig. 13.3). The positions of the tar fragments on the tool, for example on the base of an arrowhead, substantiate this interpretation (fig. 7.8). One piece of birch bark tar was found at Schipluiden (see chapter 13), further corroborating the proposition that implements were hafted and retooled at the site itself. Another twelve artefacts displayed other kinds of traces interpreted as resulting from hafting, such as patches of friction gloss, rounding or an abrupt end of the use-wear polish. The incidence of hafting is not very great. Many tools were evidently used without a haft.

7.7.11 *The relationship between form and function*

One of the central research questions that can be addressed via wear-trace analysis is whether tool types were made with specific functions in mind (table 7.5). For example, scrapers are commonly associated with hide working and axes with chopping wood. Several such relationships could be demonstrated for the flint implements from Schipluiden. Most hide-working traces were indeed observed on scrapers (62.5% of the hide traces and 100% of the fresh hide-working traces), but scrapers were not used for this purpose alone. On the contrary, scrapers seem to have been fairly multifunctional, as suggested by the range of different types of contact materials, even if that range is not all that great (pyrite, plants and unknown materials). This was also observed at Wateringen 4 (Van Gijn 1997).

Another tool type that is strongly bound to a specific function is the point. Half of the triangular points displayed impact traces indicative of their use as arrowheads, but one of them actually served as a strike-a-light.

Another function-specific tool type is the borer. Although the contact materials varied, borers were essentially used for drilling. The Schipluiden borers seem to have been used predominantly for drilling mineral substances.

artefact type \ motion	longitudinal	transverse	boring	diagonal	pounding	shooting	transverse / longitudinal	hafting	hafting with tar	indet.	totals
geometric microlithic points	–	–	1	–	–	1	–	–	–	1	3
triangular points	1	–	–	–	1	10	–	3	5	–	20
leaf-shaped points	1	–	–	–	–	1	–	–	1	3	6
half product points	1	3	–	–	1	2	–	1	2	–	10
point undetermined	–	–	–	–	–	1	–	1	–	–	2
single borer	–	2	7	–	–	–	–	–	–	–	9
single reamer	–	–	1	–	–	–	–	–	–	–	1
combination tool	–	1	1	–	1	–	–	–	–	1	4
scraper	2	11	–	–	1	–	–	4	–	2	20
side scraper	1	3	–	–	–	–	–	–	–	–	4
tanged scraper	1	2	–	–	–	–	–	1	–	1	5
axe	1	1	–	–	–	–	–	–	–	–	2
pointed blade	5	1	–	1	2	1	2	–	–	2	14
strike a light	–	–	–	–	15	–	–	–	–	–	15
retouch general	–	1	–	–	1	–	–	–	–	–	2
retouched blade	19	7	–	–	2	–	2	–	–	2	32
blade steep retouch	–	–	–	–	–	–	–	–	–	1	1
blade border retouch	1	–	–	–	–	–	1	–	–	–	2
retouched flake	8	8	–	–	2	–	1	2	–	2	23
retouched core	–	1	–	–	1	–	–	–	–	–	2
flake core	–	–	–	–	4	–	–	–	–	–	4
not modified	7	7	1	–	1	1	–	–	1	1	19
Totals	*48*	*48*	*11*	*1*	*32*	*17*	*6*	*12*	*9*	*16*	*200*

Table 7.5 The relationship between form and function of 200 actually used edges: artefact type versus motion.

With their characteristic rounded tip and elongated shape, strike-a-lights are very homogeneous tools in terms of use. Their typical shape can be clearly identified by the naked eye, and was actually the criterion used in classifying artefacts as strike-a-lights, so the homogeneity of this tool type is not surprising. What is however remarkable is that a wide range of tool types were used as strike-a-lights, including a triangular point, a scraper, a pointed blade and retouched blades, flakes and cores. Apparently, any tool with a sturdy tip capable of withstanding blows and allowing a firm grip was deemed suitable for starting fires, possibly as a secondary function.

The pointed blades are an intriguing tool type as they seem to have been highly multifunctional. They were used as strike-a-lights, to cut plants (possibly cereals in this case), to work hide and mineral substances such as jet and so forth. The type seems to have been used rather like our Swiss knives. The same multifunctionality is also reflected by the retouched blades and flakes. These tools were used on a variety of contact materials. Many of both the pointed and the retouched blades, along with the retouched flakes and the strike-a-lights, showed several used zones: six retouched blades showed two AUAs, four showed three used zones and one four such zones.

7.8 Spatial patterning

The various raw materials were found all over the dune, with no apparent concentrations. A large proportion of the flint came to light in the dump zone on the southeastern slope. The same holds for the tool types – they, too, appeared to be randomly distributed across the site, again, of course, with a concentration in the dump zones. We finally attempted to plot the activities carried out at the site (figs. 7.18a-c). The only concentration that is possibly meaningful is that comprising one jet-working implement and one used on mineral material found close to two semi-finished jet beads (fig. 7.18c).

7.9 Diachronic differentiation

The dune seems to have been continuously occupied, from *c*. 3630 to 3380 BC (chapter 2). Within this time span, four

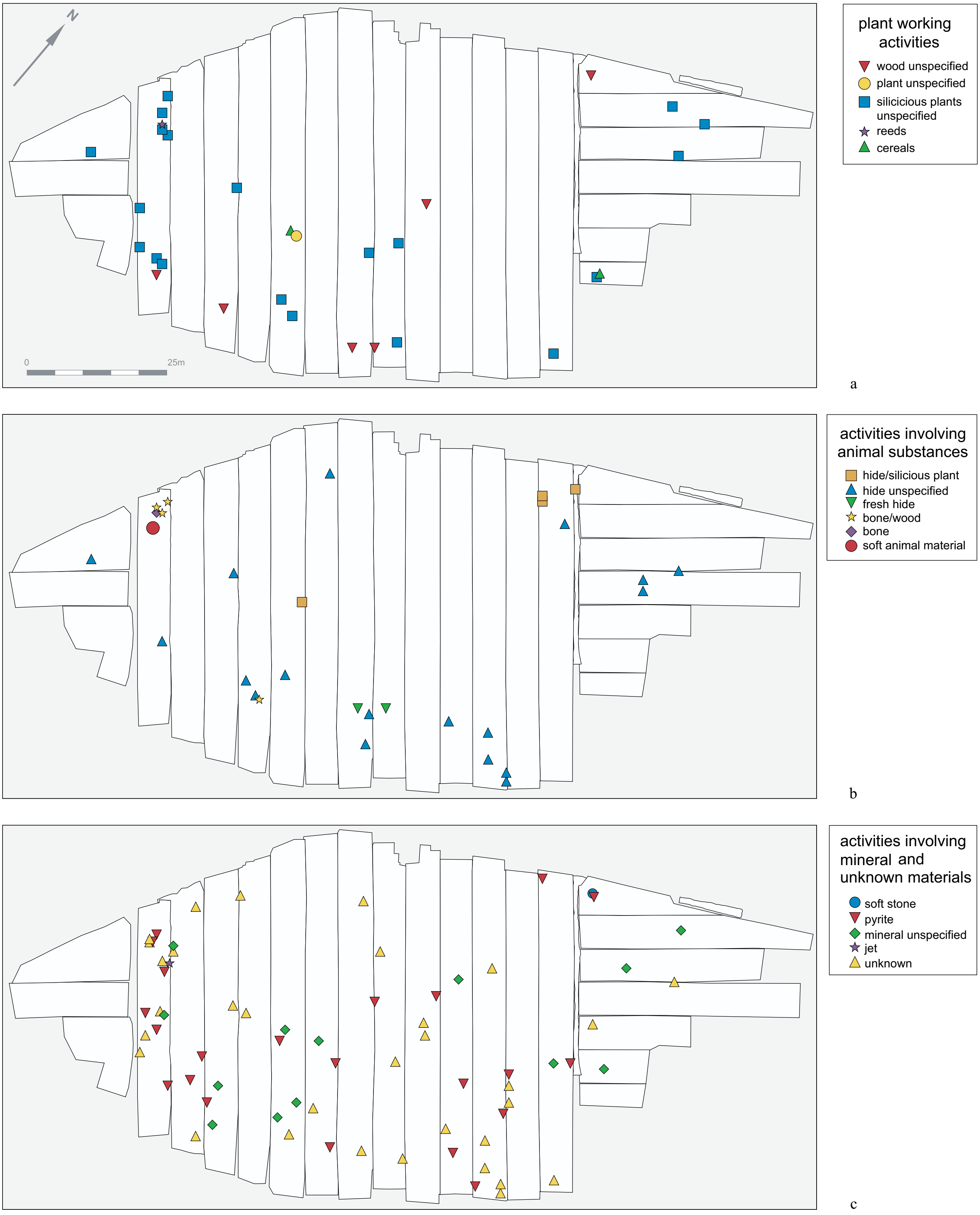


Figure 7.18 Distribution patterns of the activities inferred from micro-wear analysis.

flint variety	N= phase 1	phase 2a	phase 2b	phase 3	phase 1-3	totals	% phase 1	phase 2a	phase 2b	phase 3	phase 1-3	totals
rolled pebbles	4	97	162	434	842	1539	.	60.2	54.2	57.6	58.2	57.7
Cap Blanc Nez	–	5	9	9	38	61	.	3.1	3.0	1.2	2.6	2.3
Obourg	–	3	4	16	23	46	.	1.9	1.3	2.1	1.6	1.7
black, homogeneous	–	–	2	5	10	17	.	–	0.7	0.7	0.7	0.6
light grey Belgian	–	–	–	5	12	17	.	–	–	0.7	0.8	0.6
various Belgian	1	10	6	15	29	61	.	6.2	2.0	2.0	2.0	2.3
Spiennes/Rijckholt	–	1	1	1	2	5	.	0.6	0.3	0.1	0.1	0.2
northern	–	–	1	–	2	3	.	–	0.3	–	0.1	0.1
indet.	–	45	113	269	490	917	.	28.0	38.0	35.7	33.8	34.4
Totals	*5*	*161*	*298*	*754*	*1448*	*2666*	.	*100*	*100*	*100*	*100*	*100*

Table 7.6 Flint variety versus occupation phase.

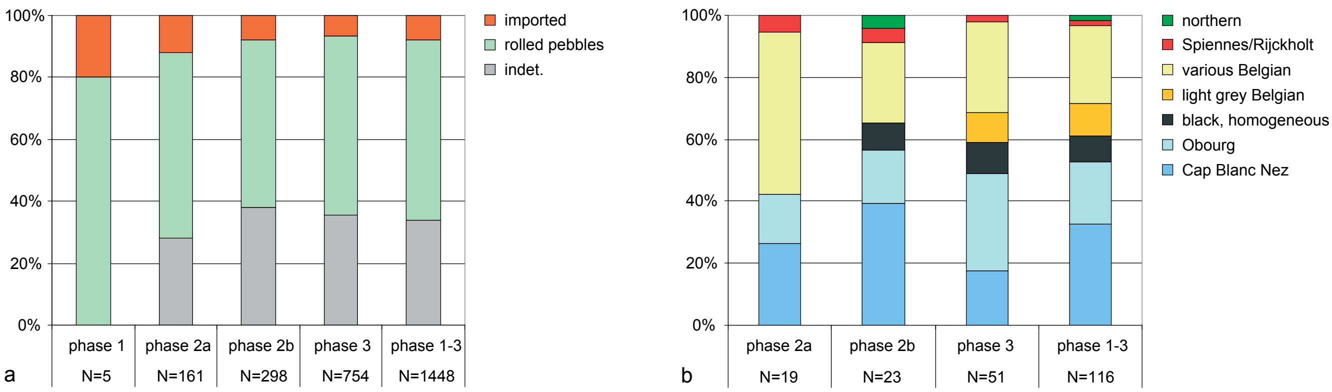


Figure 7.19 Composition of the flint assemblage per phase.
a ratio of rolled pebbles and all 'imported' flint varieties
b composition of the category of imported flint

occupation phases have been distinguished (chapter 2). As much of the flint came from the 'occupation layer' Unit 20, about half of the total amount could not be attributed to a specific occupation phase (54.4%) and only five implements were dated to phase 1. Sufficiently large samples are however available for the other three phases, 2a, 2b and 3, and no diachronic differences are observable between those phases as regards the types of raw materials used (table 7.6; fig. 7.19). The relative percentages of imported flint and rolled pebbles remained unchanged throughout the occupation period, as did the types of imported flint. This means that the contact networks of the local community remained stable in character through the generations.

A similar picture emerges from the analysis of tool typology through time (table 7.7). Again, insufficient implements could be dated to phase 1 to allow a meaningful assessment. The percentages of tool types dating from the other three occupation phases are entirely comparable, differing to only a minor extent. Although the numbers of implements examined for traces of wear are relatively small, it is likely that the activities carried out at the site remained constant through time, too, suggesting a stable site function. The only exception concerns a decrease in the proportion of flake cores from phase 2a (34%) through phase 2b (17%) to phase 3 (15%), compensated by an increase in retouched flakes and unmodified pieces. It is not clear what meaning should be attributed to this shift, as it is not compensated by an increase in for example blade cores.

artefact type	N= phase 1	phase 2a	phase 2b	phase 3	phase 1–3	totals	% phase 1	phase 2a	phase 2b	phase 3	phase 1–3	totals
geometric microlithic point	–	–	1	1	4	6	.	–	+	+	+	+
triangular point	–	6	14	25	43	88	.	4	5	3	3	3
leaf-shaped point	–	–	–	2	3	5	.	–	–	+	+	+
halfproduct point	–	–	12	13	16	41	.	–	4	2	1	2
point indetermined	–	1	1	5	7	14	.	1	+	1	1	1
borer	–	4	2	7	12	25	.	3	1	1	1	1
burin	–	–	–	–	4	4	.	–	–	–	+	+
scraper	–	4	2	19	27	52	.	3	1	3	2	2
combination tool	–	–	1	–	2	3	.	–	+	–	+	+
axe	–	1	3	3	7	14	.	1	1	+	1	1
pointed blade	–	1	5	7	18	31	.	1	2	1	1	1
strike a light	–	3	2	8	21	34	.	2	1	1	2	1
retouched blade	1	2	3	11	17	34	.	1	1	2	1	1
retouched flake	–	31	87	208	389	715	.	19	29	28	27	27
retouched core	–	2	4	5	6	17	.	1	1	1	+	1
retouched block	–	–	1	–	1	2	.	–	+	–	+	+
retouched type unknown	–	–	5	13	19	37	.	–	1	2	1	1
notched flake	–	–	–	–	1	1	.	–	–	–	+	+
core preparation piece	–	5	9	19	90	123	.	3	3	3	6	5
flake core	3	54	49	111	318	535	.	34	17	15	22	20
blade core	–	–	–	–	1	1	.	–	–	–	+	+
core not identifiable	–	–	–	–	1	1	.	–	–	–	+	+
core rejuvenation piece	–	3	5	9	41	58	.	2	2	1	3	2
not modified	1	44	92	288	400	825	.	27	31	38	28	31
Totals	*5*	*161*	*298*	*754*	*1448*	*2666*	.	*100*	*100*	*100*	*100*	*100*

Table 7.7 Flint, artefact types by occupation phase.

7.10 Conclusions

7.10.1 Raw materials and their provenances

The flint from Schipluiden is to a large extent comparable with the flint found at contemporary sites in the region. The range of raw materials used is the same, with a strong emphasis on rolled pebbles that were probably available fairly close by, possibly even on the beaches. This was supplemented with finished tools of imported flint from southern Belgium, from Hainaut in the west to (possibly) the Hesbaye area in the east. The assemblage may contain a few pieces of Rijckholt flint, but, if so, it is an atypical material that cannot be distinguished from the flint from Spiennes. If the pieces concerned are indeed of Rijckholt flint, then it was probably collected from the Meuse river gravels in the central part of the Dutch province of Limburg, and its procurement was embedded in the same exchange/mobility context as that of the hard stone.

7.10.2 Tool types and their affinities

Besides the ranges of raw materials, the ranges of tool types represented at Wateringen 4 and Schipluiden are also similar: pointed blades, scrapers, triangular points and retouched blades. A notable difference is the presence of tanged scrapers and strike-a-lights at Schipluiden and their absence at Wateringen 4. No parallels for the tanged scrapers have been found in the literature; this tool type seems to be unique to Schipluiden. The tools are made of imported Belgian flint and were very finely worked (possibly by pressure flaking). They were most likely imported as finished products. Strike-a-lights may not have been identified as such in previous analyses, and have been classified as reamers or heavy borers instead. A few implements from Wateringen 4 with a rounded tip that were interpreted as having been used on a mineral substance are probably indeed strike-a-lights. Ypenburg also yielded strike-a-lights (pers. observ.; Koot/Van der Have 2001). Further east, the same probably holds for one of the reamers from Kraaienberg (Louwe Kooijmans/Verhart 1990, fig. 30, tool no. 26).

When we compare these coastal assemblages with what has been found at Michelsberg sites in Belgium, the most notable difference is the absence of tranchet axes at the coast (Vanmontfort *et al*. 2001/2002; Vermeersch 1987/1988). This tool type is frequently encountered at Belgian Michelsberg sites, but seems to be absent at inland Michelsberg sites in the Netherlands, too. The tool type was for example not found at Gassel (Verhart/Louwe Kooijmans 1989) or Kraaienberg (Louwe Kooijmans/Verhart 1990). The points and scrapers do seem to agree with what has been observed for the Michelsberg culture elsewhere. As mentioned above, the tanged scrapers have not been observed anywhere else, but this may be due to different typological classifications by different researchers. As for the size of the Schipluiden artefacts, only some of the large imported blades show the macrolithic character that is so typical of many Michelsberg assemblages. Generally speaking, large blades proper of the kind observed at Kraaienberg seem to be absent at Schipluiden.

7.10.3 Flint procurement network

In their flint-procurement strategies, the occupants of Schipluiden seem to have turned in a direction different from that of the Late Mesolithic and earlier Neolithic wetland inhabitants of the same general area. At the Late Mesolithic sites of Hardinxveld-Giessendam Rijckholt-type flint was reasonably common. The most striking example is a large pre-core of Rijckholt flint found at Polderweg that was not exploited for tool production at all, and a large Rijckholt blade found at De Bruin (Van Gijn *et al*. 2001a, b). At the Middle Neolithic site of Brandwijk, Rijckholt flint was still imported, but then probably as finished products, considering the complete absence of knapping waste and cores of this material at this site (Van Gijn 1998). It is not clear why the subsequent Hazendonk people deviated from this practice and turned in a more southerly direction for their flint procurement. The fact that some of the contemporary sites around Antwerp show the same range of raw materials suggests the existence of social networks between the two areas that determined the flint procurement practices.

7.10.4 Knapping techniques

The knapping techniques reflected by the Schipluiden flint are still rather sophisticated compared with the techniques of the subsequent Vlaardingen group. There is evidence of core preparation and rejuvenation, and the striking platform was also often prepared. But the small rounded pebbles constituting the main category of employed raw material greatly limited the possible reduction techniques and processes. Bipolar reduction was commonly practised, the implements were small and many were only minimally retouched. These practices continued in the subsequent Vlaardingen group, in which the flint from Hekelingen III bears the closest similarity to the Schipluiden flint, with a similar range of raw materials. The Leidschendam flint is different in that it contains virtually no imported material and the site's inhabitants relied exclusively on (locally available) small rolled pebbles (Van Gijn 1990).

7.10.5 Craft activities

The range of activities attested for by use-wear analysis is broad. Wood was chopped with flint axes, but most of the woodworking was actually done with the aid of non-flint tools. The coarser wood cleaving and cutting was done not with flint tools but with large quartzite flakes (chapter 8; fig. 7.20), whereas the fine woodworking was done with the aid of small bone chisels (chapter 10). Silicious plants such as reeds or stinging nettles were cut, but, oddly, virtually no transversely used silicious plant processing tools were found. Such processing tools are common features in Late Mesolithic and Early Neolithic assemblages and are easily identified. It is therefore unlikely that this absence is due to overlooking of the relevant traces. More likely it represents a shift in technology, reflecting a change in basketry, plaiting and rope techniques, but it may also be related to a shift in subsistence. Bone awls were still used in the same fashion on silicious plants as in the Late Mesolithic, forming the toolkit for basketry and plaiting, alongside the flint knives used for harvesting the necessary raw material (chapter 10). The large number of silicious plant cutting tools indicates that wild plants were still important, and that only the processing techniques had probably altered.

Other craft activities include the making of beads out of jet and possibly also amber. Several borers display traces of working mineral substances. It is not strange that such tools were encountered, considering the number of semi-finished jet beads found in the site (chapter 9). Fire making seems to have been an important activity. Traces formed in striking pyrite constitute the largest category of use-wear traces. This should however be viewed in relation to the duration of occupation and the fact that these traces are highly visible and cannot be overlooked (we may actually have 100% coverage here). Other categories of worked material have all been missed to various degrees because they show no macroscopic features on flint making artefacts identifiable as tools. The large category of retouched flakes certainly includes many butchering knives, craft-working implements and sickles, but definitely no more strike-a-lights.

7.10.6 Subsistence

With respect to subsistence we found evidence of two activities: shooting and cereal harvesting. Points with impact

Figure 7.20 Toolkit for coarser wood-working tasks: flint axe, stone axe and flakes of quartzite, together with a piece of waste of primary wood-working (*cf.* figs. 11.8 and 11.10).

traces indicate that hunting was practised and that arrows were repaired and retooled at the site. A few tools with traces formed in contact with soft animal tissues may indicate that the animals were also butchered and processed at the site. The presence of sickles supports the assumption, developed in the analysis of the botanical macro-remains, that cereals – more specifically naked barley – were grown by the inhabitants in the close vicinity, in spite of the brackish wetland conditions (chapter 19). The micro-wear traces on the sickles are not typical in the sense that they do not display a broad band of highly reflective polish as commonly observed on LBK sickle blades. Instead, they show a polish quite similar to some of our smoother experimental polishes. It should be noted that some sickles may also have been included in the category of tools identified as used for 'cutting silicious plants'; if so, they did not display the subtle characteristics needed to distinguish them from this general category.

7.10.7 Group composition and site function

The wide range of activities demonstrated to have taken place at various moments at the Schipluiden site points to the long-term presence of complete households. Differentiating gender-specific tasks is a notoriously difficult enterprise due to the great cultural variation in labour division across gender lines. However, we would contend that it is very likely that women were present at the site, considering the range of tasks that were carried out. Basketry, rope making, bead manufacture and possibly also hide processing may have been the tasks in which women were involved. Flint working and hunting are commonly considered specifically male tasks, although it is sometimes claimed that women may have produced some tools themselves: simple flakes for household tasks (Gero 1991). In the case of Schipluiden they may have worked the small rolled pebbles, maybe by means of bipolar reduction. The crude mistakes made in jet bead manufacture suggest that children were involved in the initial production stages of the beads. The presence of children of different ages and at least one woman is attested by the physical remains (chapter 5).

Whether the site was a (temporary) base camp or a permanent settlement cannot be decided on the basis of the results of this study alone. The variety of features, the spatial analysis and the archaeozoological data indicate that the site was probably occupied permanently, on a year-round basis (chapters 3-4, 22-23). The results of the analysis of the flint assemblage certainly do not contradict this supposition.

7.10.8 Social and ideological significance

Although most flint may not have had any special significance for the inhabitants, the fact that people took the trouble to import high-quality flint from the south, in spite of the fact that they probably had sufficient raw material available closer by, indicates that the exchange networks through which they obtained this material must have been of great social and cultural importance for the Schipluiden people. This is also suggested by the fact that many of the imported tools show well-developed use-wear traces, some resulting from different contact materials, indicating that those tools were valued in a special way and curated. This holds especially to one heavily used sickle, made of import flint, that seemed to have been rubbed with ochre prior to deposition indicating a special connotation. Flint may even incidentally have been attributed some ideological meaning, as testified by the three strike-a-lights that accompanied the dead man in grave 2, along with a nodule of pyrite, probably contained in a pouch. These objects most probably constituted the man's personal tool kit. The fact that no grave goods other than body ornaments were found in graves at 'coastal sites' such as the Swifterbant graves and those of the Ypenburg cemetery (Koot/Van der Have 2001) suggests that the man had a specific function during his life. Interestingly, this particular combination of grave goods – strike-a-lights and pyrite – has been observed in several burials of the *Bandkeramik* culture in southern Germany and also at Niedermerz, an LBK cemetery much closer to our region (Dohrn-Ihmig 1983; Nieszery 1992). The fire-making tools were always placed near the arms or the head and are invariably associated with male graves. This suggests that it was a southern tradition. The position of the Schipluiden grave goods – in the hand close to the mouth – evokes an image of someone blowing the sparks resulting from the striking of the pyrite with flint in order to make a fire. With fire traditionally having special connotations in traditional societies, it can be suggested that the dead man was a religious specialist, *e.g.* a shaman.

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notes

1 For tool typology and raw materials, use was made of the list of Archis, the centre for digital archiving of the Dutch National Trust.

2 The active search for the exact sources of the different types of flint at Schipluiden using our own reference collection and by consulting Dr M.E.Th. de Grooth (Bonnefantenmuseum, Maastricht) and Prof. dr P. Crombe (University of Ghent, Belgium) made it clear that the internal variation of the different sources is very large indeed. Different layers within the same source yield flint of different colours, textures, grain sizes and even with different inclusions. Rijckholt itself is the best example of this, with flint varying from a very fine-grained (but never translucent) homogeneous black variety to a very coarse-grained light grey material with many inclusions of even more chalky flint.

3 Besides the complete and almost complete axes there are also hundreds of smaller axe fragments, mostly flakes and waste. Some of those flakes display the original edge of the axe, for example part of the cutting edge or the side. These flakes are not discussed in this section (but see section 7.6.1). They were studied for a BA thesis by Karsten Wentink (2004).

4 Although generally this type of perpendicularly oriented silicious plant polish is associated with basketry (e.g Juel Jensen 1994), it cannot be entirely excluded that it is actually related to a subsistence task: the peeling of starchy roots of waterplants. Experiments in which this task was reproduced have so far, not resulted in a polish that is convincingly similar to that observed on the archaeological tools, but this may be due to the short duration of the experiments. Experiments are currently being conducted in which large amounts of roots are being processed.

5 Shooting an arrowhead results in highly characteristic microscopic linear impact traces that are commonly referred to as MLITS (Fischer *et al*. 1984; Van Gijn 1990).

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8 Stone, procurement and use

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A variety of stone objects was found at Schipluiden. All the stone had to be imported from distant regions. The types of stone represented point to a predominant source in the Meuse riverbeds or terraces, but some smaller gravel may have been collected closer by. Modified implements include grinding stones, querns, hammer stones and axe fragments. The grinding stones were used mostly to polish flint. A phytolith study of querns yielded evidence of the processing of cereals. One piece of pyrite was recovered from a burial along with some flint strike-a-lights.

8.1 Introduction

Stone objects other than flint artefacts usually receive little attention in archaeological research, partially because the majority of the stone objects were not modified into classifiable implements. Another reason for the lack of interest in stone objects is the fact that stone, in contrast to flint, is a rather heterogeneous category in terms of manufacturing techniques (or lack thereof), use and even ideological significance. Unmodified net sinkers, for example, constitute a marked contrast with highly elaborate stone grave goods. Nevertheless, research into hard stone assemblages can provide information about topics such as mobility, exchange contacts, ideology and daily activities. Stone is and was not available locally in the western part of the Netherlands, in particular the delta, and had to be imported. This means that every piece of stone found at the site was selected somewhere and transported to Schipluiden, presumably with a specific application in mind. For a better understanding of the action radius of the Schipluiden people it was considered essential to try to identify the sources of the stones. Knowledge of those sources would provide information about external contacts or mobility, and therefore also about the cultural affiliations of the people at the site. Research into hard stone objects may also yield data on subsistence. For example, querns may provide evidence of agricultural activities. Evidence of various craft activities such as bead manufacture and axe grinding indicates that a site was used by complete households over a long period.

8.2 The material

A total of 4770 pieces of stone other than flint were collected by hand. Most were recovered from the $1 m^2$ units (94%), a much smaller proportion from sections and pit fills. The 4-mm sieving programme produced an additional quantity of about 900 pieces of stone, predominantly very small, angular pieces without traces of manufacture or use.[1] This corresponded to approx. 55 kg of stone. It should be realised that this sample represents a total of about 11,000 stone objects contained in the excavated volume, since only 8% was sieved.

It was decided to restrict the analysis of the hard stone to a selection of the more informative material in view of the number of stone objects in absolute terms and in relation to the planning. For this purpose a lower limit of 2 cm maximum dimension was chosen. Pieces of stone with smaller dimensions are often very hard to classify and the stone type is difficult to determine. This resulted in a selection of 1728 pieces, 1725 of which were manually collected and only three (all pieces of pyrite) derived from the 4-mm sieve residue (table 8.1). This means that the material analysed represents almost full recovery of this >2 cm fraction, and

	trench 10 pilot		total excavation		>2 cm selection
excavated volume	10 m^3	60 m^3	80 m^3	1000 m^3	
collected by hand in Units		81		4518	1630
idem from pit fills		4		253	95
total		*85*		*4771*	*1725*
4-mm sieve	286		3059		3
4-mm sieve, extrapolated		1716		38,237	
Totals		*1801*		*43,008*	*1728*

Table 8.1 Number of stone objects found using different collection strategies. The extrapolation demonstrates the total number of artefacts >4 mm originally present in the excavated volume.

	N =	sum	%	sum
sedimentary				
general	339		19.6	
quartzitic sandstone	498		28.8	
micaceous sandstone	36		2.1	
conglomerate	5		0.3	
lydite	13		0.8	
vein quartz	210		12.2	
limestone	3		0.2	
total		*1104*		*63.8*
metamorphic				
general	2		0.1	
quartzite	159		9.2	
amphibolite	7		0.4	
slate	3		0.2	
phyllite	15		0.9	
schist	28		1.6	
gneiss	68		3.9	
total		*282*		*16.3*
igneous				
general	19		1.1	
basalt	1		0.1	
granite	227		13.1	
diorite	3		0.2	
syenite	1		0.1	
gabbro	1		0.1	
diabase	3		0.2	
porphyry	15		0.9	
total		*270*		*15.8*
mineral				
pyrite	40		2.3	
marcasite	1		0.1	
total		*41*		*2.4*
indet.		*31*		*1.8*
Totals		*1728*		*100*

Table 8.2 Worked stone, raw material frequencies.

that only *c*. 33 pieces (approx. 2%) will have been missed in the excavation.[2]

Also included in this sample are pieces <2 cm showing one or more worked facets and the smaller pieces of pyrite/marcasite, the only minerals deliberately collected. Excluded are the semiprecious stones jet and amber (N=54) that were used for the manufacture of beads; they will be separately dealt with in the next chapter.

The variety of stone found at Schipluiden is quite large, ranging from common stone types such as quartzitic sandstone to quite unusual ones such as amphibolite, porphyry and various more exotic types, some of which could not be classified beyond basic rock type (table 8.2). However, the stone types most frequently encountered – quartzite, quartzitic sandstone, sandstone and quartz – are the same as at other Hazendonk sites such as Wateringen 4 and Hazendonk. Another remarkable feature is the considerable number of stone objects bearing traces of manufacture or use (N=559; table 8.3). However, the modified and used objects (N=278) represent only 16.1% of the manually collected material, a percentage comparable to that obtained at Wateringen 4 (13.2%; Molenaar 1997).[4]

8.3 Methodology

8.3.1 Technological analysis

The variables described include dimensions (in cm), weight (in grams), primary classification (flake, core, etc.), raw material (according to the specifications of Archis, the digital national reference collection set up by the Archaeological State Service, Amersfoort, the Netherlands), typology (according to the Archis list), modification, degree of burning, fragmentation, grain size, patination and the extent and character of the cortex. All stones were carefully examined for traces of modification, produced during either manufacture or use. This was done using a stereomicroscope, which was also used in the identification of stone types (magnifications in the range of 10-64×).

8.3.2 Use-wear analysis

High power use wear analysis of hard stone tools is relatively new. Most research to date made use of stereo-microscopy only (Hamon 2004a, b; Dubreuil 2002; Van Gijn *et al*. 2001; Van Gijn/Houkes 2001). There is a very practical reason for the lack of high-power use-wear studies of stone tools and that is the limited work space of metallographic microscopes that excludes virtually all stone tools from analysis. The purchase of a metallographic microscope with a free arm made such a study of the Schipluiden stone tools possible. Re-examination of the experimental tools also made clear that polish and striations could be distinguished and that traces varied according to the different tasks carried out.

A total of 60 implements were selected for a use-wear and residue study. The selection aimed to cover all typological categories, such as grinding stones, querns, hammer stones, axes, cooking stones and simple flakes. All the implements were first examined by stereomicroscope (with incident and oblique lighting) in order to locate any residues and obtain a general view of the polished zones, striations or directionality in the polish, and edge removals. The implements were then studied by incident light metallo-graphic microscope with magnifications ranging from 100 to 560 ×. Photographs were taken with a digital camera. None of the implements were chemically cleaned, but some were immersed in the ultrasonic cleaning tank (in distilled water) to remove adhering dirt.

artefact type / raw material	implements (modified)												debitage					totals			
	grinding stone	quern	rubbing stone	axe	axe flakes	hammer stone	retouchoir	anvil	Geröllkeule	ornamented stone	used (unspecified)	totals	blade	flake	block	burnt	indet.	totals modified	not modified	totals	% modified
sedimentary																					
sandstone	4	4	1	–	–	11	1	–	–	–	5	26	–	23	–	37	1	87	252	339	*26*
quartzitic sandstone	23	13	4	1	5	28	2	–	–	–	30	106	2	52	–	99	1	260	238	498	*52*
micaceous sandstone	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	35	36	*3*
conglomerate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	5	–
lydite	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	12	13	*8*
vein quartz	–	–	–	–	–	19	–	–	–	–	1	20	–	–	–	–	1	21	189	210	*10*
limestone	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3	–
metamorphic																					
general	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	1	1	2	–
quartzite	13	4	–	4	–	21	–	–	1	–	12	55	–	29	1	4	2	91	68	159	*57*
amphibolite	–	1	–	–	–	3	–	–	–	–	1	5	–	–	–	–	–	5	2	7	–
slate	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	1	2	3	–
phyllite	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	15	*0*
schist	–	1	–	–	–	1	–	–	–	–	–	2	–	1	–	–	1	4	24	28	*14*
gneiss	2	2	–	–	–	1	–	–	–	–	10	15	–	4	–	1	3	23	45	68	*34*
igneous																					
general	–	1	1	2	–	2	–	1	–	–	1	8	–	–	–	–	1	9	10	19	*47*
basalt	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	1	–
granite	1	9	–	–	–	11	–	–	–	–	11	32	–	–	–	3	2	44	183	227	*19*
diorite	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	1	2	3	–
syenite	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	1	–	1	–
gabbro	–	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–	–	1	1	–
diabase	–	1	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	2	1	3	–
porphyry	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1	–	2	13	15	*13*
mineral																					
pyrite	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	*0*
marcasite	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–
indet.	–	–	–	–	–	–	1	–	–	1	–	2	–	2	–	–	–	4	27	31	*13*
Totals	*43*	*37*	*6*	*8*	*5*	*98*	*4*	*1*	*1*	*2*	*73*	*278*	*2*	*121*	*1*	*145*	*12*	*559*	*1169*	*1728*	*32*

Table 8.3 Worked stone, raw material versus artefact type.

The collection of experimental hard stone tools of the Laboratory for Artefact Studies was used as a reference. It includes 51 tools used for a variety of activities, such as grinding seeds, polishing bone and antler, pounding ochre and flaking flint. A few extra experiments were performed for the specific context of the Schipluiden site, most notably polishing a flint axe, polishing jet and several experiments with the use of querns to grind cereals and other plant material.

8.3.3 Phytolith/residue analysis

A total of six implements – five querns and one rubbing stone – were selected for phytolith analysis. Additionally, four soil samples were taken from pit fills (features 20-101, 10-140, 12-314, and 16-454. The stones were completely immersed in distilled water in an ultrasonic cleaning tank in order to remove all residues and were then centrifuged for 5 minutes at 3000 rpm. This procedure was repeated twice in order to compare the results after the first and second rinses to account for possible contamination of adhering sediments. No chemicals were used to extract the phytoliths. The soil samples were soaked for 10 minutes and were subsequently sieved in four steps (through 0.25 mm, 0.175 mm, 0.125 mm and 0.075 mm). The samples were then centrifuged twice for 5 minutes at 3000 rpm and the supernatant was poured away between the two sessions. The glass slides were examined under a transmitted-light microscope (magnifications up to 1000 ×). The phytolith analysis was performed in collaboration with Dr Channah Nieuwenhuis.

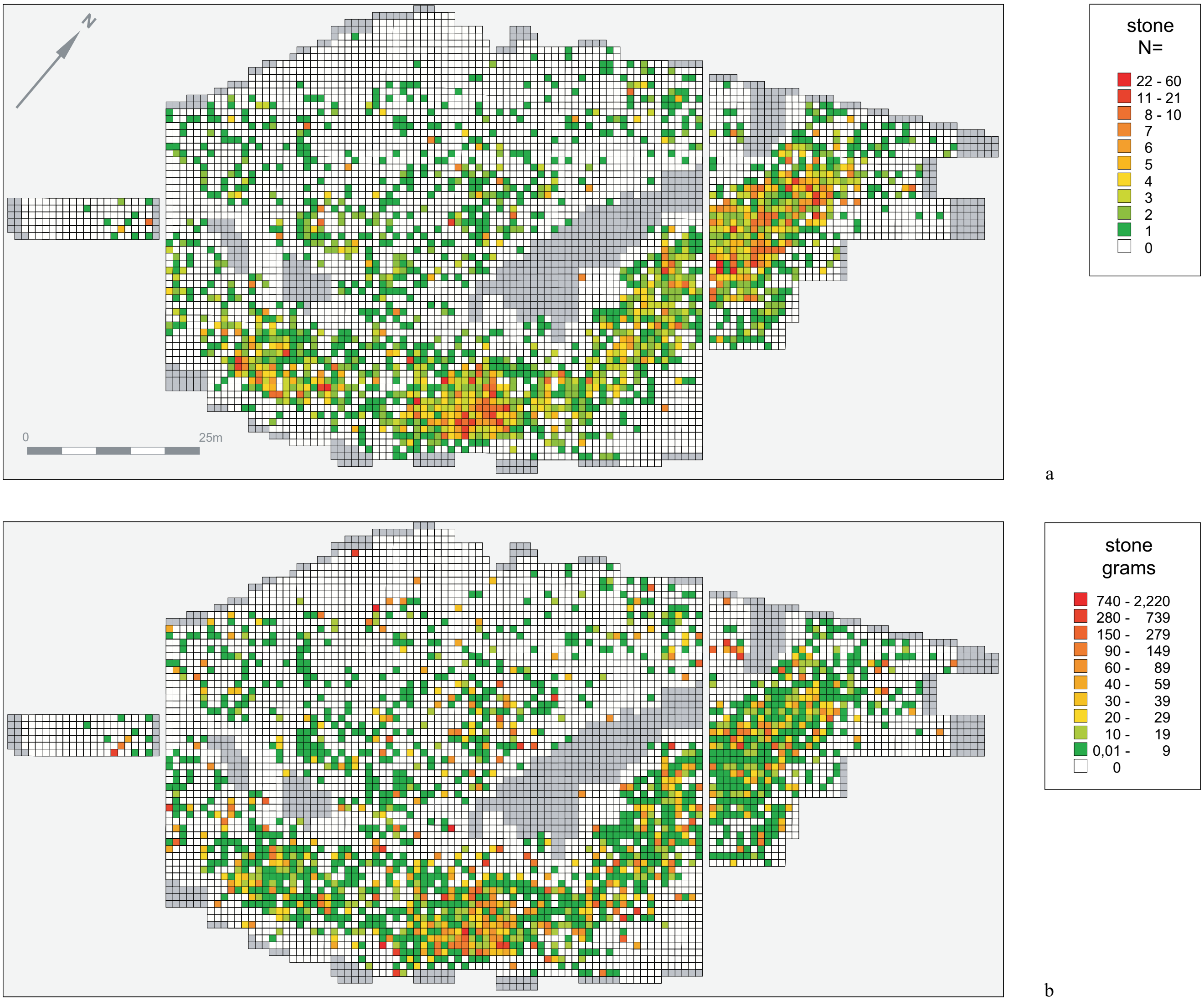


Figure 8.1 Distribution patterns of the stone artefacts per square metre; number of finds (a) and total weight (b).

8.4 Taphonomy

8.4.1 Deposition

The general distribution of the fragments of stone implements corresponds to the distributions of the other find categories, with a concentration along the southeastern margin of the dune and a diffuse spread all over the dune area. Stone objects were however also found on top of the dune, where very few finds of the other categories had survived (fig. 8.1). Considering stone's resistance to weathering and colluviation, we may consider the amount of stone found to be representative of the original quantity, except in the eroded central zones (chapter 4).

It would seem that the southeastern margin of the dune should indeed be considered a dump zone, where material was deposited away from the central habitation area. Intentional deposition of stone objects seems to have been confined to the small pyrite nodule in the hand of the dead man in grave 2 (chapter 5).

8.4.2 Preservation

All the stones have a fresh appearance, without traces of weathering or patination, with the exception of pieces of igneous stone, especially granite, which often crumbled as a result of weathering. A considerable number of artefacts still showed their natural, rolled outer surface. All the stone has a dark colour, ranging from varying shades of grey to almost black. This may be due to the peaty, humic deposits in which the material was found.

Fragmentation was common, with a considerable number of objects displaying fracturing marks or even complete fragmentation (for example those of granite). This fragmentation seems to be attributable to cultural, not natural causes, such as pounding granite or quartz for the production of temper for pottery, or the production of flakes from discarded grinding stones.

Quite a few of the stone objects display signs of burning (35.8%). Some of these objects can undoubtedly be interpreted as cooking stones, while others were probably burnt by accident.

The wear traces are well preserved. Patination was observed in a handful of cases (N=8). The surfaces of the fractures look very fresh, with sharp edges in the case of the majority of the tools examined. It should however be noted that use-wear analysis of hard stone tools may not always yield the same detailed information as a functional analysis of flint because of the coarser grain size of most types of hard stone. A coarser grain size results in a slower development of wear traces than is the case with fine-grained or translucent flint. Sometimes hard stone tools were rejuvenated by pounding, which will have removed any wear traces previously present. This is for example frequently the case with querns and sometimes precludes identification of contact materials. The direction in which an implement was used is however usually identifiable. No residues were observed, except on a few coarse-grained tools classified as querns, which seemed to show some sort of deposit. They were selected for phytolith analysis.

8.5 Raw materials

8.5.1 Variety of stone

The assemblage includes a great variety of stone types, including sedimentary, metamorphic, and igneous stones (table 8.1). The assemblage is generally characterised by a dark grey colour regardless of the type of rock, presumably a result of the matrix in which most of the stones were embedded (fig. 8.3). The largest category of stone is that of quartzitic sandstones. The degree of metamorphisation of these sandstones varies from very little (almost sandstone) to very much (almost quartzite). Sandstones (fine and coarse) are also very common; both fine-grained and coarser-grained varieties are represented. Some of the sandstones contain considerable quantities of muscovite and were identified as micaceous sandstone. Five artefacts were identified as arkotic sandstones.

Quartzites are common among the metapmorphic stones. A remarkably large number of the quartzites contain blue quartz crystals. Gneiss is a common stone type. Many of the gneiss pieces are quite large. Schist was also found, including micaceous schist. Other metamorphic stones encountered in smaller quantities are slate, amphibolite and phyllite.

The assemblage also includes a variety of igneous rocks. The most frequently encountered igneous rock is granite, with a total weight of over 1100 grams. The granite is often severely fragmented. This is largely due to taphonomic factors because granite is sensitive to weathering under moist conditions. Granite was however also used to temper pottery, and might have been crushed intentionally (see below). Some of the concentrations of fragmented granite may even be interpreted as disintegrated sherds that were tempered with granite. Porphyry is the second largest group of igneous rocks, represented by a total of 15 objects. Three objects of diorite were found, and three of diabase. Gabbro and syenite were each identified once.

Pyrite was found quite frequently (N=40) and is probably associated with the large number of strike-a-lights in the flint assemblage (chapter 7). One piece was identified as marcasite. Only three pieces of pyrite were retrieved from the sieve, implying that we missed about half of the pyrite originally present at the site. Vein quartz was also abundant, especially in the size fraction below 5 mm. The small pieces of vein quartz were usually rounded and formed part of the natural sediment. The larger pieces must all have been imported. A total of 210 pieces of vein quartz were contained in the coded sample >2 cm. They included broken specimens as well as some larger pebbles.

8.5.2 Sources

At present, no natural sources of stone are to be found in the presumed territory of the site, and essentially nowhere in the extensive Holocene sedimentation area commonly referred to as the 'Rhine-Meuse delta' (fig. 8.2). Gravels are to be found only in the riverbeds, but they are beyond normal reach today and this was most probably the case in the Neolithic, too. The coastal beaches are nowadays also devoid of stone, and there are no indications in older deposits suggesting that this was any different in the Neolithic.[3] Old gravel deposits below the North Sea floor are covered by Late Glacial coversands reworked into the younger sea sand, where they are beyond reach of waves and currents. The situation in the Middle Neolithic – when the sea level was 6 to 4 m lower – was not different in this respect. Only reworked gravel beds may have been more readily accessible (Van der Valk in prep.). It is likely that small nodules, measuring c. 3 cm. in diameter, of quartz, quartzite and quartzitic sandstone could be collected nearby. More thorough research into possible stone sources is clearly needed.

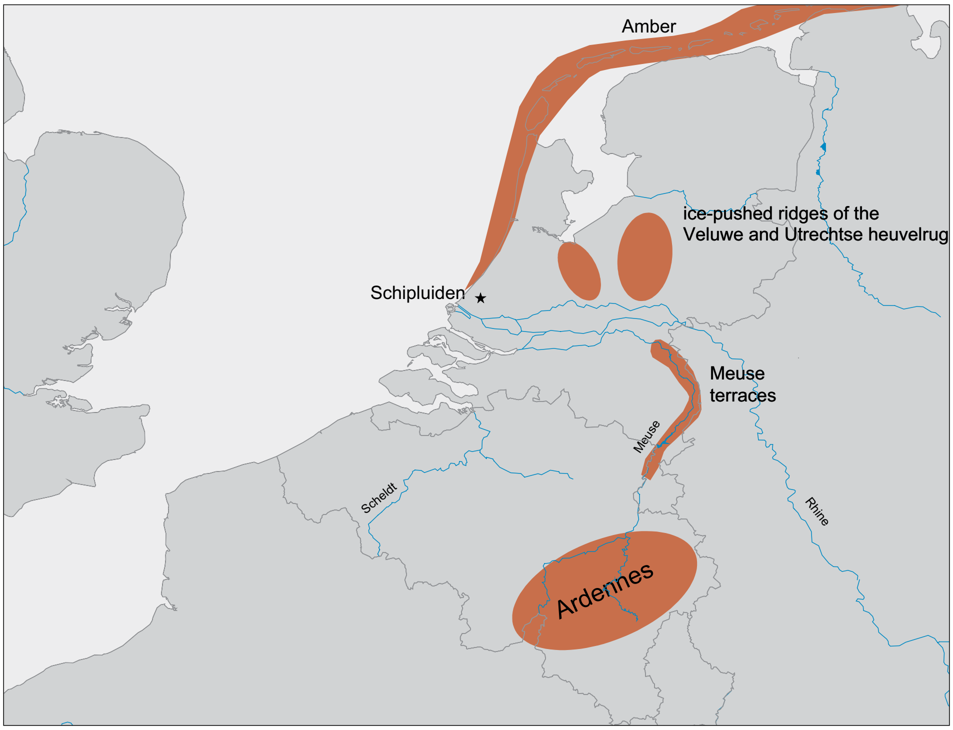


Figure 8.2 The stone sources mentioned in the text.

Although all the hard stone was evidently brought to the site from distant sources, it is for several reasons not easy to pinpoint those sources. In the fist place, the assemblage could be a mixture of materials from various areas. Secondly, the material does certainly not reflect the composition of the sources in a representative way, since prehistoric people will have selected specific stone types for specific uses. Thirdly, all potential sources are secondary deposits (river gravels, boulder clays), occurring over vast geographic areas. This means that we will have to work with specific 'guide types' for the various sources, which may however be missing in our assemblage because they were not selected. For example, the absence of jasper – a typical Rhine gravel component – does not mean that Rhine gravels were not exploited.

The margins of the nearest upland – the coversand landscape of Noord-Brabant – lay 50 km from the site at that time (fig. 14.2). This area has however not been investigated sufficiently to be able to say which stone types could be collected here. The nearest certain sources of pebbles and boulders lay 75 km to the east, in the Utrechtse Heuvelrug, an ice-pushed ridge consisting of Middle Pleistocene Rhine and Meuse gravels with some local Saalian boulder clay relics. Other potential sources lay between 110 and 140 km from the site: the boulder clay outcrops of the former island of Urk (IJsselmeer region), ice-pushed river gravels and patches of boulder clay in the Veluwe region and Meuse terrace gravels to the south of Nijmegen. We must realize that prehistoric people in the wooded flat landscape of this country were dependent on the rare natural exposures of stone-bearing deposits, for example at points where the outer bends of the main rivers had eroded ice-pushed ridges or terraces and brooks had cut into the deposits.

The represented range of stone types generally indicates a southern origin for the majority of the materials. Many of the stone objects show at least part of a naturally rolled surface, indicating a source in a pebble bed along river banks or seashores or in terrace deposits. The great variety of stone types points to the Meuse riverbeds and terrace deposits as the most likely source (J.G. Zandstra, pers. comm.). The Ardennes contributed pebbles of phyllite (Cambrian), vein quartz from the Devonian and Carboniferous, diabase (Bosch 1982) and probably also amphibolite (Van der Lijn 1963, 77). The blue quartz crystals observable in many of the dark grey quartzitic sandstone and quartzites also point to the Meuse as the most likely source (P. Cleveringa pers. comm.).

The Scheldt is not a possible source, because this river only cuts through Mesozoic deposits and carries a limited variety of stone types. The only stone types that would have been available in the Scheldt basin are sandstones. There is no evidence of a source in the Rhine beds or terraces: Taunus quartzites, *Buntsandstein* and yellowish sandstones – all of which are typical of Rhine river deposits – are absent.

A major problem is the sourcing of the igneous rock fragments: do they derive from Middle Pleistocene Meuse gravels to the south or from northern boulder clay outcrops? In this context it should be borne in mind that the Moselle formerly belonged to the catchment area of the ancient Meuse, until it was tapped by the Meurthe. The Moselle cut through the Vosges and carried granites and other stone types that the present-day Meuse gravels no longer contain (Bosch 1982; Van der Lijn 1963). Material from the Vosges, such as pebbles of granite, porphyry, lydite and a schistose gneiss with large amounts of biotite, can therefore occasionally be found in the Middle Pleistocene Meuse deposits. Some of the igneous material may also have had a northern origin or it may have been collected to the east, in the boulder clay occurrences of the Veluwe, the Utrechtse Heuvelrug or the more distant areas mentioned above. Clear northern indicators are however absent (J.G. Zandstra pers. comm.). The fragmentary condition of most of the granite pieces (270 with a total weight of only 1100 grams) at the site is however a major drawback for a positive identification of characteristic Scandinavian erratics. Red granites containing many feldspar crystals are most likely of northern origin, but they are not included in the assemblage. White granites are more problematic because they have also been reported for the Meuse riverbeds of southern Limburg (Bosch 1982) and in the ice-pushed river deposits of the 'old Meuse' near Amersfoort (Van der Lijn 1963). The same holds for diabase, which is normally considered a northern stone type, but has also been reported for the Meuse riverbeds. The few pieces of gneiss and diorite can probably be safely considered to be of northern origin, but they may also have been picked up quite close to the areas where the Meuse material was collected, in the rivers area to the east, where Saalian ice-pushed ridges were eroded by the rivers.

Pyrite was long considered a rare commodity, which had to be transported over considerable distances. The Triassic chalks around Winterswijk are often mentioned as a possible source of pyrite, as are the Ardennes (Van der Lijn 1963, 27). This mineral may however be more common than frequently assumed and occurs, if in very small quantities and in a highly fragmented state, in the Meuse beds and along the brooks of Noord-Brabant (P. Cleveringa, pers. comm.). More research is needed to establish the size and kind of pyrite occurring in these areas, but radial pyrite seems to be rare. The pyrite found at Schipluiden displays such a radial pattern. Nodules of radial pyrite are confined to the Ardennes and the chalk of Normandy and southern England (Van der Lijn 1963, 27). This type of pyrite quickly crumbles into a fine powder, an observation that led researchers to assume that it does not survive water transport. Considering the fact that the imported flint was obtained from central and southern Belgian sources (chapter 7), it is likely that the pyrite was procured in the context of the same mobility pattern or exchange relationships. This makes a source in the Ardennes the most likely.

This suggests that the inhabitants of Schipluiden travelled long distances to obtain the stone raw materials they needed. Small pebbles of quartz, quartzite and quartzitic sandstone may have been collected nearby, but most of the implements were made on larger pieces of stone, all of which had to be transported to the site. In the absence of results of detailed fundamental research into sources, it is very difficult to say with any certainty exactly where the different stone types were procured, but a source in the Meuse valley is the most likely. This may have lain as far north as the ice-pushed ridges just north of the main rivers where material of the 'old Meuse' was deposited and where some northern erratics could also be collected. Some of the larger pebbles were more probably obtained further south, either from the Meuse terraces or from the gravel beds. If our assumption that the Ardennes were the most likely source of high-quality radial pyrite is correct, then some of the other stones may also have been collected in that same general area, even though stone types typical of the Ardennes, such as Revinien quartzite, were not selected.

Although the distances from Schipluiden to the sources of raw material may seem very long – up to 200 km – they are not unusual for coastal communities, as has also been demonstrated for the Late Mesolithic occupants of the site of Hardinxveld-Giessendam Polderweg (Van Gijn *et al*. 2001). At Polderweg a large, angular piece of schist was found that most probably came from the northern Ardennes. Northern material deriving from boulder clay deposits was absent at this site. The site of Hardinxveld-De Bruin (Van Gijn/Houkes 2001) showed a spectrum of stone types that could be collected closer by, at distances of around 45-70 km from the site along the ice-pushed ridges of the Veluwe region.

8.6 Tool typology and function

8.6.1 Introduction

Stones were frequently used without any further modification. This holds for net sinkers, hammer stones, weights of various kinds and anvils. Across the world examples of the use of unmodified stones abound (*e.g*. Oswalt 1976; Stewart 1996). Such tools are notoriously difficult to identify, also because wear patterns may not be clear. Hammer stones can of course be identified by the presence of pounding marks, but net sinkers are much more difficult to identify as wear traces are at best very ambiguous. Use-wear analysis can sometimes yield information, but not all apparently unmodified stones can of course be subjected to such time-consuming research. Another problem with the analysis of stone objects is the fact that the objects are often highly fragmented, due to either burning or intentional reduction in

motion \ contact material	plant unspec.	cereals	wood unspec.	bone	miniral unspec.	soft stone	flint	granite	unknown use	indet.	totals
cutting	–	–	1	–	–	–	–	–	–	–	1
scraping	–	–	1	–	–	–	–	–	–	–	1
chopping	–	–	–	–	–	–	–	–	–	1	1
wedging	–	–	1	–	–	–	–	–	–	–	1
pounding	–	–	–	–	–	–	–	–	–	16	16
grinding	–	–	–	–	–	1	19	1	–	7	28
polishing	–	–	–	1	–	1	–	–	–	1	3
rubbing	1	–	–	–	1	–	–	–	–	4	6
milling	–	6	–	–	–	–	–	–	–	–	6
crushing	–	–	–	–	1	–	–	–	1	1	3
hafting	–	–	–	–	–	–	–	–	–	1	1
indet	–	–	–	–	–	–	–	–	–	4	4
Totals	*1*	*6*	*3*	*1*	*2*	*2*	*19*	*1*	*1*	*35*	*71*

Table 8.4 Functional analysis of 44 stone artefacts with 71 used zones: inferred contact materials versus motions. The frequencies represent the number of used zones and *not* the number of artefacts, as some implements may display more than one used zone.

artefact type \ contact material	plant unspec.	cereals	wood unspec.	bone	miniral unspec.	soft stone	flint	granite	unknown use	indet.	totals
axe	–	–	1	–	–	–	–	–	–	3	4
hammer stone	1	–	–	–	1	–	–	–	1	15	18
grinding stone	–	–	–	–	–	–	18	–	–	4	22
stone with grooves	–	–	–	1	–	–	–	–	–	1	2
quern	–	6	–	–	1	1	–	–	–	3	11
cookingstone	–	–	–	–	–	–	1	–	–	1	2
flake	–	–	1	–	–	–	–	–	–	–	1
unmodified stone	–	–	–	–	–	1	–	1	–	4	6
indet	–	–	1	–	–	–	–	–	–	4	5
Totals	*1*	*6*	*3*	*1*	*2*	*2*	*19*	*1*	*1*	*35*	*71*

Table 8.5 Artefact type versus inferred contact material. Note that grinding stones were predominantly used on flint, while many querns were used for processing cereals. The frequencies represent the number of used zones and *not* the number of artefacts.

the past. Numerous stones display only a tiny part of a worn facet, from which it is difficult to reconstruct the shape of the original tool.

The majority of the stones found at Schipluiden show no signs of modification (N=1169, *i.e.* 67.6%; table 8.3). A total of 200 artefacts (11.6%) could be classified into typological categories. The use-wear analysis of a sample of 60 implements produced a total of 71 used zones on 44 tools (tables 8.4 and 8.5). A total of 12 artefacts did not show any traces of wear, three implements could not be interpreted and one may have been used. Some of the implements displayed more than one used zone, especially the grinding stones. Below, various categories of tool types will be discussed from a technological and a functional viewpoint.

Figure 8.3 Grinding stones and their fragments. Note the predominantly dark grey colour of the implements.

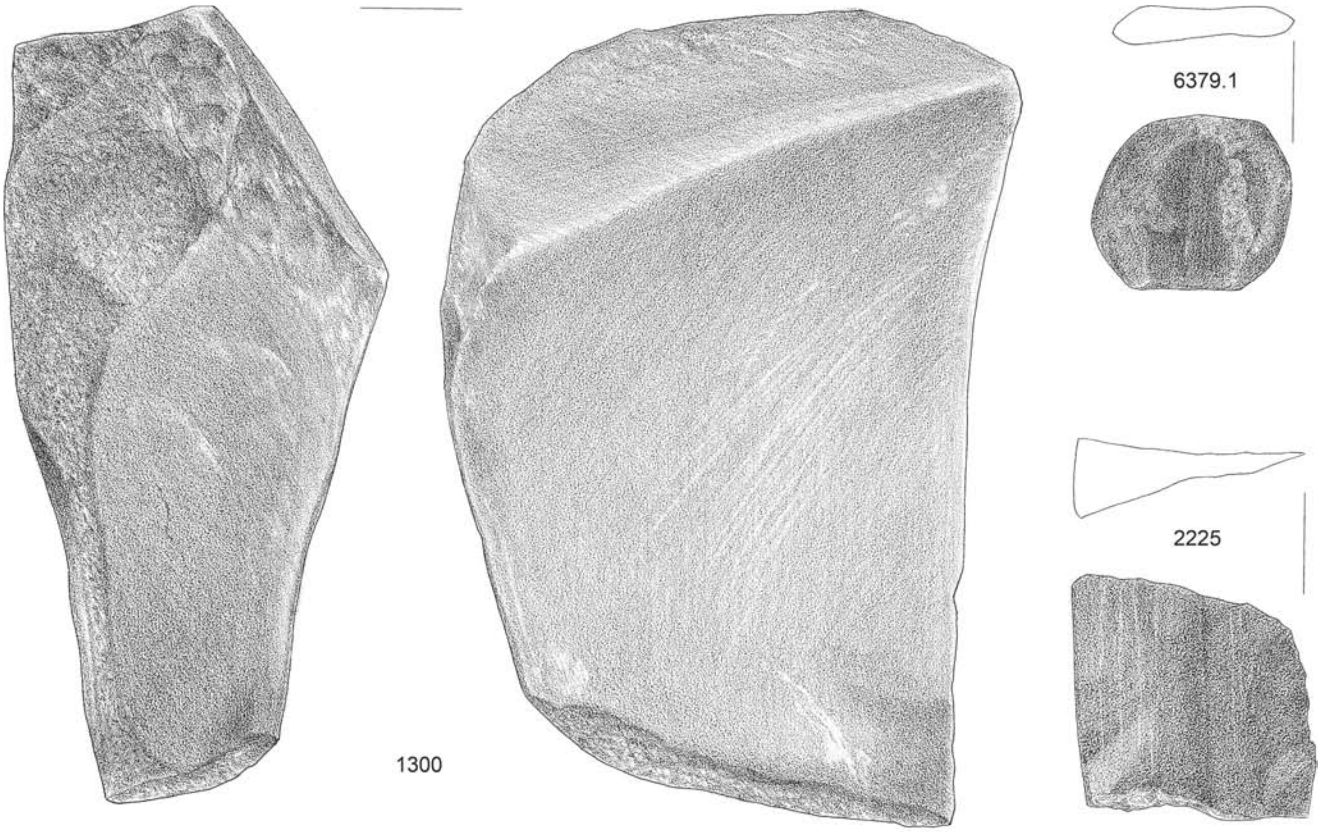
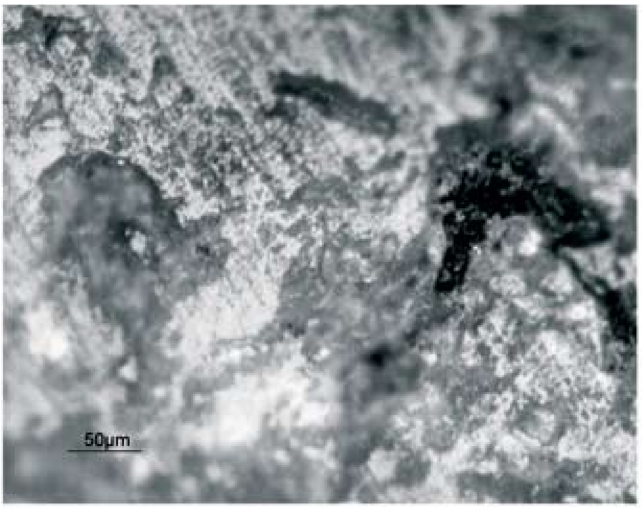


Figure 8.4 Grinding stones (scale 1:2).

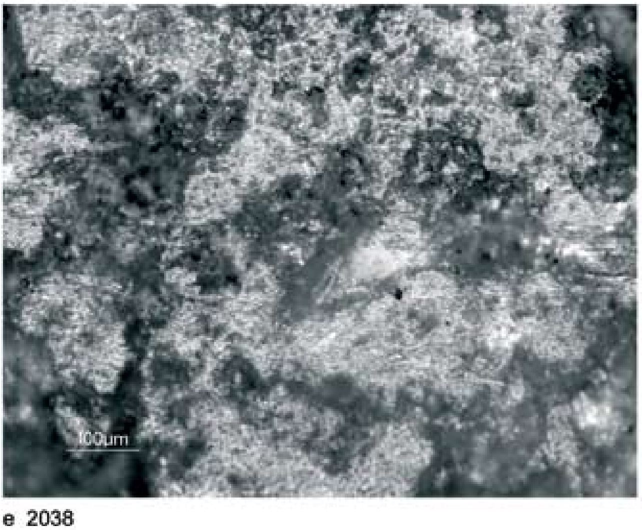


a 1300

b 4187

c 6380

d 6379



e 2038

f 9215

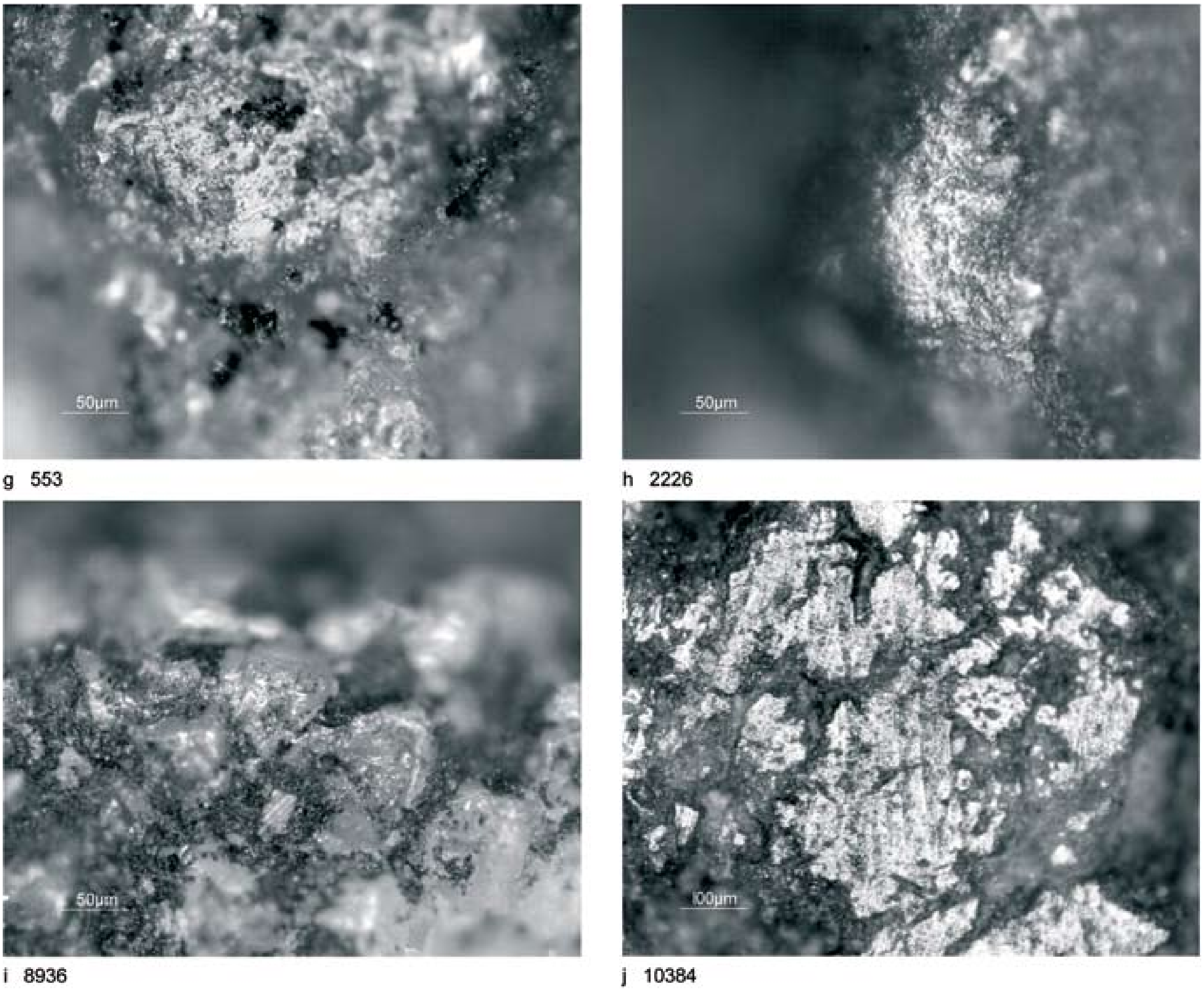


Figure 8.5 *(cont)* Use wear traces observed on various stone tools.
- g traces formed in pounding plants (200×)
- h probable wood cutting traces (200×)
- i probable wood scraping traces (200×)
- j traces interpreted as resulting from grinding or sharpening stone, possibly granite (100×)

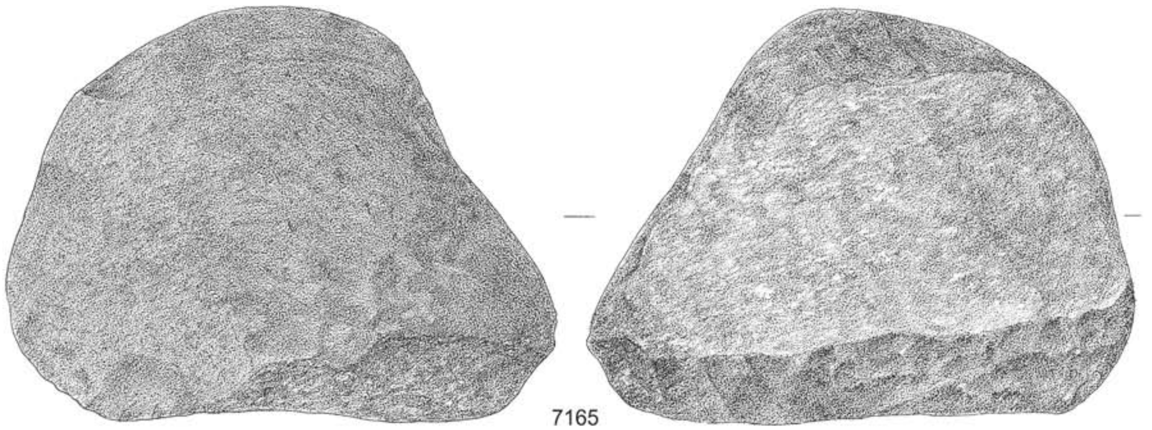
◂Figure 8.5 Use wear traces observed on various stone tools.
- a-c polish and striations interpreted as resulting from grinding flint (200×)
- d traces interpreted as resulting from the grinding bone (100×)
- e-f traces interpreted as resulting from processing cereals (e 100×; f 200×)

8.6.2 Grinding stones (figs. 8.3-4)
Fragments of grinding stones were common at Schipluiden (15.8% of the shaped implements). Grinding stones are characterised by one or more facets with a highly polished surface and linear scratches that are clearly visible with the naked eye. They were made predominantly on a very dense, dark grey quartzitic sandstone and dark grey quartzite. Although some aspects of the tools still display their original natural surface, the tools were also intentionally flaked to give them the desired shape. This could be deducted from the presence of flake scars around their outlines.

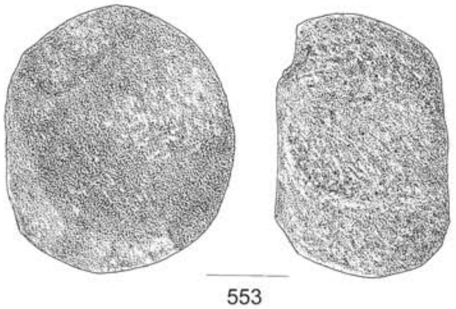
Some larger fragments show that a characteristic grinding stone was used on several sides. Eight implements had more than one used surface. Three large broken implements were used on three sides (nos. 1300, 4187, 6803) and three on two sides (nos. 2205, 6380, 6436). Even one small fragment (no. 5899) has two used aspects. Two tools displayed one facet with a groove (nos. 2225, 6379.1; fig. 8.4). The use-wear traces, which were clearly visible with the naked eye, were found to overlie manufacturing traces where present. In cases in which more than one used facet were present, they were usually functionally different, with one aspect having a very narrow, almost gouge-like wear pattern, presumably formed in the polishing of the sides of axes. The other one or two aspects display a flatter wear pattern, reflecting the grinding or polishing of the ventral and dorsal aspects of the axes and the rounded edges.

A total of 14 grinding stones or fragments were microscopically studied for traces of wear. The great majority seem to have been used for polishing flint, as they bear a very flat, bright, metallic and highly striated polish (figs. 8.5a-c). The sheen is easily distinguished with the naked eye, as is the directionality in the polish. This frequent grinding of flint can be associated with the many axe fragments encountered among the flint assemblage (chapter 7), indicating that such axes must have played a significant role in the technological system. This is also demonstrated by the fences (chapter 11) and the many postholes of wooden structures found at the site (chapter 4). Apart from the flint grinding tools, one small grinding stone was used on bone. It displays a narrow gouge with two pointed ends that will have been ideal for sharpening awls or needles (no. 6379.1; fig. 8.4). The polish has a different texture, being much smoother than that formed in flint grinding and having a less clear-cut direc-tionality (fig. 8.5d).

Figure 8.6 Querns and quern fragments made on various types of stone, such as sandstones and quartzitic sandstones.



7165



553

Fig. 8.7 Quern and rubbing stone (scale 1:2).

The tool may have been used to sharpen the bone awls during their use and may have formed part of the toolkit used in basketry and rope making (see chapter 10). Its small size will have made it an easy tool to carry around.

Quite a number of grinding stones displaying one or more facets of use were later fragmented by removing some large flakes. Although some grinding stones may have been broken during use, it is likely that fragmentation was mainly intentional, probably because the grinding stones constituted an ideal source of stone for the production of flakes. Some of the large flakes were then used for sawing wood. Attempts to refit the flakes resulted in only one joint. It is strange that so few refits could be made, considering the severely fragmented state of most of the grinding stones. This could mean that the flakes were taken away from the site for some cutting or sawing task. According to this scenario, grinding stones will have been discarded after having been used maximally, probably because ample fresh flakes could still be struck from the depleted grinding stones.

8.6.3 Querns and rubbing stones (figs. 8.6-7)

A total of 37 querns and quern fragments were found. The querns are characterised by a flat or slightly concave surface and a regular shape, probably obtained by pecking. The used surface feels smoother than the other surfaces of the tool. It is clearly visible with the naked eye, but does not display gloss. Two complete querns have a slightly oblong shape. The most preferred stone types for querns were first of all quartzitic sandstone, followed by granite (including in one case – no. 2857 – biotite granite) and quartzite (for example no. 2038). One quern was made on a coarse-grained stone containing large olivine minerals; this stone is certainly crystalline and was tentatively identified as diabase (no. 7165, figs. 8.7 and 8.15 upper right hand corner). Some of the querns display manufacturing traces in the form of pecking marks along the outer circumference and base.

The sample of querns selected for use-wear analysis contained nine implements. The use-wear traces were not always easy to distinguish because of the nature of the raw material selected: a coarse-grained stone. Where it could be made out, the polish was rough and matt, with short striations and a clear directionality parallel to the implement's longest axis and resembling experimental polish from milling cereals (figs. 8.5e-f). One quern was probably used on both aspects (no. 2857). Some of the querns and quern fragments showed no identifiable traces of wear. This does not mean that these implements were not used; it is just that the coarse-grained stone made wear-trace analysis using high-power microscopy virtually impossible. In such cases we had to rely on low-power microscopy, which can reveal the extent of rounding, smoothing and other more general patterns of wear, but does not allow examination of polishes and fine directionality within the spots of polish.

Besides the querns, six other implements were classified as rubbing stones. They were round, with pounding traces along their circumference and two parallel, flat, worn surfaces (no. 553, fig. 8.7). Such implements are sometimes classified as hammer stones on the basis of the observable pounding marks, but those marks are actually only associated with the shaping of the artefact by pecking. The Schipluiden tools do not have a clearly visible smooth surface like the stones classified as grinding stones, but localised patches of gloss are nevertheless visible with the naked eye. Similar tools were found at Kraaienberg (Louwe Kooijmans/Verhart 1990). This type of tool has also been found in Late Neolithic and Bronze Age contexts (Kolhorn: Drenth/Kars 1990; Aartswoud: Van Iterson-Scholte/De Vries-Metz 1981; Boog C-Noord: Niekus/Huisman 2001; De Bogen: Van Gijn *et al.* 2002; Eigenblok: Van Gijsel *et al.* 2002).

Two such implements were studied for wear (nos. 553 and 1520, fig. 8.5g). They were both found to display a smooth, highly reflective polish with a directionality indicating a rotating movement. The polish was interpreted as the result of plant processing. The fact that this type of tool was used in a rotating motion on plant material suggests that this type of 'hammer stone' should actually be interpreted as the rubbing stone of a quern.

8.6.4 *Phytolith analysis of the querns* (fig. 8.8)

Five querns were selected for phytolith analysis (nos. 2038, 2857, 7165, 8393, 9215). All five samples revealed phytoliths typical of Poacaea, *i.e.* wild grasses or domestic cereals. Various characteristic phytoliths were found both on the tools and in the soil samples, such as dendriforms, hairs, hair bases, stomata and rods. The following information is partly based on the expertise of Patricia Anderson and Pascal Verdin (CRA, Valbonne, France). In two cases (tools nos. 7165 and 8393) some of the phytoliths appeared to be of the Hordeum type, an inference based on the shape of the cell margins in the spodograms (fig. 8.8a).[5] Two querns (nos. 2038 and 2857) showed bilobate phytoliths of the Panicoid type, probably from a wild grass. The last tool (no. 9215) showed only crushed rods deriving from Poacaea (cereals, grasses), which could not be further differentiated. Although it is not usually possible to distinguish between wild and domesticated species, the size of the phytoliths seems to point to domestic cereals. Interestingly, many of the phytoliths display signs of processing. A considerable number of phytolith rods have lost their spikes and seem to have been ground (no. 2857, fig. 8.8b). Some of the grinding seems to have involved dehusking of the grain on the querns, as testified by the presence of spodograms of leaf sheaths (no. 7165, fig. 8.8c). However, the presence of these chaff fragments is not necessarily attributable to dehusking, as quite a bit of chaff may have ended up on the quern along with the grain (Procopiou *et al.* 2002). There were numerous crushed and fragmented leaf and stem fragments, which probably formed part of the same winnowed fraction as the (hulled) grain (no. 7165, fig. 8.8d). One sample showed a processed dendriform phytolith of a glume, indicative of the process of flour making. The use of the querns for making flour is also demonstrated by the presence of tiny broken phytolith fragments.

The analysis of the soil samples from four pit fills showed a similar picture. The phytoliths were found to be comparable with those observed on the stone tools in terms of both type and size. The phytoliths found in the soil samples were extremely well preserved, probably because they became covered with sediments soon after deposition. Sample 1416 from feature 10-140 – a shallow well – contained phytoliths from cereals, suggesting dehusking (fig. 8.8e). The sample from feature 16-454 (sample 4279) was found to contain dicot leaves,[6] which were highly fragmented due to processing (fig. 8.8f). The presence of phytoliths in these pits may initially come as a surprise. But if winnowing was practised at the site, fragments of stems and leaves will have been blown around and will have become trapped in the waterlogged pits. It is also possible that processing waste was dumped in the pits while they were silting up.

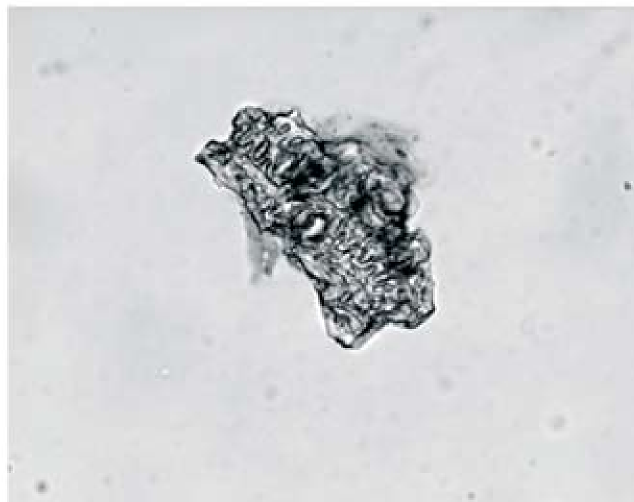
The phytolith analysis of the querns and the soil samples from pits showed that the inhabitants of Schipluiden certainly

Figure 8.8 Phytoliths observed on querns and in pit fills. ▸
a spodogram of the Hordeum type (length 70 µm)
b rods with abraded spikes (length 70 µm)
c spodogram from cereals, showing evidence of processing (length 80 µm)
d glume phytoliths (length 70 µm)
e phytoliths from cereals, indicating dehusking (soil sample, length 190 µm)
f leaf phytoliths with stomata, fragmented due to processing (soil sample, length 50 µm)

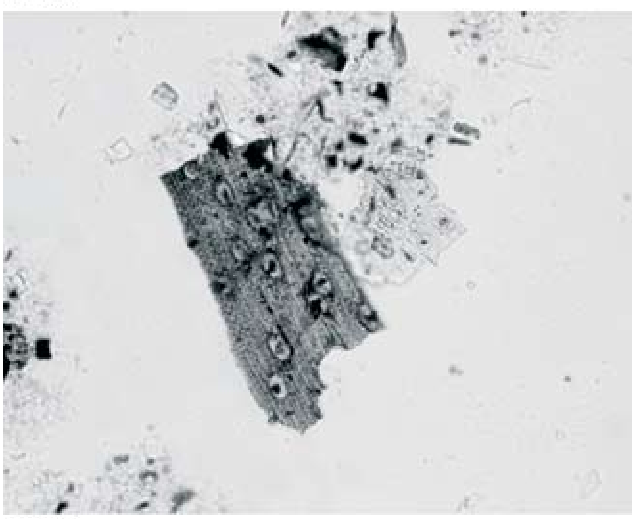
a 7165

b 2857

c 7165



d 7165



e 1416

f 4279

processed seeds to make flour. Whether wild grasses were also processed is not altogether clear as the phytoliths of wild grasses and cereals are virtually the same, but the fairly large size of the phytoliths points to domestic cereals. Processing of wild grasses by hunter-gatherers was however not unusual in prehistory (see Fullagar/Field 1997). The fact that phytoliths were also found in the pit fills indicates that winnowing was done at the site. These data corroborate the archaeobotanical evidence of the local growing of cereals (chapter 18), an inference further supported by the presence of flint sickles (chapter 7).

8.6.5 Hammer stones

A total of 98 hammer stones were found. They include all implements with pounding marks on one or more sides. The complete hammer stones can be differentiated into one-sided hammer stones (N=13), bipolar hammer stones (N=12) and hammer stones with multiple used sides (N=10). Three implements display pounding marks all round. The stone type used most frequently is quartzitic sandstone, followed by quartzite and granite. Some nodules of vein quartz also display traces of pounding, but in this case the pounding was most probably intended to cause fragmentation, *e.g.* to obtain pottery temper.

The shape of the hammer stones varies somewhat, but most are rounded, with the impact traces located on a protrusion. A total of 20 such implements were studied for traces of use. Most of the hammer stones examined revealed traces of pounding, but no clues were detected as to the contact material involved. No residues were encountered and high-power microscopy was difficult due to the grain size of the stones. Two assumed hammer stones (nos. 5492 and 6258) revealed evidence of rubbing or grinding rather than pounding, but in these cases the contact material could not be specified. Three implements showed no traces of use. One quartz pebble was actually probably pounded itself rather than that it served as a hammer stone. The intention was probably to pound it into temper.

8.6.6 Axes and axe flakes (fig. 8.9)

Stone axes and axe fragments were found in smaller numbers than flint axes and axe fragments (chapter 7). This may be partly attributable to the fact that flint axes break more easily than stone axes, but stone axes may indeed originally have been less common. Both types of axe will have been used both off-site and on-site in chopping wood and wood construction work, as demonstrated by the posts used for the fences (chapter 11). So they will have been damaged, broken and even discarded off-site as well as on-site, unlike other implements such as querns and grinding stones that were for the most part discarded on-site.

Only one complete polished stone axe was recovered, along with the butt end of one flake axe and five axe flakes. The complete axe (no. 1434) is very small and displays a considerable amount of edge damage, plus a polish indicative of woodworking and pounding marks at its butt end. It is made of quartzite and probably served as a wedge in woodworking, considering the impact damage at the butt end and the typical wood polish on the cutting edge. One pointed butt end of a typical Michelsberg axe with an oval cross section made of an unidentifiable crystalline stone was found (no. 2918). The stone was completely polished and showed no traces of hafting or wear. The third axe resembles a flake axe made of flint, and for convenience it was referred to as such (no. 6282). Flake axes of flint are a typical feature of Belgian Michelsberg assemblages, but were completely absent at Schipluiden. The stone axe was made of quartzite and was very roughly flaked to an axe-like shape.

The five axe flakes were not secondarily modified into another tool. One (no. 9056) was secondarily used as a hammer stone after its removal from the axe. No cutting

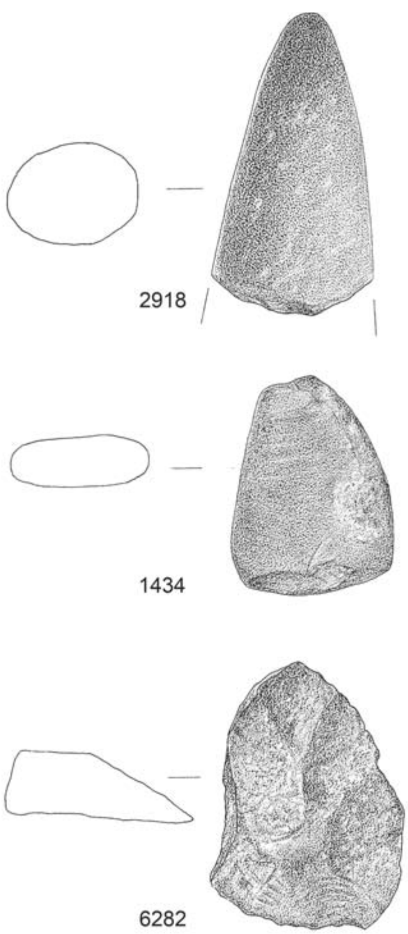


Figure 8.9 Axes and axe fragments (scale 1:2).

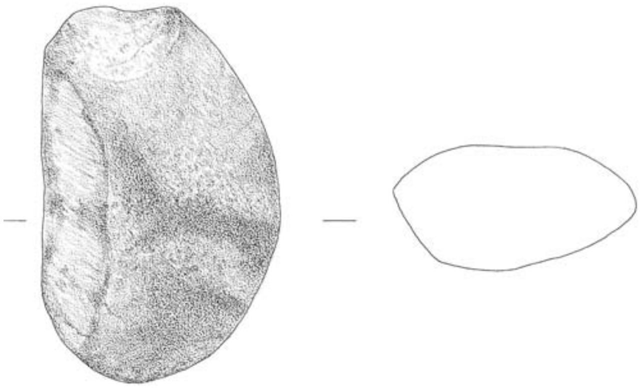


Figure 8.10 Flake with use-wear traces (scale 1:2).

edges of stone axes were found. The presence of other parts of stone axes indicates that greater numbers of such axes were originally present at the site; they were either lost off-site or taken elsewhere.

8.6.7 Burnt stones

A large number of stones displayed signs of burning (N=145). Quite a few of these stones were angular blocks broken from larger stones. They may have been used for the construction of hearths or as cooking stones. The majority are of quartzitic sandstone or sandstone. Stones of the former type were suitable for use as cooking stones while sandstone was often chosen for the construction of hearths. Burnt stones constitute the only spatially distinct category of finds (fig. 8.12a). There were two distinct clusters of burnt stones, both on the southeastern slope, one at the southern end and the other slightly further east. It is possible that it concerned processing areas involving fire but the stones may have also have been dumped, considering the location of the two concentrations in relation to the house clusters (chapter 4).

8.6.8 Flakes and fragments (fig. 8.10)

Apart from the axe flakes and flakes with a polished facet (originally deriving from a grinding stone), a large number of flakes of hard stone were recovered (N=121). Most of the flakes showed a well-developed bulb of percussion, indicating the use of hard hammer percussion. Quite a number of flakes without facets of polishing traces on their dorsal aspects were of the same stone type as the grinding stones: a dense dark grey quartzite or quartzitic sandstone. This observation supports the assumption that spent grinding stones were intentionally reduced to flakes. Two flakes (no. 2226 of quarzite and no. 8936 of quartzitic sandstone) display traces of use. The first seems to have been used to cut wood (fig. 8.5h), the other to scrape wood (fig. 8.5i). The polish was visible on the quartz crystals and was characterised as smooth, slightly domed and with a clear directionality. It is theoretically possible that the flakes found at the site, especially those of very dark grey quartzite or quartzitic sandstone, actually represent the waste formed in shaping the grinding stones and possibly the querns. As mentioned above, our refitting efforts were not successful; long-term use and possible resharpening may have changed the original shape of such tools beyond recognition, making refitting virtually impossible. It is therefore impossible to conclude whether the flakes should be considered manu-facturing waste or whether they are the products of intentional reduction of rejected grinding stones. The latter option is the more likely as some of the larger flakes display polished areas.

It is remarkable that so many broken stone tools were found and that none of them could be refitted. Quite a few broken fragments must therefore have left the site. In theory it is possible that for example the broken grinding stones were brought to the site in a broken form, as a source of raw material. This is however considered less likely because some of them are still rather large, with very fresh wear traces. If these stones formed part of a stock, the wear traces would have been modified. But even then we should have been able to refit at least some fragments. The fact that we achieved almost complete recovery of the remains as they were left on the dune following the site's abandonment precludes an explanation along the lines that the stone tools were discarded elsewhere at the site. Alternative explanations must therefore be considered, such as use of broken artefacts as net sinkers or to weight down fish traps. Evidence of such off-site uses is seldom found. A significant percentage of the stone tools were definitely discarded off-site, having been used for various off-site subsistence activities.

8.6.9 Unmodified vein quartz and granite

A considerable number of fragments of broken quartz and granite were found. Granite is evidently completely fragmented by weathering, and a large proportion of the granite fragments may be attributed to this process. Another explanation for the presence of such large quantities of fragmented quartz and granite could be that those two stone types were used to temper pottery. In order to test this hypothesis, eight sherds selected by Raemaekers (chapter 6) were analysed for the presence of minerals and were compared with a random selection of broken granite and quartz. This analysis showed that the blue quartz crystals that are so prominent and distinctive in many of the quartzites and quartzitic sandstones were also contained in the pottery temper. Sherds nos. 2654, 3391, 3463 and 4404 all contained blue quartz minerals. The latter three were tempered with crushed granite and, besides the quartz, they also contained biotite (3463) or mica (3391) and pink feldspars (no. 4404). Sherd no. 729, which was also tempered

raw material	N= phase 1	phase 2a	phase 2b	phase 3	totals	% phase 1	phase 2a	phase 2b	phase 3	totals
sedimentary										
general	–	37	46	90	173	.	15.7	19.7	21.7	19.4
quartzitic sandstone	4	50	66	155	275	.	21.2	28.2	37.4	30.8
micaceous sandstone	–	4	2	13	19	.	1.7	0.9	3.1	2.1
conglomerate	–	1	–	2	3	.	0.4	–	0.5	0.3
lydite	–	1	2	3	6	.	0.4	0.9	0.7	0.7
limestone	–	1	–	–	1	.	0.4	–	–	0.1
(vein) quartz	1	41	28	29	99	.	17.4	12.0	7.0	11.1
metamorphic										
general	–	1	–	1	2	.	0.4	–	0.2	0.2
quartzite	1	25	22	36	84	.	10.6	9.4	8.7	9.4
slate	–	–	–	1	1	.	–	–	0.2	0.1
phyllite	–	–	5	1	6	.	–	2.1	0.2	0.7
schist	–	5	4	8	17	.	2.1	1.7	1.9	1.9
gneiss	–	9	13	7	29	.	3.8	5.6	1.7	3.2
igneous										
general	1	1	3	4	9	.	0.4	1.3	1.0	1.0
basalt	–	1	–	–	1	.	0.4	–	–	0.1
granite	2	37	28	48	115	.	15.7	12.0	11.6	12.9
diabase	–	–	1	1	2	.	–	0.4	0.2	0.2
porphyry	–	7	4	2	13	.	3.0	1.7	0.5	1.5
mineral										
pyrite	–	11	7	8	26	.	4.7	3.0	1.9	2.9
marcasite	–	–	1	–	1	.	–	0.4	–	0.1
indet.	–	4	2	6	12	.	1.7	0.9	1.4	1.3
total	9	236	234	415	894	.	100	100	100	100

Table 8.6 Raw material frequencies per occupation phase.

with granite, likewise contained pink feldspars and quartz, but of a white variety. Mica and biotite were quite commonly observed, for example in nos. 1510 (mica in combination with white quartz), 977 (biotite with white quartz) and 2654 (large biotite minerals and blue and white quartz). Three sherds contained white quartz only (nos. 710, 711 and 733).

The pottery was evidently tempered with a range of materials reflecting the range of stone types represented in the lithic assemblage. The close resemblance of the ranges of available raw materials and employed stone tempers suggests that the granite-tempered pottery was made locally, which was indeed also the conclusion obtained for all the pottery in general in the diatom analysis (chapters 6 and 14).

8.6.10 *Pyrite* (fig. 8.11)

A total of 40 pieces of pyrite and one piece of marcasite were found, among both the sieved material (N=3) and the material collected by hand (N=37). Although none of them display modification traces, they are treated as special tools here because they were brought to the site for a specific purpose, notably to make fire. Pyrite contains sulphur (it is a sulphur dioxide) and was used to make fire in combination with strike-a-lights made of flint. The flint assemblage comprises a considerable number of such strike-a-lights (chapter 7). Marcasite, a mineral chemically identical to pyrite and with similar functional properties that is difficult to distinguish from the latter without detailed analysis, has been reported for Wateringen 4 (N=6, 1.3% of the total number of stones, contemporary site of Ypenburg also yielded pyrite plus at least one strike-a-light (Van Gijn, pers. observ.). Earlier finds of very similar radial pyrite are some pieces from Hardinxveld-Polderweg phase 1/2 (5100 cal BC) and De Bruin phase 2 (5100-4800 cal BC) (Van Gijn *et al.* 2001, 165, 171; Van Gijn/Houkes 2001, 199, 204).

N=								%						
	phase 1	phase 2a	phase 2b	phase 3	total phased	not phased	site total	phase 1	phase 2a	phase 2b	phase 3	total phased	not phased	site total
grinding stone	–	6	5	11	22	21	43		2.6	2.3	2.7	2.5	2.5	2.5
quern	1	6	4	9	20	17	37	.	2.6	1.8	2.2	2.3	2.0	2.1
rubbing stone	–	1	–	2	3	3	6	.	0.4	–	0.5	0.3	0.4	0.3
axe	–	–	–	2	2	6	8	.	–	–	0.5	0.2	0.7	0.5
axe flake	–	2	2	1	5	–	5	.	0.9	0.9	0.2	0.6	–	–
hammer stone	1	25	9	10	45	53	98	.	10.7	4.1	2.4	5.1	6.2	5.7
retouchoir	–	–	–	1	1	3	4	.	–	–	0.2	0.1	0.4	0.2
anvil	–	–	–	–	–	1	1	.	–	–	–	–	0.1	0.1
Geröllkeule	–	–	–	–	–	1	1	.	–	–	–	–	0.1	0.1
ornamented	–	–	1	–	1	1	2	.	–	0.5	–	0.1	0.1	0.1
used (unspecified)	–	10	–	13	23	50	73	.	4.3	-	3.1	2.6	5.9	4.2
Subtotal worked	*2*	*50*	*21*	*49*	*122*	156	*278*		21.4	9.5	11.8	13.9	18.4	16.1
burnt stone	–	3	17	49	69	76	145	.	1.3	7.7	11.8	7.9	9.0	8.4
blade	–	–	–	2	2	–	2	.	–	–	–	–	–	0.1
flake	–	8	28	31	67	54	121	.	3.4	12.6	7.5	7.6	6.4	7.0
block	–	–	1	–	1	–	1	.	–	0.5	–	0.1	–	0.1
indet.	–	3	6	3	12	–	12	.	1.3	2.7	0.7	1.4	–	0.7
not modified	7	170	149	280	606	563	1169	.	72.7	67.1	67.6	68.9	66.3	67.7
Totals	*9*	*234*	*222*	*414*	*879*	*849*	*1728*	.	*100*	*100*	*100*	*100*	*100*	*100.0*

Table 8.7 Types of stone implements by occupation phase, in numbers and percentages.

Among the most remarkable finds from Schipluiden are the grave goods from grave 2, consisting of one piece of pyrite in association with three flint strike-a-lights in the deceased's right hand (chapters 5, 7). The combination of pyrite and flint strike-a-lights as burial goods has been previously noted for the Bandkeramik of Bavaria and was also observed at the Niedermerz cemetery closer by (Nieszery 1992).

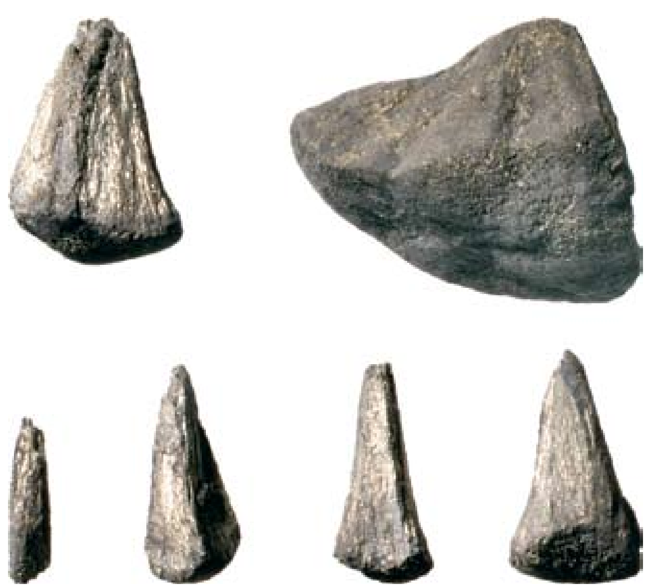


Figure 8.11 Fragments of pyrite nodule, mostly of radial pyrite. Some of the pyrite has crumbled (magnification 2×).

8.7 Diachronic differentiation

The number of stones that could be dated to a specific phase was too small to allow the detection of significant diachronic differences. No differences in terms of raw materials are observable across the occupation phases (table 8.6; fig. 8.12). The range of raw materials represented for phases 2 and 3 (including Unit 11) is of course wider because the number of stones dating from these phases is much greater. Otherwise the main stone types represented for each phase (sedimentary rocks, quartzitic sandstone, quartzite and granite) show roughly the same percentages.

The percentage of hammer stones is around 10% for phases 1 and 2a and seems to show a drop afterwards in phases 2b and 3. The relative numbers of burnt stones

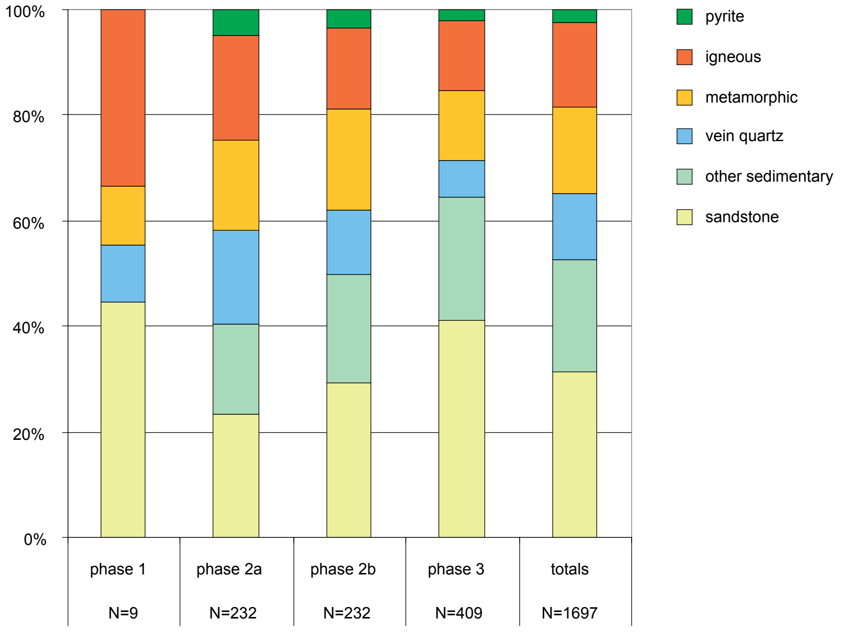


Figure 8.12 Raw material composition of the stone assemblage per phase

		phase 1	phase 2a	phase 2b	phase 3	total phased	not phased	total site
N=		9	236	234	415	894	834	1728
mean length	cm	6.5	3.8	3.4	3.6	3.6	4.2	3.9
mean width	cm	4.7	2.8	2.7	2.7	2.7	2.8	2.8
mean thickness	cm	2.2	1.9	1.3	1.3	1.5	1.5	1.5
mean weight	grams	128.8	54.7	28.2	27.8	36.0	37.4	36.7

Table 8.8 Mean dimensions of stone artefacts per occupation phase.

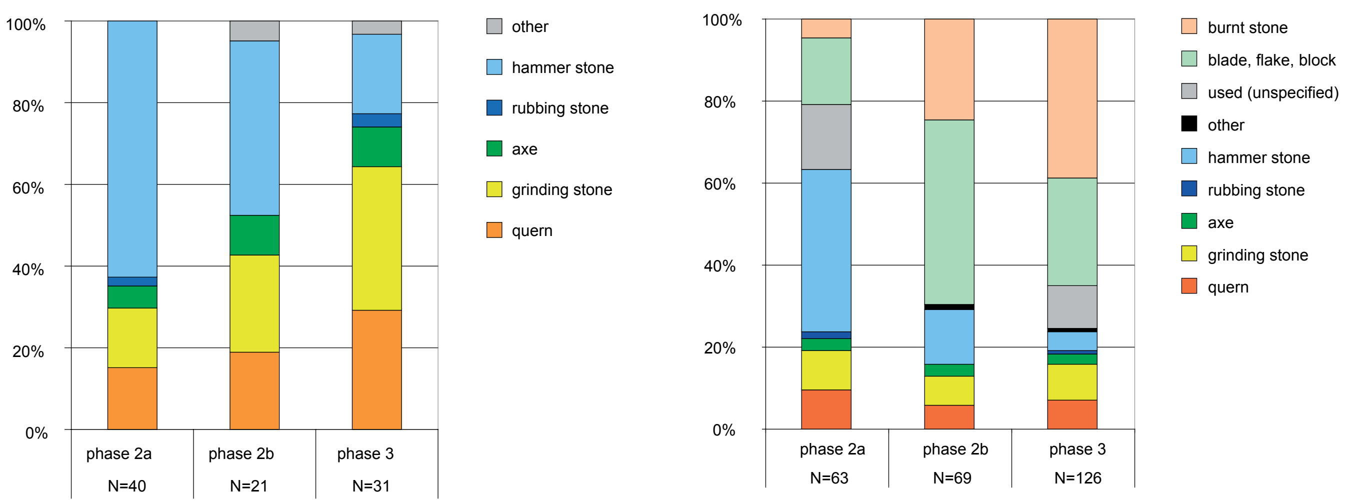


Figure 8.13 Implements, worked and used stones per phase.
a all worked stone
b implements only

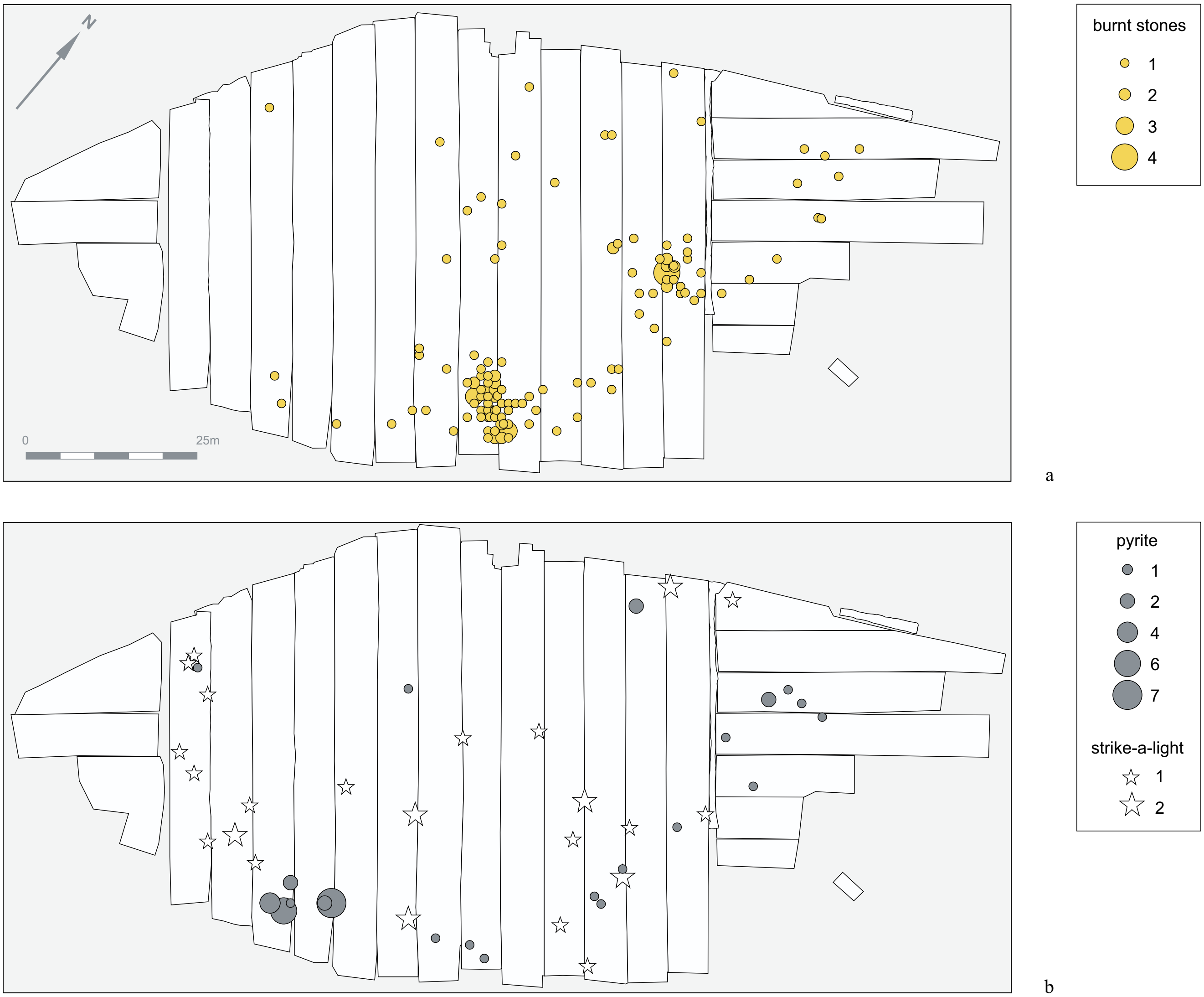


Figure 8.14 Distribution patterns of selected stone categories.
a burnt stones, interpreted as cooking and hearth stones
b pyrite and flint strike-a-lights

(cooking stones and/or hearth fragments) on the contrary seem to show an increase through time from zero in phase 1 to 11.8% in phase 3. It is not clear what meaning should be attributed to this observation (table 8.7; fig. 8.13).

The stone objects from phase 1 appear to be the largest, but this is due to the way the material was collected, namely by machine instead of by manual shovelling. The average weights of the stone objects are 129 grams in the case of phase 1, 55 grams in the case of phase 2a, 28 grams in the case of phase 2b, and 23 grams in the case of phase 3 (table 8.8).

8.8 Spatial distribution

The great majority of the stone objects were found in the deposits along the southern margin of the dune. As stone is readily preserved, stone objects were also found across the area of the dune itself, if in smaller numbers (chapter 3). None of the tool types, nor the types of raw materials, including pyrite, show any concentrations. The only exceptions are formed by the burnt stones of quartzite and quartzitic sandstone, which appeared to be concentrated in two clusters (fig. 8.14). It could not be made out whether they are primary activity areas, or just dumps of the adjacent yards.

8.9 Conclusion

8.9.1 Stone use and group size

The stone assemblage of Schipluiden displays a great variety in terms of both raw materials and the represented range of tool types. The raw materials selected and brought to the site are largely similar to those found at the nearby sites of Ypenburg and Wateringen 4: at both sites sandstone, quartz and granite were reported to have been the most abundant (Koot/Van der Have 2001; Molenaar 1997). As the material from Ypenburg has not yet been published, it is difficult to draw comparisons. The number of modified stones found at this site does appear to be very small (Koot/Van der Have 2001, 113). The range of implements found at Wateringen 4, including hammer stones, grinding stones and querns, corresponds to that of Schipluiden. At Wateringen 4, the total number of stones was 471, 62 of which were implements, modified by intent and/or use, representing 13.2% of the assemblage, which is comparable with the 15.8% of Schipluiden. Contemporary sites further east such as Kraaienberg and Gassel also yielded relatively many unmodified stones (pebbles and blocks), reflecting the easier access to the stone sources (Kraaienberg: 3.1% modified, Louwe Kooijmans/Verhart 1990; Gassel: a small number of the total of 627 stones, Verhart/Louwe Kooijmans 1989).

All in all, it seems that the quantitative difference between Wateringen 4 and Schipluiden lies in the differences in group size and duration of the occupation. Schipluiden was occupied for around 250 years, by several households, whereas Wateringen 4 was probably occupied for only half a century at the most ("at least two house generations", Raemaekers *et al*. 1997, 150) and by a single household. The Wateringen inhabitants used 7.13 kg of stone in 50 years, whereas those of Schipluiden used around 55 kg. Assuming similar patterns of consumption and discard for both sites, this comparison lends further support to the interpretation that several house-holds were present at Schipluiden.

8.9.2 Lithic sources

No larger stones were available in the vicinity of Schipluiden, so virtually all the raw material had to be imported. Only small nodules of gravel, quartzites, quartz and quartzitic sandstones, with a diameter of at least 3 cm, may have been collected along the coast. The people carefully selected the most suitable stone types for making specific tools or for carrying out specific tasks. The black, homogeneous dark grey quartzitic sandstones are perfectly suitable for grinding and polishing flint axes. All of the grinding stones are made of the same raw material. The stone has a very dense structure and is fine-grained. The selection of types of stones for the manufacture of querns was more ad hoc. A range of different stone types were used for this purpose, all of which

Figure 8.15 Toolkit used to harvest and process cereals: three flint sickle blades and two querns, interpreted as having been used to process cereals. The quern in the right top hand corner is made of a crystalline stone containing olivine, possibly a diabase.

Figure 8.16 Grinding and sharpening flint axes (grinding stone no. 1300 and axe no. 845).

were suitable for the intended task. Stones were evidently selected from the gravel deposits with a specific function in mind, implying that the users had a thorough knowledge of the physical properties of the different raw materials.

The presence of non-territorial raw material at Schipluiden provides some insight into the inhabitants' range of communication, via either mobility or long-distance exchange contacts (fig. 8.2). Unfortunately, due to the lack of detailed research into stone sources in the Netherlands and adjacent parts of Belgium, it is very difficult to identify sources where raw materials may have been obtained in the past. We have to be content with general areas of origin. It is likely that virtually all the stone types represented in the assemblage were to be found in either the riverbeds of the Meuse or its terraces. The igneous component may include northern material, but it cannot be positively identified. Rhine gravel is completely absent. River pebbles may have been accessible at points where the rivers had cut into ancient Meuse deposits, for example in the ice-pushed river deposits of Utrecht, the Veluwe region and the environs of Nijmegen. Some, at least, of the Schipluiden stones may have been collected in these areas. Another option is a source further south, along the course of the Meuse in Limburg. The larger stones, such as the grinding stones, may have been collected here. This is also the area from which some of the flint was obtained (chapter 7). The pyrite may have been collected in the Ardennes, or less likely along the chalk coastline of northern France. Both areas lie around 200 km from Schipluiden. Sandstones may also have been obtained from the Scheldt basin in the south, along with the flint that was imported from Hainault (chapter 7). No quartzitic sandstones or quartzites are however known from that area (P. Crombé, pers. comm.). Whether the inhabitants obtained the stones via down-the-line exchange systems or whether they organised expeditions to collect the material themselves is hard to determine. Considering the fact that the distances to be covered were relatively small (between 75 and 150 km to Limburg), the latter option is the more likely. The collection of stone may have taken place in the context of social gatherings. The substantial importance of the 'southern connection' indicated by the raw materials and also the character of the burial customs (chapter 5) suggests strong ties between the communities to the south including those in the coastal areas. In many ethnographically documented societies raw material procurement is part and parcel of the social network, and social ties between various communities are structured through the procurement and exchange of raw materials over long distances (*e.g.* McBryde 1997).

Figure 8.17 Polishing bone awls on a small grinding stone (awl no. 8362 and grinding stone no. 6379.1).

8.9.3 Activities

The activities involving hard stone tools carried out at the site were varied, and support the interpretation of the site having been occupied for a long time by a fairly large group of people. Woodworking was performed with axes and large crude flakes. Only one small complete axe was found. It was used as a wedge on wood. There is no evidence to suggest that the axes were used to chop trees. This may have been done predominantly with flint axes. Large flakes removed from rejected grinding stones were used for coarse woodwork such as sawing and shaving. The hard stone woodworking tools thus complemented the flint axes used to chop wood and the small bone chisels that were employed in shaping wooden objects (chapters 7 and 10).

Seed processing took place at the site, as testified by the presence of querns used to grind Poacaea, *i.e.* cereals and wild grasses (fig. 8.15). Several querns show polish and striations suggesting that they were used in cereal processing. The five querns sampled for phytolith analysis all produced fragments of glumes and stems. Although it is not always possible to identify phytoliths to the species level, most of the Schipluiden samples do seem to derive from barley. The size of the phytoliths suggests that the cereals were cultivated. Wild seed may also have been processed, either intentionally or accidentally, as suggested by the presence of Panicoid phytoliths. The phytoliths were very rounded and rolled, their natural protrusions having disappeared. This suggests that the grains were processed into flour and not boiled whole to make porridge. The presence of glumes on the querns supports the assumption that crops were grown locally (see chapter 19). Some of the rubbing stones and a few hammer stones with pounding marks along their entire outlines were probably used to pound and grind other plant materials such as nuts or seeds.

Many hammer stones were found at the site. Some, at least, of these stones were most probably used in flint knapping, considering the coarse pounding marks and the stones' sheared surfaces. Hard hammer percussion is evident in the flint assemblage (chapter 7). Unfortunately, it was not always possible to specify the activities in which the hammer stones were used.

The presence of a number of grinding stones used to polish flint axes (fig. 8.16) indicates that axes were maintained and suggests that blanks were processed into finished tools on site. Although the grinding stones may have served mainly for (re)sharpening imported flint axes, the shapes of the used areas on the grinding stones, comprising the three different aspects of an axe, suggest that flint axes were also shaped locally. This is supported by the observation that local, dark coloured 'sea flint' (section 7.5) was also used for their production. Making flint axes is rather time-consuming. Experiments have shown that polishing an average flint axe involves about 6-8 hours of heavy work (Madsen 1984). Our own experiments suggest an even longer time, *i.e.* several days for a large flint axe, but polishing stone axes take considerably less time. This is supported by ethnographic fieldwork in Papua New Guinea. Because it takes so long, it is often done communally as a social activity, if possible close to the occupied area (Burton 1984; Pétrequin/Pétrequin 1993). The fact that this activity took place at Schipluiden implies that the inhabitants spent considerable time at the site, and that they probably constituted a fairly large group of people. One small, round grinding stone was used to polish bone (fig. 8.17). It probably served to sharpen the bone awls that played a role in basketry, coiling and rope making (chapter 10). Being so small, and hence portable, it probably formed part of the toolkit used for basketry and related plant-processing activities.

The presence of pyrite indicates that stones played a role in fire making. In combination with flint implements – the strike-a-lights – pyrite creates sparks to start off a fire. One piece of radial pyrite was found in the hand of the man buried in grave 2, along with three flint strike-a-lights (chapter 5). As argued elsewhere (chapters 5 and 7), this combination of grave goods may be seen as an indication that this man had a special role in the community during his life, possibly akin to that of the shamans known from northern latitudes.

Crushed stone, especially quartz and to a lesser extent granite, was also used to temper pottery (chapter 6). All the broken, angular quartz is probably to be interpreted as tempering material. The quartz was brought to the site as small nodules. Many of the small nodules found at Schipluiden display pounding marks, indicating that they are not hammer stones but were intended for use as tempering material.

There is no evidence of the polishing of jet and amber beads, which is odd, as the beads show the facets formed in polishing. Especially the grinding and polishing of jet leaves very distinct, characteristic traces, which were not encountered during the use-wear analysis. Such traces may of course occur among the material that was not studied for use-wear analysis. Stones also played a role in cooking and hearth construction, as testified by the large number of burnt stones, especially sandstones.

The roles of stone tools in the toolkits used to carry out various tasks testify to the users' knowledge as to what constitutes a suitable tool for a specific task. An examination of a technological system from a more holistic point of view, including an analysis of wear traces on flint tools, but also on stone, bone and antler objects, shows which types of tools people in the past chose for their tasks. The choices they made indicate the users' knowledge of the physical properties of different raw materials in relation to the tasks at hand, and can also reveal cultural choices. Unfortunately, few assemblages have been studied from this point of view, making it virtually impossible to make comparisons. Stone does however appear to have played a more prominent role in the technological system than observed at the Late Mesolithic sites of Hardinxveld. The range of uses to which the stone tools were put is larger, including seed grinding, bone polishing and flint axe production and maintenance.

The large variety of activities demonstrated and the fact that stone tools formed integral parts of various toolkits composed of tools made of different raw materials indicate the presence of complete households that lived at the site for an extended period of time. Although we must exercise due care in extrapolating present-day gender roles – even in more or less comparable societies – to the past, it is nevertheless highly likely that cereal processing – the grinding of seeds – was done mainly by women. Polishing axes is on the contrary invariably a male task. The data presented here do not warrant any statements about the exact length and season of occupation. They only indicate the likelihood of a long-term stay, during which all sorts of tasks involving complicated toolkits had to be carried out.

Although it seems that most stones were put to specific uses in full account of their specific properties, their procurement may on the contrary have been imbued with great social and ideological significance. The same holds for 'exotic' materials such as pyrite, jet and amber, as demonstrated by the burial goods and ornaments (chapter 9). The long-distance contacts that this procurement entailed may have been vital for the continuous occupation of a site as remote as Schipluiden.

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notes

1 In the field module the natural coarse fraction (4-6 mm) of the dune sand, also that recovered on the 4 mm mesh, was included in the records. This fraction was subtracted in this presentation, using the ratio obtained in the trench 10 pilot study (natural:artefactual = 201:85).

2 The 4-mm sieve fraction represents about 8% (1/12) of the excavated volume.

3 Present-day beaches are 'polluted' with recent building materials. The odd flat pebble has been found in older beach deposits.

4 It should be noted that the total numbers of stones found at Wateringen 4 and Schipluiden may not be entirely comparable due to differences in the employed excavation strategies. When the small stones (<5 mm) of Schipluiden (found in the sieving) are omitted from the calculation, the percentage of modified stone artefacts at this site becomes much higher.

5 A spodogram is a sheet (ranging in size from 10-20 microns to macroscopic dimensions) of silica-incrusted plant tissue, usually of the epidermis, in which the phytoliths (the silica incrusted cells) have survived in anatomical association.

6 Dicot leaves are the leaves of Dicotyledons, a genus of flowering plants having two cotyledons (embryonic leaves) in their seeds, which usually appear at germination.

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9 Ornaments of jet, amber and bone

Annelou van Gijn

Ornaments of jet, amber, bone and stone provide a small window onto the less utilitarian aspects of life on the dune. Jet must have washed ashore quite frequently, considering the number of unworked blocks, pieces of production waste and unfinished beads found at the site. The entire production sequence is represented. Amber was a rarer commodity. Two bone beads accompanied a small child as burial gifts.

9.1 Introduction

Some of the most fascinating artefacts found at the Schipluiden site are beads and pendants of jet, amber, quartzite and bone (fig. 9.1). The presence of such ornaments along with semi-finished products indicates that the site was not just briefly visited. People evidently spent enough time here to manufacture these ornaments, as well as to loose or discard them. The study of the ornaments can therefore lead to a better understanding of the role of the site in the settlement system. The use of non-local raw materials for the ornaments indicates external contacts, either in terms of special expeditions intended to procure the material, reflecting the extent of mobility of the occupants, or in terms of exchange with neighbouring groups. Ornaments also tell us something about the people who wore the beads and pendants, as they reflect aspects of the bearer's identity.

9.2 Materials and selection

A total of 37 jet artefacts were found, with a total weight of 212 grams (table 9.1). The jet objects include not only finished objects, but also raw materials, blanks and unfinished products, representing the different stages of production. Amber was found less frequently: only 17 artefacts, with a total weight of only ten grams. Other ornaments are a pendant made on a flat piece of quartzitic sandstone and three bone beads.

Figure 9.1 Some of the finished beads and pendants made of amber, jet and bone, together with an unfinished stone pendant.

	jet				amber			
	trench 10 pilot		total excavation		trench 10 pilot		total excavation	
excavated volume (m³)	10	60	80	1000	10	60	80	1000
collected by hand in Units	–	2	–	32	–	1	–	10
idem from pit fills		–		1		–		–
total	–	*2*	–	*33*	–	*1*	–	*10*
4 mm sieve	2	–	4	–	–	–	7	–
4 mm sieve, extrapolated	–	12	–	50	–	–	–	88
Totals, recovered	*4*	–	*37*	–	*1*	–	*17*	–
Totals, extrapolated	–	*14*	–	*83*	–	*1*	–	*98*

Table 9.1 Composition of the sample of amber and jet ornaments. The extrapolations show the number of ornaments missed as a result of partial sieving.

The amber and jet were initially treated as part of the lithic assemblage, but were later identified as representing a separate category of semi-precious stone used for ornaments rather than implements. Because the objects of jet, and especially those of amber, are so small, the 4-mm sieve residues of the samples from all the trenches were examined for the presence of these materials. Only four jet finds were recovered from the sieve residues, two from samples from trench 10. Extrapolation of this figure to the entire excavated area suggests that a total of 46 jet artefacts were overlooked during the excavation, *i.e.* more than 50%. This proportion is even greater in the case of amber artefacts. A total of ten pieces of amber were recovered by hand and seven artefacts were encountered in the sieve residues. Extrapolation of this number to the entire excavated area suggests that a total of 81 amber artefacts (*i.e.* 89%) were missed during the excavation. These calculations show that the numbers of amber and jet artefacts were probably quite similar, the amber artefacts only having considerably smaller dimensions than the jet artefacts. All the amber and jet artefacts were examined, irrespective of their size.

The number of bone beads is very small (N=3); one was collected by hand, the other two were found in one of the graves (see section 5.3.1). An unfinished pendant of quartzitic sandstone was also collected by hand. All in all, the described sample may be regarded as representative in qualitative terms, but not in quantitative terms. Of a calculated total of 185 beads originally present on the site, 58 were recovered; the other 127 were overlooked as a consequence of the partial (8%) 4-mm sieving procedure. The number of beads recovered from pilot trench 10 shows that this calculation should be considered a rough estimation rather than an accurate indication.

9.3 Methods

All the ornaments and the pieces of jet and amber without manufacturing traces were studied. Among the variables considered in the study are raw material, type, manufacturing traces, fracture patterns and metrical attributes. All the beads and pendants of amber and jet, including the semi-finished products, were also examined under a stereomicroscope (enlargements of 10-160×) and a metallographic microscope (enlargements of 100-560×) in order to study the manufacturing traces and detect wear patterns indicative of how the beads and pendants were worn.

9.4 Raw materials

9.4.1 Amber

Amber is a fossil resin, often displaying fossil inclusions of plant particles and insects. The colour varies from yellow via orange to dark red. All the amber found at Schipluiden is of the orange, translucent variety, except for one pendant, which is made of yellow, opaque amber. Amber has a very low specific gravity and is therefore readily transported by the sea. It occurs naturally in primary positions in Tertiary deposits along the southern shores of the Baltic Sea, and most of the Dutch amber is indeed of Baltic origin, but was collected on the northern beaches of the Netherlands.

There are three ways in which amber may have made its way to the coasts of the Wadden Islands and the province of Noord-Holland. In the first place, nodules of Baltic amber occur in Saalian boulder clay deposits, some of which lie in the North Sea Basin. Amber nodules may have been washed out of those deposits and deposited on the beaches of the Wadden Islands and, to a lesser extent, those of Noord-Holland. Secondly, amber nodules may also have been washed out by marine transgressions in the Baltic area. Those nodules will subsequently have been transported to the North Sea coasts of Denmark, the Netherlands and eastern England by sea currents. And thirdly, some of the amber may also derive from lignite deposits dating from the Pliocene in the north of the Netherlands and Germany (Huisman 1977). In the past, amber was to be found on the northern shores of the Netherlands in considerable quantities, allowing some people to make a living out of collecting it. Even today, amber can still be picked up on the Wadden

Islands (Waterbolk/Waterbolk 1991). Whether any amber was to be found near Schipluiden is difficult to say. The fact that amber was found in such small quantities (and in the form of finished objects only) indicates that it was a rare commodity, which was either incidentally picked up on the beach or obtained through exchange with Neolithic communities further north.

9.4.2 Jet

Jet is a carboniferous rock, akin to lignite, cannel coal and oil shale. It was used as fuel, but it can also be readily shaped into ornaments because of its softness and because it can be polished to a fine gloss. In mineralogical terms jet is defined as “a hard coal-black variety of lignite usually found in isolated masses in shale and representing coalified fragments of coniferous wood” (Pollard *et al*. 1981, 140). It is formed in areas where layers of plant matter cannot decompose because they are cut off from water. Instead, a process of carbonisation sets in, which may result in two kinds of jet: a soft variety in which annual rings are still visible (a sedimentary rock) and a hard variety (metamorphic rock), in which the plant cells have been completely compressed (Muller 1987). The hard jet displays a conchoidal fracture, whereas the soft variety is layered and has horizontal fracturing planes. The differences between jet, cannel coal, lignite and oil shale essentially lie in the ratios of the carbon and mineral contents. Analysis of several British samples has shown that jet has a very high organic content (approx. 80%). The organic content of cannel coal is 76%, that of carbon and lignite 66.7%, while that of oil shale varies from 8.7 to 37.9% (Pollard *et al*. 1981, 140).

Jet still occurs on the other side of the North Sea, along the east coast of England in Jurassic Lias deposits in North Yorkshire. Other sources are the Jurassic Poseidon slate that outcrops in southern Germany in the Frankish and Schwabian Alps (Muller 1987). Huisman (1977) noted the occurrence of *Bruinkoolhout* in the same Pliocene lignite deposits in the northern parts of the Netherlands and Germany in which he also encountered small lumps of amber. He argued that pieces of this material may have been washed out of these extensive deposits in tidal channels of the North Sea and subsequently deposited on the coasts. Quite a few fairly large jet artefacts were found at Schipluiden, including several large pieces of jet without manufacturing traces and some semi-finished products. The fact that several semi-finished products were discarded without further efforts to turn them into finished products suggests that this resource was not scarce. It should be borne in mind that the specific gravity of jet is 1.18 (Pollard *et al*. 1981), facilitating transport by sea. The jet may therefore derive from the Yorkshire deposits, having been transported by currents in the North Sea, but another source in for example the Normandy coast, cannot be ruled out Attempts have been made to source jet: Muller (1987) claims that the ratio of the aluminium, silicon and sulphur contents is diagnostic of different sources of jet. However, Pollard and others (1981) noted considerable variation in the elements assumed to be diagnostic in sourcing jet and dismissed the possibility of sourcing.

9.4.3 Stone and bone

The other ornaments include a flat piece of quartzitic sandstone with an incomplete perforation and three bone beads. The quartizitic sandstone was probably obtained together with the other stones (chapter 7).

The two tubular bone ornaments were made on a hollow long bone of a bird. The third bead was produced on an ear bone of *Sus scrofa/domesticus*.

9.5 Production and use of ornaments

9.5.1 Jet beads (tables 9.2-3)

The entire production sequence of the jet beads is represented in the Schipluiden assemblage, from chunks of raw material to highly polished beads (figs. 9.2-4). It is generally assumed that flint blades were used to cut blocks of jet to a size close to the intended size of the beads. Four used zones on flint artefacts show traces resembling those observed on flint tools used to cut jet in experiments (chapter 7). One rectangular block was found to contain a circumferential groove made with a flint blade. For some unknown reason the block was never cut in half (no. 3622, fig.9.3). Some of the jet has a laminated structure, which will have made it possible to split the blocks to the required thickness. This is only possible with soft, less jetonized pieces.

The blanks thus obtained were then either further sawn into shape, as can be inferred from cutting marks on the edges, or they were perforated first. All observed perforations were made with a solid drill, which resulted in a typical ‘hour-glass’-shaped perforation (fig. 9.3). The perforations were made from the two opposite aspects, with the two halves meeting each other in the narrow bit in the middle. The perforations all show circular scratches, indicating that the drill was somewhat irregular, with protrusions. The perforations were most probably made with flint borers.
Use-wear traces on some of the flint borers found at

		N=	min.	max.	mean
length	mm	37	0,8	43	5,85
width	mm	37	0,7	33	4,65
thickness	mm	37	0,2	16	2,59
weight	grams	37	0,1	45	5,73

Table 9.2 Jet artefacts, descriptive statistics.

type \ modification	not modified	flaked	complete perforation	partial perforation	perforation and polish	saw marks	indet.	totals
disc-shaped bead	–	–	2	–	2	–	–	4
tubular bead	–	–	1	–	2	–	–	3
prefabricated bead	–	–	5	4	–	7	–	16
flake	1	–	–	–	–	–	–	1
not modified	11	–	–	–	–	–	1	12
not applicable	–	1	–	–	–	–	–	1
Totals	*12*	*1*	*8*	*4*	*4*	*7*	*1*	*37*

Table 9.3 Jet ornaments, type versus traces of modification.

Schipluiden show that they were indeed used on mineral material (chapter 7). One large reamer shows traces closely resembling those observed on the experimental jet drill (fig. 9.2; see also chapter 7). Interestingly, the makers of the beads in some instances misjudged the positions of the two halves of the perforation and had to abort their work (no. 3565). This suggests that the material was not scarce and that the occupants had ample jet to work with. On the other hand, viewed from the perspective of two and a half centuries of use, only small quantities of jet were discarded or lost at the site.

The last manufacturing stage involved the further grinding of the bead into its final shape and the finishing of the perforation. The grinding may have been done with one of the grinding stones included in the lithic assemblage (chapter 8). Experiments have shown that jet can be quickly ground and polished to an intended shape, resulting in a very bright, smooth polish on a grinding stone made of fine sandstone. Only one small grinding stone with some bright patches of polish bears some similarity in wear traces to the experimental jet polishing stone. The archaeological polish is however somewhat 'flatter'. It may be that the grinding stones were multifunctional and that they were also used to polish the much harder flint axes. This would have obliterated or at least modified the jet working traces.

In the last stage of the production process the perforation was finished and smoothed. As described above, the initial perforations were made before the object was cut into its

Figure 9.2 Production of jet beads: raw material, roughouts, production waste and some of the flint implements displaying traces interpreted as resulting from cutting or drilling jet or an unidentified mineral material.

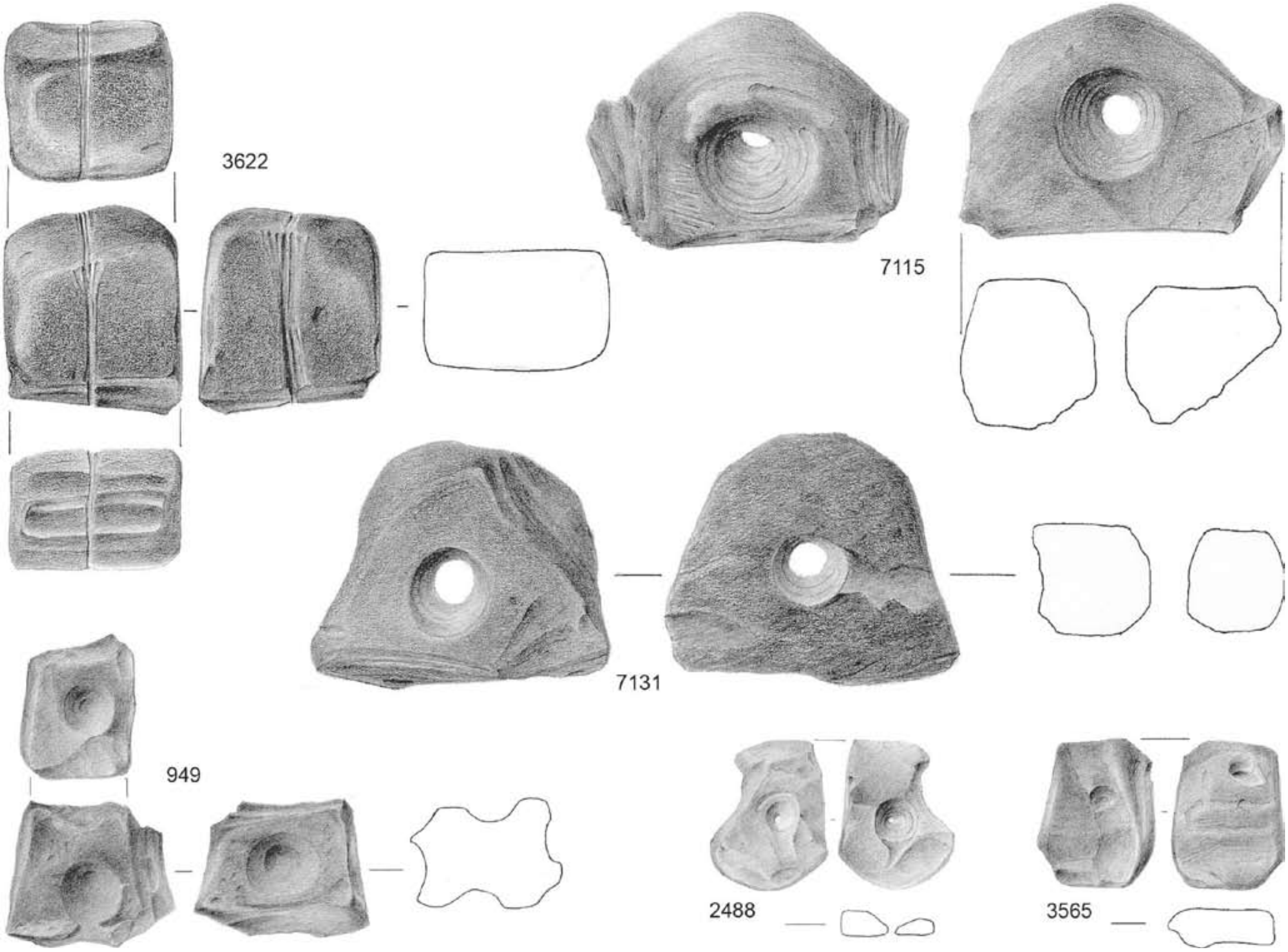

Figure 9.3 Production waste formed in jet bead manufacture (scale1:1).
top rows: block of jet showing cutting marks and 'hour-glass' perforations in roughouts
bottom row: incomplete perforations

final shape, and they still showed circular scratches from the flint borer. The finished beads all have a very regularised perforation, although traces from the 'hour-glass' perforation are still visible. It is not clear how the perforation was smoothed. Some silicious plant matter such as rough horse tail (*Equisetum hyemale*) may have been pulled through the perforation to smooth the circular scratches. This plant is highly abrasive and is known to have been used for polishing steel pans in bygone days.

Only seven finished beads were found – three tubular and four disc-shaped (fig. 9.4). The size of these two types of beads was standardised, especially that of the disc-shaped variety, which has a uniform diameter of 1.7 cm (±1.6-1.8 cm). The length of the tubular beads shows more variation – from 1.4 to 2.1 cm with a mean of 1.8 cm. It could not be determined whether the beads were worn on a string or sewn onto clothing. Some of the jet beads show signs of wear along the rim of the perforation, suggesting that they were suspended on a thread, but in none of the cases is the rounding very pronounced. One tubular bead shows an extremely well developed polish (no. 3436). This may be due to a long period of use. This bead shows no signs of damage; we may assume that it was lost.

9.5.2 Amber beads and pendants (tables 9.4-5)
Amber has a hardness of 2-2.5 on Moh's scale and can therefore be easily worked with flint. It has a homogeneous structure, does not possess fracturing planes and displays a conchoidal fracture, allowing it to be flaked into a rough shape. It is however very brittle. Amber was not found in

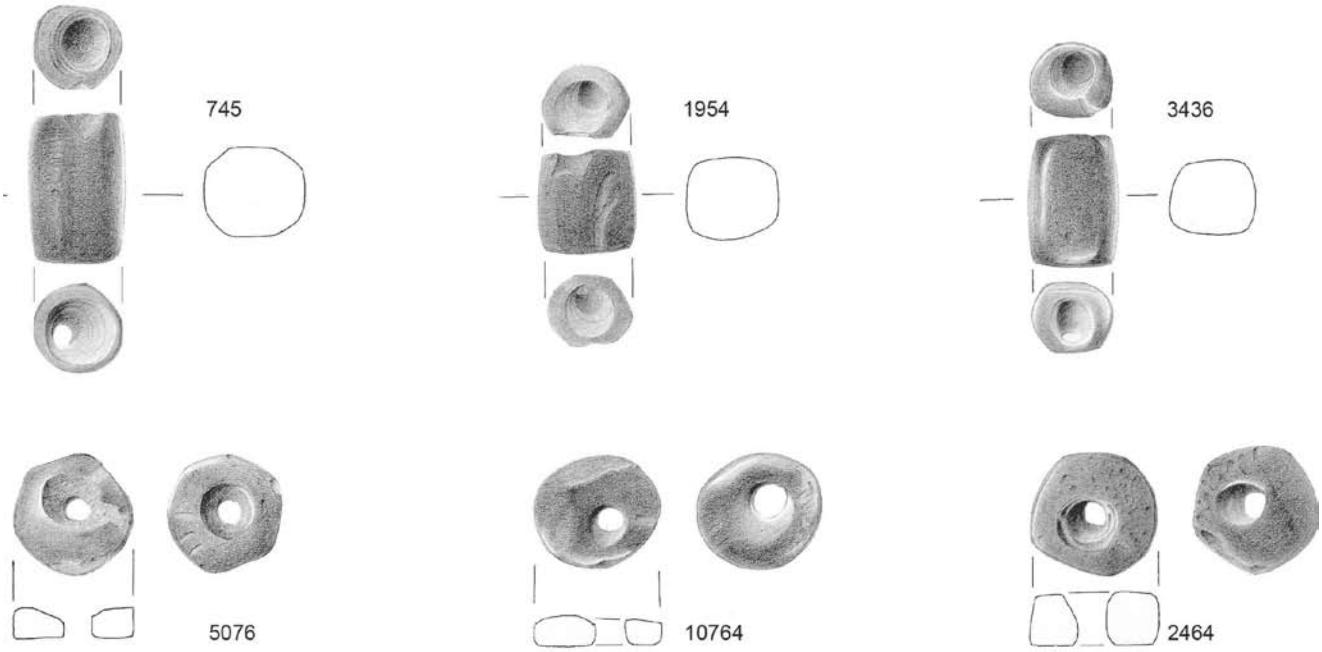

Figure 9.4 Jet beads (scale 1:1).
top row: tubular beads
bottom row: flat, cylindrical beads

such large quantities at Schipluiden as for instance at the late Neolithic site of Aartswoud, where the entire production process of amber ornaments was represented (Piena/Drenth 2001). At Schipluiden only finished beads, pendants and unmodified material were found (fig. 9.5).

A blank can be produced from a nodule of amber in two ways: by flaking and by cutting. One artefact shows negatives formed in flaking. No cut marks were observed on the pieces of amber. Our own experiments showed that amber can be quite easily cut with flint tools, providing it does not contain too many internal cracks causing it to crumble under the pressure of the blade. Amber can also be cut with a thread (Hirsch 1987), evidence of which was observed on some of the amber beads found at Aartswoud (Piena/Drenth 2001). No such marks were observed on the Schipluiden amber though. Maybe the subsequent polishing process obliterated cutting marks.

Most of the perforations in the amber ornaments were made in a different way than those in the jet beads, using a hollow rather than a solid drill, which resulted in cylindrically shaped holes. This was clearly visible on one piece in which part of the plug at the bottom end of the perforation had survived (no. 7352). The perforations were completely smooth, indicating that the drill had a regular surface. Flint borers were evidently not used to drill these

		N=	min.	max.	mean
length	mm	15	0.6	11.0	2.03
width	mm	15	0.4	1.7	0.97
thickness	mm	15	0.4	1.0	0.68
weight	grams	17	0.0	1.8	0.59

Table 9.4 Amber artefacts, descriptive statistics.

modification / type	flake	flaked	complete perforation	partial perforation	perforation and polish	totals
pendant	–	–	3	–	–	3
bead	–	–	2	–	4	6
prefabricated	–	1	–	–	–	1
not modified	4	–	1	1	–	6
not applicable	1	–	–	–	–	1
Totals	*5*	*1*	*6*	*1*	*4*	*17*

Table 9.5 Amber ornaments, type versus traces of modification.

Figure 9.5 Amber beads and pendants, together with a piece of unmodified amber and a flint drill showing traces formed in contact with an unidentified mineral material.

amber beads and pendants. Hollow bird bones could perhaps have been used as drills. An exception is the one yellow amber pendant in the assemblage (no. 9096, fig. 9.6). This ornament has an irregularly shaped perforation, which was clearly made from two directions as the two halves do not quite meet. The perforation is also scratched, suggesting that it was made by means of a solid flint drill.

The number of finished amber ornaments is small: six beads and three pendants. The beads are almost round, and therefore differ from the tubular and flat disc-shaped jet beads. They are on the whole very small, with a mean length of only 1.26 cm (table 9.4). The pendants are irregularly shaped and vary in size from only 1 cm to 3.1 cm. Most of the amber beads show wear traces along the rim of the perforations, indicating that they were worn on a string. Four beads had broken in half, one of them recently.

9.5.3 Bone beads

Two tubular bone beads were found (no. 8091, fig. 9.7), both of them in grave 6, an inhumation of a young child (section 5.3.1). They were recovered from the fill of the pit and may be regarded as grave goods.[1] The beads were made on a hollow long bone of a bird. A similar type of bone, showing cut marks and fractures, was encountered amongst the worked bone. Cut marks are visible on the two beads, indicating that the bone was cut into smaller parts. The marks on one of

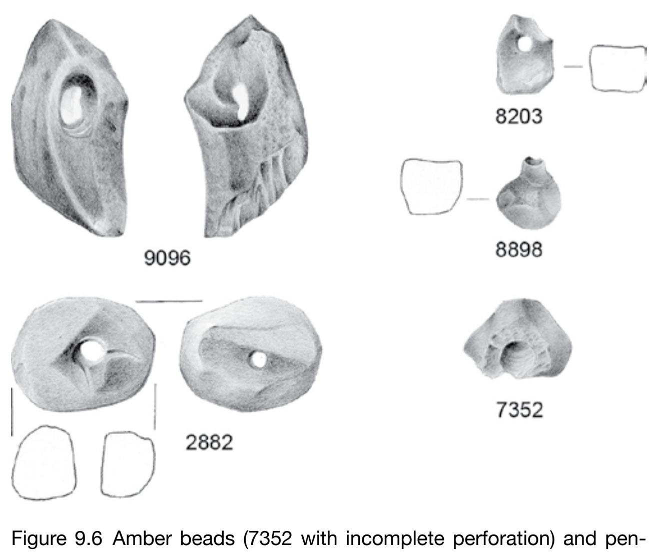

Figure 9.6 Amber beads (7352 with incomplete perforation) and pendants (scale 1:1).

the beads show that the bone was incised from two opposite directions, after which the part intended for the bead was broken off. The sharp end was subsequently ground to a smooth finish. There are no indications of a perforation. Most probably the bone was hollow and the bead could be strung without any further work. Attempts to see whether the beads could be refitted to one another or to the broken long bone with cut marks were unsuccessful.

The other bone bead (no. 8462, fig. 9.7) was made on an ear bone. Some of the holes are natural. There is one perforation, but it is difficult to follow its trajectory because it bends. Ear bones contain natural perforations and have a complex labyrinthine structure. The bead shows extensive polishing due to wear. It was probably discarded because it was worn through at the point where it was highly polished, which had resulted in an extra ‘hole’.

9.5.4 Stone ornament

One small, flat, round pebble of quartzitic sandstone (no. 4072) shows a partial perforation (fig. 9.7) – an incomplete ‘hour-glass’ perforation. It is not clear why the perforation was made from one side only and never finished. No traces of wear are observable. The pendant or bead measures 2.3 × 2.4 cm.

9.6 Spatial patterning

The spatial distribution of the beads and pendants, semi-finished products and unmodified pieces of jet and amber does not reveal any activity areas. The jet finds were recovered over the greater part of the excavated area, with the beads concentrated along the southeastern dumping zone (fig. 9.8). The same holds for the flint tools showing traces formed in working jet or mineral substances that could not be further specified. There may be one exception and that is a find recovered from trench 12 consisting of two pieces of jet accompanied by one flint tool with use-wear traces resembling those observed on experimental jet-working implements and one with traces from contact with a mineral substance. This concentration may represent an area where jet ornaments were produced.

The amber finds show the same spatial pattern (fig. 9.8). Apart from the two bone beads that are assumed to be grave goods, all the objects seem to have been either lost or discarded.

Figure 9.7 Bone beads and an unfinished stone pendant (scale 1:1).

9.7 Phasing

It is impossible to ascertain any diachronic differentiation. Quite a few of the finds concerned derive from Unit 20 and cannot be attributed to a specific phase. A very small number of ornaments were found in features and layers dated to the earlier occupation phases. No pieces of jet or amber can be attributed to phase 1, only one was dated to phase 2a, seven to phase 2b and fifteen to phase 3 (all of them from Unit 11). The phase 2b remains include one jet bead and one amber pendant, while the remains dated to phase 3 comprise two jet beads, an amber bead and an amber pendant. Comparison of the percentages of finished ornaments of jet and amber from phase 2b (29%) and phase 3 (26%) and the total percentage (28%) indicates that the relative quantities of waste and final products remained constant. Most of the remains however clearly date from the later phases of occupation, in contrast to the general find ratios.

9.8 Conclusions

Beads and pendants of amber and jet are common at Neolithic sites. They were not encountered at the late Mesolithic sites of Hardinxveld-Giessendam, nor at Hoge Vaart. However, they have been found at sites of the later Swifterbant culture. At Swifterbant S2 the head of the skeleton of an adult man was adorned with amber beads. Near the man’s right ear was a pendant of pierced stone and on his chest a pendant made on a wild boar’s tooth (Deckers *et al.* 1980). At Swifterbant S2 some perforated flat quartzite pebbles were collected, one with an incomplete perforation very similar to that found at Schipluiden. This site also yielded a large pendant of jet (Deckers *et al.* 1980). The megaliths of the Funnel Beaker Culture yielded numerous amber beads and, in smaller quantities, also jet beads. A good example is the site of the demolished *hunebed* at Glimmeres in the province of Groningen (G2), where 70 amber beads were found (Brindley 1986). Ornaments have also frequently been encountered at sites of the Vlaardingen group. Voorschoten yielded half of a jet bead with crudely bored holes made from two sides. Interestingly, the two halves of the ‘hour-glass’ perforation do not meet very well in this bead either (Glasbergen *et al.* 1967), as also observed in the case of a few of the jet objects found at Schipluiden. Leidschendam

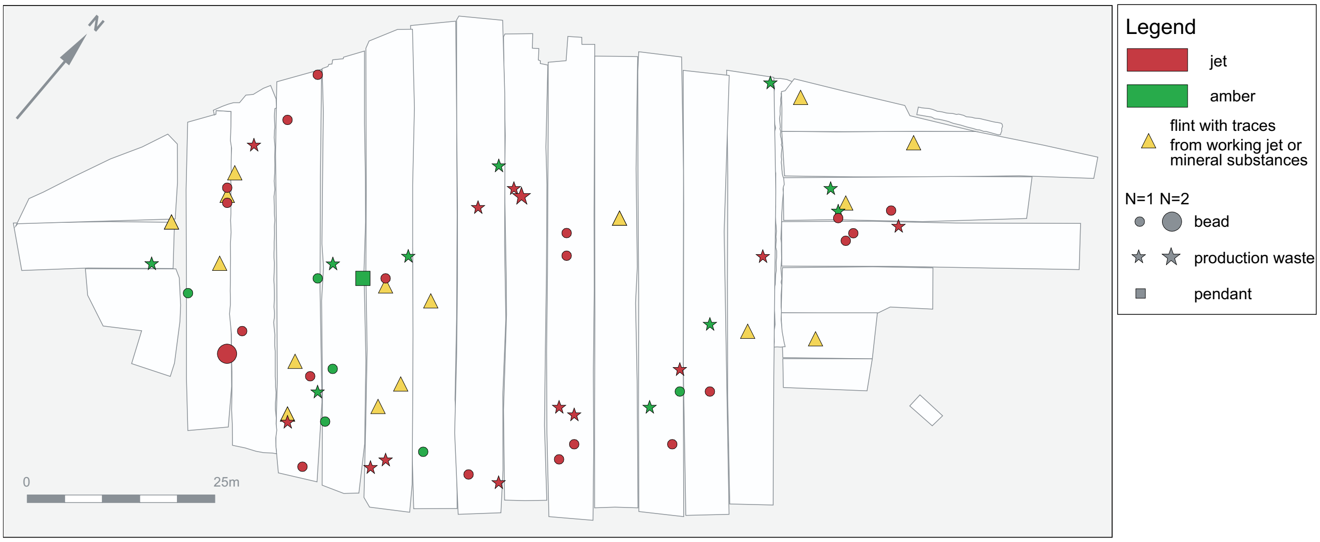

Figure 9.8 Findspots of the jet and amber ornaments and the flint tools used on mineral substances.

produced two broken jet beads and one small piece of amber (Glasbergen *et al*. 1967), while the type site of Vlaardingen yielded a couple of amber beads and a piece of unmodified amber (Glasbergen *et al*. 1961). At Vlaardingen a perforated dog tooth was recovered and at Hekelingen I a perforated canine of a brown bear (Modderman 1953). No such perforated teeth were found at Schipluiden or at any other sites of the Hazendonk-3 group. Assemblages from later Beaker times such as those of Artswoud and Mienakker also contain numerous beads made predominantly of amber (Piena/Drenth 200; Bulten 2001). Amber beads have been found in Bronze Age burial contexts, too (Butler 1990).

Ornaments of jet and amber have also been recovered at contemporary sites such as Wateringen 4 and Ypenburg. At Wateringen 4 one jet bead came to light (Molenaar 1997). Some of the deceased buried in the cemetery of Ypenburg were adorned with amber and jet beads. In one burial two jet beads were found near the skeleton's shoulder; they were presumably sewn onto an item of clothing. Near the head of another body were three amber beads. A small bone ring had been placed around the finger of a five-year-old child (Koot/Van der Have 2001). Inland sites from the same period, such as Het Vormer, on the contrary yielded no ornaments.

The production sequence of amber beads has been demonstrated elsewhere (Piena/Drenth 2001). Jet beads are usually isolated finds and very few semi-finished beads have been found. At Schipluiden, however, the entire production sequence of jet beads is represented by the artefacts: from unmodified blocks of raw material to highly polished beads, including all the intermediate stages in the form of disregarded blanks and semi-finished beads. The production of amber beads is less clearly defined at Schipluiden. Both unmodified raw material and finished beads have been found, but the intermediate stages are not represented, with the exception of one flaked piece. Maybe this material was less readily available than jet, and greater effort was therefore made to avoid or repair mistakes during production.

Jet and amber may have been picked up on nearby beaches and do probably not reflect long-distance contacts of the site's occupants. The fact that jet was relatively frequently used to produce ornaments probably implies that this material was more commonly available than amber. This is further corroborated by the fact that the proportion of amber that was turned into ornaments is higher than that of jet: nine of the seventeen amber artefacts are finished products (53%), whereas the total of 37 jet artefacts includes only seven ornaments (19%). This indicates that amber was treated in a less careless fashion than jet. In historical times, amber was to be found more commonly along the coasts further north, in the northern part of Noord-Holland and in the other northern provinces; this may also have been the case in the Neolithic, which would explain why the number of amber objects relative to jet objects at Neolithic sites increases in a northerly direction.

It is difficult to say what meaning we should attribute to the fact that beads were produced locally on the dune. What does this mean in terms of group composition? Although (semi-industrialised bead production was often in the hands of men (Roux 2000), beads may well have been produced on a small scale for the household by women, too. The number of mistakes made especially in the manufacture of jet beads, including the misjudging of the positions of the two halves of an 'hour-glass' perforation by approximately 3 mm, may even suggest that children were allowed to practice their skills on pieces of jet, which, presumably, were easy to obtain. If this is correct, it would support the supposition that Schipluiden was inhabited by complete social entities, encompassing men, women and children.

All of the beads and pendants described here will have served as ornaments for the occupants. Whether they were combined on a string or were worn sewn onto clothing is difficult to determine, though the position and extent of wear in the perforations provide some clues. One jet bead (no. 2464) was asymmetrically worn, suggesting that this particular bead was sewn onto something. Most of the beads show rounding around the circumference of the perforation, suggesting that they formed part of a string of beads. The perforations of the pendants are on the contrary asymmetrically worn. The two bone beads in the child's grave show no traces of wear.

Personal ornaments are generally believed to reflect social identity (*e.g*. Newell *et al*. 1992). Most of the beads found at Schipluiden cannot be considered intentional depositions, but were probably discarded or, incidentally, lost. This means that beads and pendants were taken along when the site was abandoned, worn as they habitually were. The only exception concerns the two bone beads that were buried as grave goods in a child's grave. The fact that these two beads show no traces of wear indicates that they were considered the child's personal ornaments, to be taken along to the afterlife. Bone ornaments may have been chosen specifically for child burials, because the only bone ornament found at Ypenburg likewise adorned a child. Unfortunately, the small number of beads found at the various sites makes it impossible to determine whether there were any differences between the groups in terms of personal ornaments. Generally speaking, flat quartzite pebbles, disc-shaped or 'barrel-shaped' amber beads, irregularly shaped amber pendants (their size depending more on the size of the available raw material) and disc-shaped jet beads seem to have been used from the early to the late Neolithic. Many of them have been found in burial contexts. The only perceptible difference is a predominance in the use of amber in the north and in that of jet in the south. This can probably be attributed to the relative availability of jet and amber, respectively.

notes

1 The beads were not found *in situ* in grave 6, but in the removed sand of the fill.

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10 Implements of bone and antler: a Mesolithic tradition continued

Annelou van Gijn

A small number of bone and antler tools were found, testifying to the continued use of late Mesolithic production techniques such as the metapodial technique for making awls and chisels and the cutting and breaking of red deer antler for the production of axes and sleeves. Remarkable is evidence of the use of the groove-and-splinter technique. Functional analysis showed that the bone and antler tools formed an integral part of various tool kits that also comprise flint and stone implements.

10.1 Introduction

In the Mesolithic, bone and antler tools played an important role in the technological system in a tradition that was to continue far into the Neolithic. Bone and antler tools have been found at all Neolithic wetland sites in the western part of the Netherlands. Schipluiden forms no exception. A technological and function analysis of the bone and antler implements complements the analyses of the stone and flint tools. All these artefacts form part of a technological system (Lemonnier 1986). One of the main objectives of the integral study of tools made of different materials was to obtain insight into the technological and functional interdependencies of the various tools. Such an approach leads to a better understanding of the technological choices people made in the past. That those choices may vary in unexpected ways was demonstrated by the study of the Late Mesolithic flint, bone and antler tools of the site of Hardinxveld-Polderweg (Van Gijn 2005; Van Gijn *et al*. 2001a; Louwe Kooijmans *et al*. 2001a). There, hides were scraped with bone and antler scrapers (sometimes recycled axes) and not with flint scrapers, the implements usually chosen for this task. By doing only a functional analysis of one category of material culture we run the risk of overlooking several other activities that may have been carried out at the site.

Although not as abundant and well-preserved as the bone and antler assemblages of Polderweg and De Bruin, the Schipluiden finds still constitute an important assemblage that illuminates the continuity of the Mesolithic bone and antler technology into the Neolithic. In comparison with the enormous quantities of bone remains, the number of bone and antler tools and production waste found at Schipluiden is relatively small (N=90). Of the total of 25 antler artefacts only five are finished tools, six are pieces of waste and 14 are possible tools. Among the latter are six unmodified antler tines that were classified as awls because they showed some damage. The number of modified bone artefacts is higher (N=65), including a total of 10 waste products, 21 possible tools and 34 finished implements, mainly awls. These artefacts however include some remarkable objects, such as a large axe-like object and waste products deriving from the groove-and-splinter technique typical of the early Mesolithic.

10.2 Selection and methods

The bones and pieces of antler displaying traces of manufacture or use comprise a mere 1% of the total of bone and antler fragments that could be identified to species level. These artefacts were all selected during the analysis of the archaeozoological material (chapters 22 and 23) and they all belong to the category of manually collected remains. Finds from the 4-mm sieve were not included in the worked bone and antler assemblage, but these finds did include some very small fragments such as broken awl tips, testifying to the meticulous care taken in the find recovery. In total, 90 pieces of bone and antler were considered ‘worked’ artefacts. They are discussed in this chapter.

The preservation of the bone and antler was very good in the lowermost parts of the excavated area, such as Unit 18. No bone and antler had survived on top of the dune. This means that the assemblage consists entirely of remains that were dumped as waste. A total of 14 artefacts display signs of burning. Thirteen of those artefacts are of bone, one is of antler.

Not all the materials of which these artefacts are made could be identified to species level due to the absence of characteristic features. Species determinations were done during the archaeozoological analysis (chapters 22 and 23). In addition, all the artefacts were examined to determine their metrical attributes, signs of burning, breakage pattern, typology and manufacturing traces.

The use-wear analysis was done with a Nikon Optiphot, magnifications of 50-560×, equipped with a free arm allowing large implements to be examined, too. All the implements were also studied by stereomicroscope to examine manufacturing traces and locate any residues.

A total of 50 artefacts were examined for traces of use. The implements were not chemically cleaned. Incidental use was made of an ultrasonic cleaning tank because some artefacts were covered with sediments that were not readily released in running water. Although some pioneer use-wear studies of bone and antler tools were done in the eighties (Campana 1980; D'Errico 1993; LeMoine 1994), systematic high-power study is a relatively recent development (Christidiou 1999; Louwe Kooijmans *et al*. 2001a, b; Maigrot 2003; Van Gijn 2005). The experimental reference collection on which the functional inferences are based includes results of experiments relating to the Late Mesolithic and Neolithic exploitation of wetland environments. The tools used in the experiments were replicas of Late Mesolithic and Neolithic implements.

Two awls (nos. 3147 and 8017), believed to have been used on silicious plants, were subjected to phytolith analysis. The implements were soaked in distilled water, using the ultrasonic cleaning tank to vibrate the residues from the awls. The solution was centrifuged for 5 minutes at 3000 rpm. This procedure was repeated twice in order to enable comparison of the results after the first and second rinses to account for possible contamination of the adhering sediments. No chemicals were used to extract the phytoliths. The samples were examined with a Nikon transmitted-light microscope (magnifications up to 1000×). The phytolith analysis was carried out in collaboration with Dr Channah Nieuwenhuis.

10.3 Tool technology and typology

10.3.1 Bone tools

Metapodial technique

Some pieces of waste point to the use of the metapodial technique for the production of a range of bone tools including awls and chisels. Red deer metapodia were used mostly for this purpose (table 10.1). The natural grooves in the metapodia were deepened by means of incision with flint implements, after which the distal or proximal part was cut off (Maarleveld 1985; Van Gijn 1990, fig. 59). This standardised technique that produces highly characteristic waste was practised in the Mesolithic already. One piece of waste, a proximal part of a red deer metapodium, displays very distinct cutting marks (no. 5860, fig. 10.1). Quite a few flat pieces of bone also showed cutting marks constituting incisions along which the bone was intended to split or break. A series of awls were made with this technique (fig. 10.2). Awls were in fact the most common type of tools (table 10.1), ranging in length from approx. 3-4 cm to 17 cm in the case of one implement. This variation in size may be attributable to rejuvenation of the awls by grinding them to a fine point each time they had become blunt due to use. Another explanation could be that awls of different sizes were produced for different purposes, but this does not seem to be supported by the results of the use-wear analysis. Many of the awls were broken and six of them show signs of burning. At least some of the awls must have been highly valued implements because considerable effort was put into finishing them. Two awls (nos. 1351 and 10,552) display a very intensive gloss all over their surface, which has completely obliterated the cut marks formed in the metapodial technique (fig. 10.2). The polishing seems to have been done by means of hide or leather (Y. Maigrot, pers. comm.).

The chisels were also made on metapodia (fig. 10.3). Most of them are very small (approx. 4 cm long with a width at the edge of approx. 1-1.5 cm); many are broken. This is probably due to frequent resharpening. Chiselling wood,

	red deer			wild boar / pig			cattle	mammal		duck	swan	
skeletal part / artefact type	antler	metacarpus	metatarsus	fibula	cranium	tooth	metacarpus	bone	antler	humerus	tibiotarsus	totals
awl	–	–	–	1	–	–	–	23	6	–	–	30
axe	3	–	–	–	–	–	–	–	–	–	–	3
bead	–	–	–	–	1	–	–	2	–	–	–	3
chisel	–	–	–	–	–	–	–	6	–	–	–	6
groove-and-splinter	3	–	–	–	–	–	–	–	–	–	–	3
hammer	1	–	–	–	–	–	–	–	–	–	–	1
sleeve	1	–	–	–	–	–	–	–	–	–	–	1
pointed spatula	–	–	–	–	–	–	–	1	–	–	–	1
indet.	6	2	3	–	–	1	1	13	2	1	–	29
waste	2	1	–	–	–	–	–	8	1	–	1	13
Totals	*16*	*3*	*3*	*1*	*1*	*1*	*1*	*53*	*9*	*1*	*1*	*90*

Table 10.1 Bone and antler implements, tool types versus skeletal parts.


5860

Figure 10.1 Cut-off distal end of red deer metatarsal constituting evidence of the local use of the metapodial technique (scale 1:1).

the activity for which these tools seem to have been used (see below), causing edges to blunt very quickly, necessitating frequent resharpening.

Other techniques
It may be assumed that there was a more opportunistic way of making implements besides the systematic metapodial technique, in view of the shapes of some pieces bearing traces of use. The bones may have been broken by pounding with a hammer stone (many of which were indeed found at the site; see chapter 8). Suitable edges will then have been selected for minor modification or even direct use (see below).

Bird bones were used for making beads (fig. 10.4). The beads show cut marks made by flint tools (fig. 10.5b). Waste products of this technique were found, too, in the form of one broken fragment of a hollow bird bone with possible cut marks. The finished beads, which appear to have been freshly made, accompanied a young child as grave goods (chapter 5). The bone was very light in weight and hollow, making it ideal for bead production. Yet another bead was made of an ear bone of a pig or wild boar (fig. 9.7, no. 8462), and was badly worn. The beads were discussed in greater detail in section 9.5.3.

Comparison with other assemblages
The range of bone tools found at Schipluiden is limited in comparison with what has been found elsewhere. At the late Mesolithic sites of Hardinxveld a lot of production waste from the metapodial technique was retrieved, as well as numerous finished tools (Louwe Kooijmans *et al.* 2001a and b); these finds form a marked contrast with the meagre evidence of Schipluiden. Moreover, several characteristic tools that were used in the Late Mesolithic and the Swifterbant culture are absent at Schipluiden. They include socketed bone axes made on the proximal part of the radius of domestic cattle of the kind that were found at Hoge Vaart (Laarman 2001) and Swifterbant (Clason 1978). Neither did Schipluiden yield any parallels of the perforated teeth of dog and horse found at Swifterbant (Clason 1978).

The Schipluiden bone assemblage bears a close similarity to the contemporary Hazendonk assemblage from the type site of this archaeological culture (Van den Broeke 1983). There, too, use was made of the metapodial technique and the number of broken awls was considerable. No bone tools were encountered at Wateringen 4, partially due to the poor preservation of organic materials (Raemaekers *et al.* 1997). Ypenburg likewise yielded only few bone tools due to poor preservation conditions (Koot./Van der Have 2001). At this site, three long bones had been modified into awls. Bones of the crane and white-tailed eagle were common, but no modified bird bones were reported (De Vries 2004).

Several sites of the Late Neolithic Vlaardingen group yielded numerous bone tools. The metapodial production technique is evident at most sites, such as Hekelingen III (Louwe Kooijmans 1985; Van Gijn 1990), the Vlaardingen levels at the Hazendonk site (Van den Broeke 1983) and the type site of Vlaardingen (Walvius 1961). The most common tool types are awls and chisels. The Late Neolithic site of Aartswoud yielded metapodia awls with the epiphysus still attached (Van Iterson Scholten/De Vries-Metz 1981). The metapodial technique must therefore have been practised over a very long stretch of time, from the Mesolithic until the Bronze Age.

The custom of using bird bones for artefact production likewise seems to have been practised for a long time. It was demonstrated at the Late Mesolithic sites of Hardinxveld-Polderweg (phase 1) and De Bruin (Louwe Kooijmans *et al.* 2001a and b), at the Early Neolithic site of Bergschenhoek (Louwe Kooijmans 1985) and at the beaker site of Aartswoud, which yielded four artefacts made on bird bones, one of which is an awl made on a tarsometarsus of a sea eagle (Van Wijngaarden-Bakker 1997).

10.3.2 Antler tools
The number of antler tools is limited (N=5 and six unmodified antler tines classified as awls). All the antler tools were made on red deer antler (table 10.1). Two basic tool-production techniques could be distinguished: the groove-and-splinter technique for obtaining splinters for the production of fine tools such as points and awls, and a technique that involved cutting and breaking red deer antler into smaller fragments that could be turned into tools such as axes or awls (fig. 10.7).

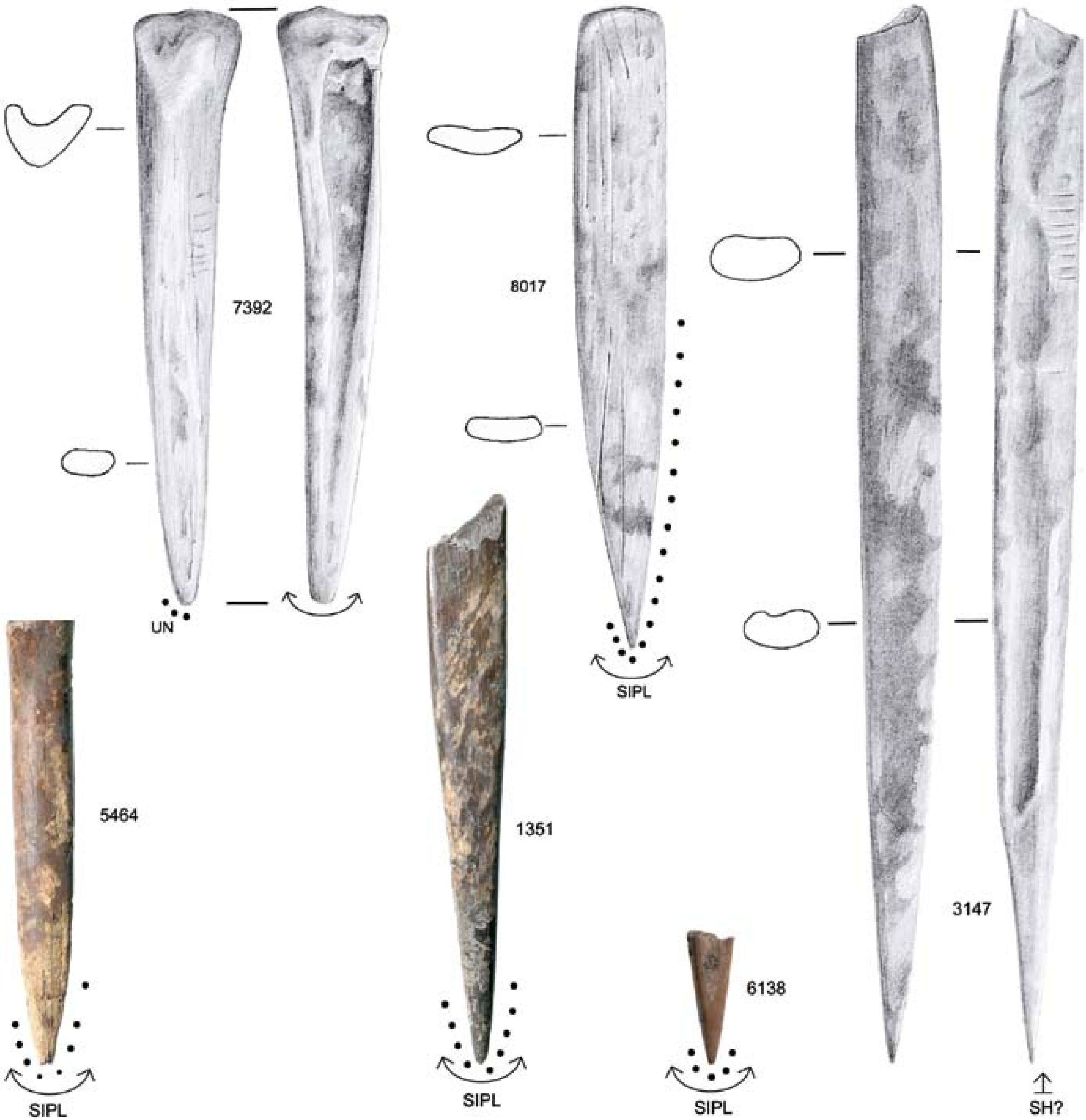


Figure 10.2 Bone awls made using the metapodial technique (scale 1:1). For legend of codes see chapter 7.

Groove-and-splinter technique (fig. 10.6)
The discovery of waste products deriving from the groove-and-splinter technique came as a surprise, because none of the other Dutch Late Mesolithic and Neolithic assemblages yielded evidence of this typically early Mesolithic technique. One cut-off antler base that was fished up from the

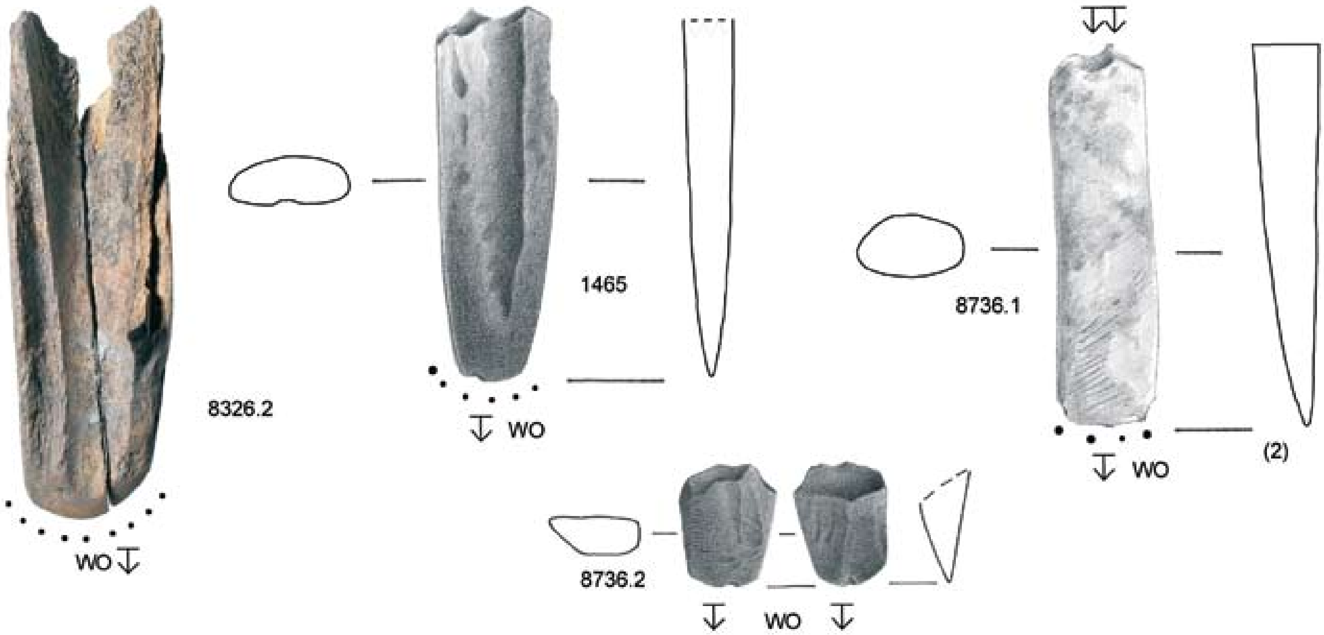


Figure 10.3 Bone chisels made using the metapodial technique (scale 1:1).

Oosterschelde and was tentatively dated to the Early Mesolithic on the basis of evidence of the use this technique is the only example known from the Netherlands (Louwe Kooijmans 1970/1971). It is therefore difficult to ascertain whether the use of this technique at Schipluiden should be interpreted as a continuation of a Mesolithic tradition or whether it should be seen as the re-invention of an old, forgotten technique. Interestingly Schipluiden yielded three classical examples of this technique.

One burr (no. 1905) of a small, shed red deer antler displays three narrow grooves, probably made with a flint implement (fig. 10.6). The rims of the cut are very straight, possibly suggesting the use of a string, but the irregular cut marks nevertheless point to the use of flint implements. Another object testifying to the use of the groove-and-splinter technique is a lower part of the beam of a red deer antler with two grooves and a perpendicular cut (no. 4590). The incision was made to the depth of the spongeous interior, after which the splinter was pried out of the shaft.

Very impressive is a long burr and beam with the bez and the ice tines removed by burning and breaking, from which a large strip was removed (no. 8038) The strip measures 22 × 4 cm. On closer inspection the strip was found to actually consist of three adjacent splinters that were removed one by one. Grooves were made along the full length of the beam until the soft spongeous interior was reached; deep cuts were made at the short ends to enable the splinters to be wedged off the antler beam. The beam is long and the antler is of very good quality, but no more objects were made on it. This would agree with the observation that antler was probably not a scarce raw material at the time of occupation.

No finished objects that could have been made on these splinters were found. It is possible that they were overlooked in the archaeozoological analysis, but it may also be that

Figure 10.4 Two beads made of bird bone showing cut marks. The beads come from the fill of grave 6 (scale 1:1, *cf.* fig. 10.2b).

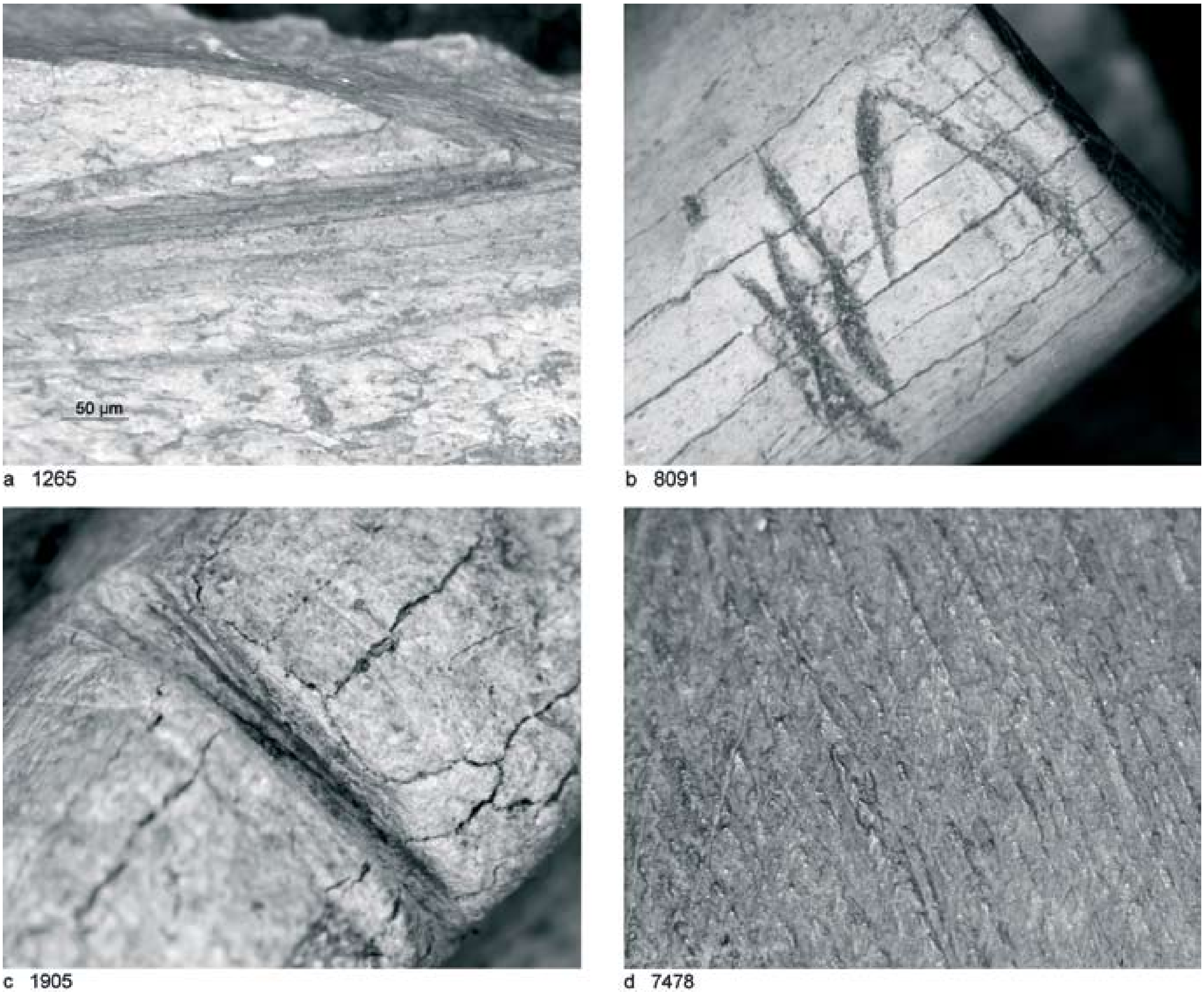
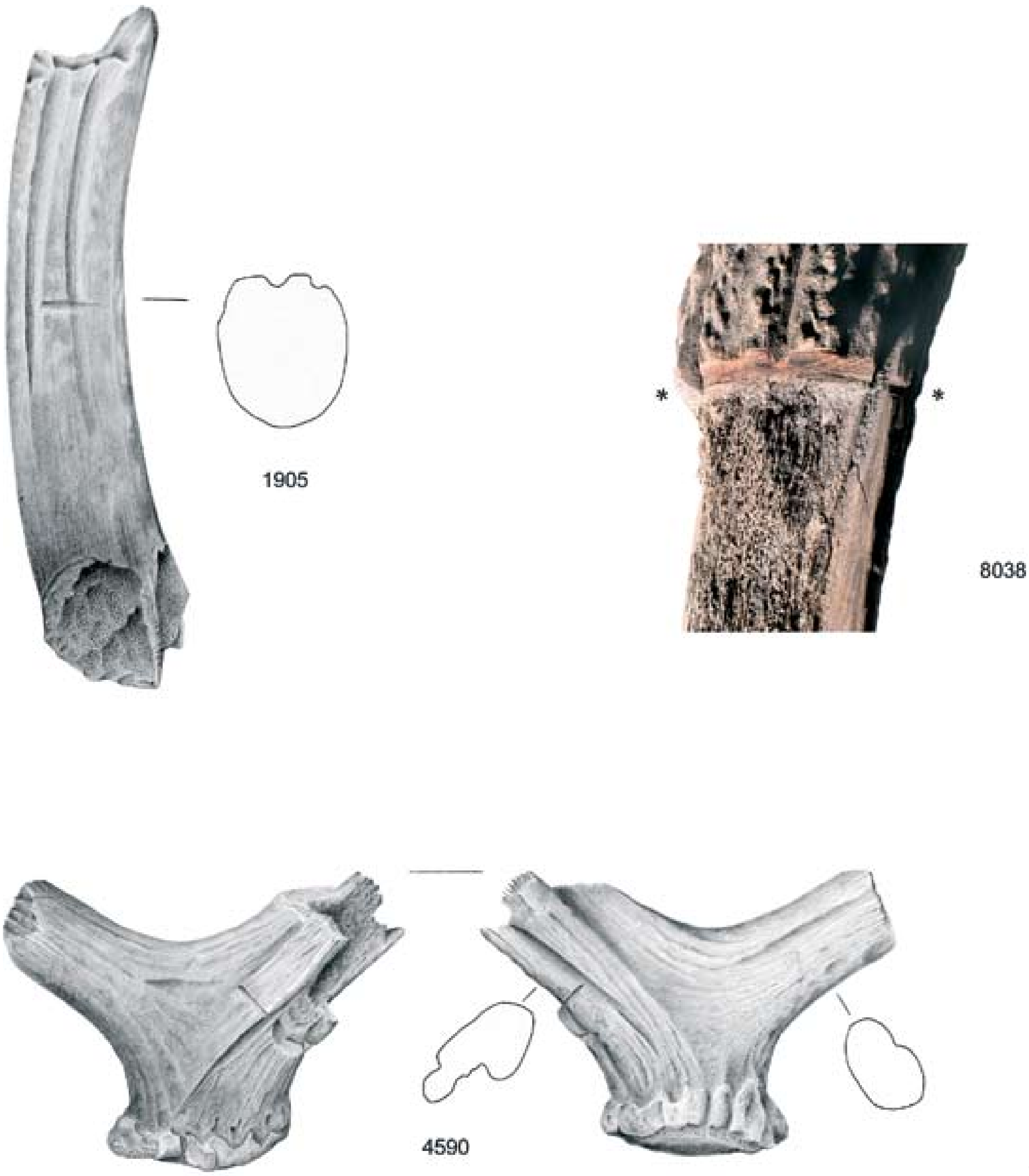


Figure 10.5 Production traces on bone and antler artefacts (stereomicroscope, magnification 7.5x)
a cut marks formed by flint on a piece of bone waste
b cut marks on a bone bead
c cut marks on a piece of waste resulting from the groove and splinter technique
d traces of grinding on a possible roughout of an axe

they were taken away from the site because they were still usable. Another disconcerting aspect of the demonstration of the groove-and-splinter technique is the absence of flint tools that could have incised or sawn antler. No use-wear traces indicative of such activities were observed in spite of the fact that such traces are very distinctive. It is possible that such tools were not selected for use-wear analysis because we do not understand which specific tool will have been used for this task (see chapter 7).

Implements made by cutting and breaking (fig. 10.7-8)
The second production technique that made use of large red deer antlers involved the division of the antler into segments for use as blanks for the manufacture of various tools.
This practice was very common in Late Mesolithic times.
At Hardinxveld-Polderweg and De Bruin tools from virtually every part of red deer antlers were found, testifying to a very intensive and economic use of this resource (Louwe Kooijmans *et al*. 2001a, fig. 11.6). A typical waste product is



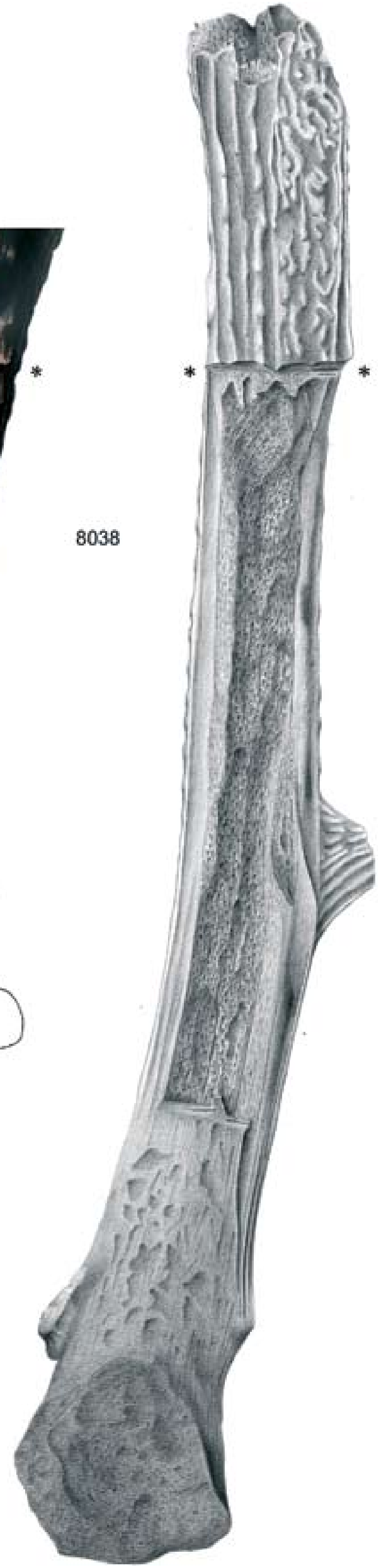


Figure 10.6 Waste products formed during the production of antler tools using the groove-and-splinter technique (scale 1:2).
1905 red deer antler beam with two parallel grooves and a perpendicular cut mark
4590 base of a shed red deer antler with three longitudinal grooves
8038 beam of red deer antler from which three splinters were removed adjacent to one another, with detail of grooves and cut marks.

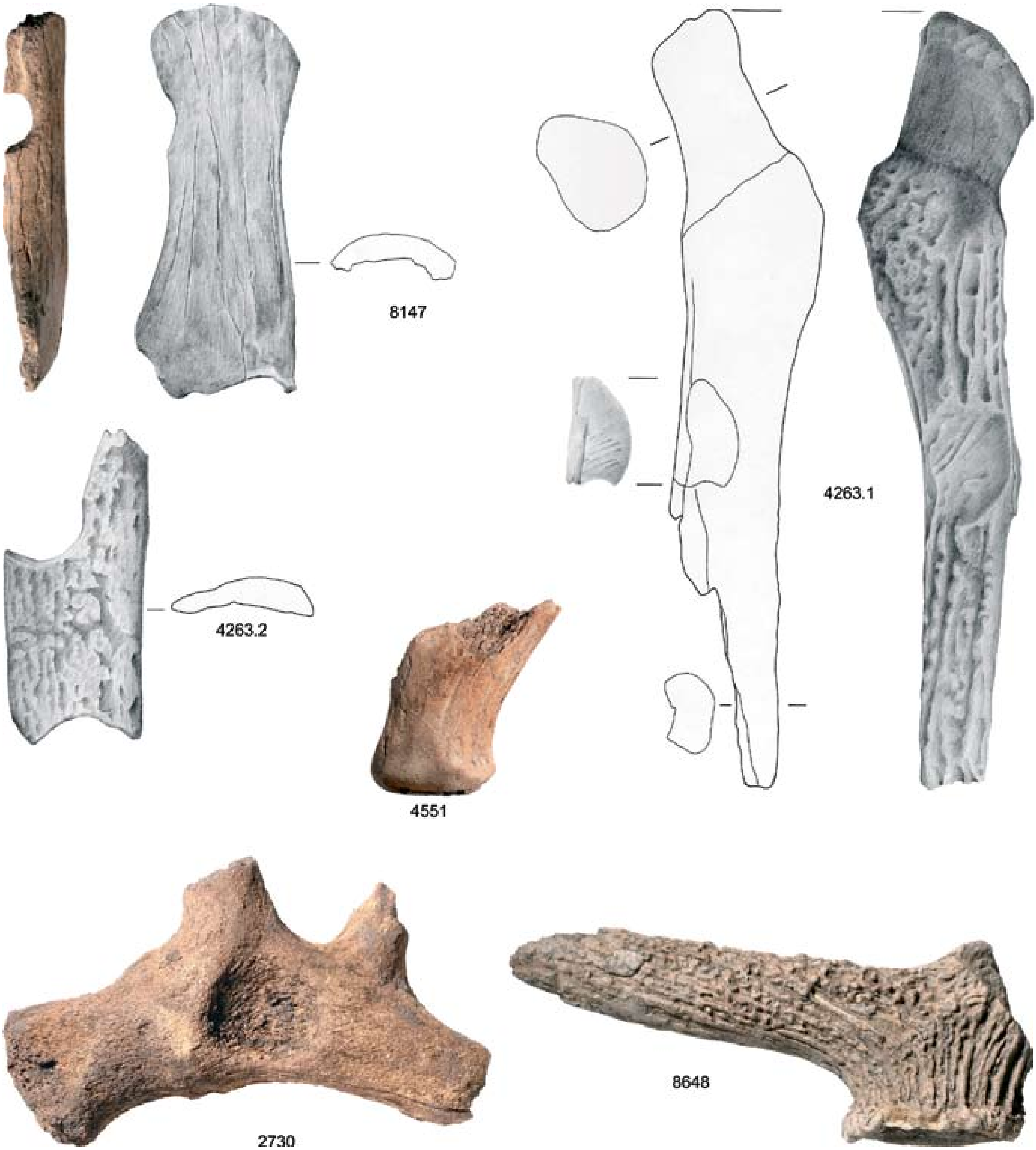


Figure 10.7 Antler tools and waste products of antler working (scale 1:2).
8147 fragment of base axe with shaft hole
4263.2 fragment of sleeve with shaft hole
4263.1 worked lower part of an antler beam with adhearing pedicel
4551 heavily worn antler base
2730 lower part of red deer antler with adhearing pedicel in which a depression was picked out
8648 base of a shed red deer antler with cut marks and signs of breaking, waste product

Figure 10.8 Bifacially worked base of an antler beam and adhering pedicle (scale 1:2) with detail (not to scale).

an antler burr bearing cut marks (no. 8648). The latter artefact may however also have served as a hammer because part of the burr was cut away. At Schipluiden only a few tool types were encountered: base axes, a sleeve, a hammer and unmodified antler tines.

One base axe (no. 4263.1) has an attached pedicle showing intensive smoothing and polishing. The edge of this piece is missing and the beam is flattened on both sides. These flattened areas were cut into shape and then further worn. They may have held a forked haft, but the leverage would have been wrong unless the tool was very long originally. The burr of this implement was completely worn away. It is not altogether clear whether this was done intentionally or whether it was due to friction with a haft.

Two other axe finds are broken fragments (4263.2 and 8147). The axes broke longitudinally, across the shaft hole. One still displays parts of the burr and is therefore probably a base axe. The other fragment is part of a beam and may bear some similarity to a T-axe fragment. Perforated T-axes are however characteristic of roughly the fifth millennium. They have been encountered in various cultural contexts of that period, *e.g*. the Ertebølle, later Lengyel and Rössen cultures, between *c*. 4700 and 4000 cal BC. In the Netherlands they have been found in Swifterbant contexts at Hardinxveld-De Bruin (Louwe Kooijmans *et al*. 2001b), at Hoge Vaart (Laarman 2001) and in the (undated) dredged-up assemblage of Spoolde (Clason 1985). They are not known from later contexts. This makes it unlikely that this particular axe fragment was actually part of a T-axe.

One last implement is a sleeve made on the beam of a red deer antler (no. 7917). It is hollow and measures 11.5 × 4.0 cm. It was poorly preserved and broken in four parts. One end displays manufacturing traces and minimal use damage, the other end is broken. Sleeves are common at Late Mesolithic sites and were found at various levels at the Hardinxveld sites, dating from 5500-4500 cal BC.

One of the most enigmatic finds of Schipluiden is also made of antler (no. 7478, fig. 10.8). It is a large beam with the burr and pedicle attached. They were both intentionally ground away to obtain two flat surfaces on the two sides of the antler, resulting in an edge suggesting that the artefact was intended to be used as an axe. However, the edge is almost square in cross-section and would have required extensive further sharpening to make it efficient. Cut marks are clearly visible along all the edges of this part of the implement. The abrasion marks formed in the grinding are also remarkably fresh and not worn away by subsequent use (fig. 10.5d). The unmodified part of the beam likewise looks remarkably fresh. In fact, the entire tool looks as though it has only just been made. It was interpreted as a semi-finished axe because the pedicle is harder than the antler itself, and will have constituted an effective edge. Artefacts with cutting edges made on the pedicle, but of a different type, are known to have been made of elk antler. In these cases the beam or shovel is perforated and the tool was probably hafted as a chisel, with the pedicle cut into a point or transverse cutting edge. Such artefacts are known from Early Mesolithic contexts onwards (Louwe Kooijmans 1971) and also from Spoolde (Clason 1985). The Schipluiden specimen is however entirely different. The freshness of the manufacturing traces, the intentional cutting of the top into a rectangular blunt edge and the fact that no tools of this type have ever before been found suggest a different function.

It is often assumed that antler tines were also used. It should however be borne in mind that tines naturally show fracturing and polish resulting from fights between the animals and rubbing against trees. It is therefore not always easy to distinguish use-wear traces with a human origin. The Schipluiden tines all seem to have been broken from the beam, as no cut marks are visible.

Other artefacts made of segments of red deer antler are difficult to classify. One base displays an incomplete large perforation (no. 2730). It is not clear whether this is an unfinished shaft hole or whether the intention was to make a small depression).The hole seems to have been at least partially made by cutting, as incision marks are visible, but it also displays signs of burning. Burning was sometimes practised as a production technique, for instance to remove the tines. Another intriguing tool is a base that was ground entirely flat to remove the burr (no. 4551). The scratches of the grinding are still visible. The rest of the artefact is broken off, so how this piece should be classified is not clear.

10.4 Tool functions

10.4.1 Bone tools

The range of activities demonstrated by use-wear analysis is rather limited, but supports the results of the functional analyses of other categories of implements and provides more insight into the technological system (table 10.2). Most of the bone tools examined are awls and chisels (table 10.3).

Plant processing

Several awls display traces formed in processing (silicious) plants, during which the tool was used in a rotating fashion (fig. 10.2). The polish is very bright and smooth, with numerous very fine, shallow scratches (figs. 10.9a, b). Remains of basketry and fabrics have been found at Schipluiden (chapter 12). They were made using a technique described as ‘looping around a core’, in which bundles of plant material were sewn together with thread. An awl is needed for this activity, to make a hole to pass the thread through. The awls found at Schipluiden may well have been used for this purpose. Phytolith analysis of two such tools

contact material \ motion	boring	chiselling	wedging	piercing	scraping	shooting	unknown	no traces	total
hide	1	–	–	–	1	–	–	–	2
wood	–	5	1	–	–	–	–	–	6
pottery	–	–	–	–	1	–	–	–	1
reed	1	–	–	–	–	–	–	–	1
silicious plants	2	–	–	1	–	–	–	–	3
soft material	–	–	–	–	–	–	2	–	2
unknown	3	–	1	–	–	1	7	–	12
indet.	–	–	–	–	–	–	3	–	3
no traces	–	–	–	–	–	–	–	20	20
Totals	*7*	*5*	*2*	*1*	*2*	*1*	*9*	*23*	*50*

Table 10.2 Use-wear results, contact material versus motion by artefact.

revealed traces of phytoliths that could not be further identified to species level, but do support the inference that these tools were used on plants, probably silicious plants. Bone awls with similar use-wear traces have been found at the Late Mesolithic sites of Hardinxveld-Polderweg and De Bruin (Louwe Kooijmans *et al.* 2001a, b) and at the Early Neolithic site of Brandwijk (Van Gijn pers. observation; Van Gijn/Verbruggen 1992).

Woodworking

Bone chisels seem to have been used for fine woodworking (fig. 10.3, table 10.2-3). Some (such as nos. 8736.1 and 8736.2) are quite small and seem to have complemented the other woodworking tools found at Schipluiden, such as the flint axes used for chopping, the stone wedge and the large quartzite flakes that were used for cutting or sawing wood (section 8.6.8). Woodworking traces are surprisingly rare on the flint tools, and seem to be largely confined to the axes and flakes of such axes (section 7.7.2). The polish on the chisels is bright and smooth and has a domed topography (figs. 10.9c, d). One broken chisel displays slightly different traces of woodworking, interpreted as resulting from the removal of bark (no. 8326). One implement, a split metacarpus of cattle (no. 3403), that could not be classified typologically, was probably used as a wedge on wood. This implement may be directly associated with the split-off tangential pieces of alder wood described in section 11.4.3. The distal part of the tool was cut into an edge, which displayed polish and striations orientated perpendicular to the edge. The edge is slightly 'bent' – something frequently observed on experimental woodworking tools. The proximal part is very rounded and polished. This end may have been covered with a piece of hide to prevent the risk of the bone fracturing upon impact. A similar tool, with a similar rounded proximal end (no. 6956), was too poorly preserved to allow any conclusion as to whether it, too, may have been used as a wedge. A large fragment of a split long bone (no. 7199, fig. 10.10) was used as a chisel on wood. The presence of a range of tools used for woodworking does support the supposition based on the large number of different types of wooden artefacts that wood was worked locally (chapter 11).

artefact type \ contact material	hide	wood	pottery	reed	silicious plants	soft material	unknown	indet.	no traces	totals
awl	1	–	–	1	3	1	6	–	6	18
axe	–	–	–	–	–	–	–	–	1	1
bead	–	–	–	–	–	–	1	–	2	3
chisel	–	4	–	–	–	–	–	–	–	4
groove-and-splinter	–	–	–	–	–	–	–	–	2	2
hammer	–	–	–	–	–	–	–	–	1	1
sleeve	–	–	–	–	–	–	–	–	1	1
indet.	–	1	–	–	–	1	4	2	4	13
waste	1	1	1	–	–	–	1	1	3	7
Totals	*2*	*6*	*1*	*1*	*3*	*2*	*12*	*3*	*20*	*50*

Table 10.3 Use-wear results, artefact type versus contact material by artefact.

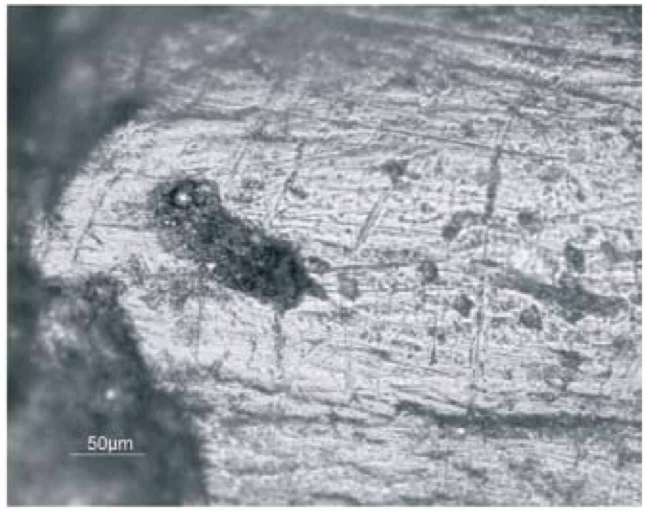
Hide working

One awl fragment displayed a rough, heavily striated polish that was interpreted as resulting from contact with hide. The scratches indicate a rotating movement, suggesting that the tool was used to pierce hides. A small piece of bone waste with a suitable edge (no. 1265, fig. 10.10c) showed the same rough, striated polish, in this case perpendicularly oriented, suggesting a scraping motion.

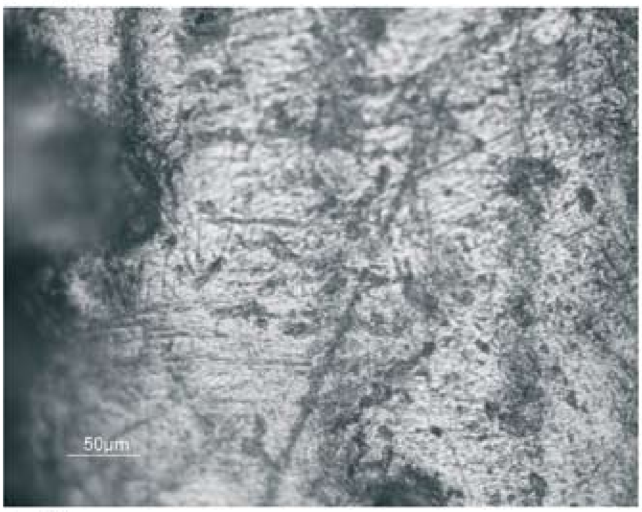
Miscellaneous

Waste was incidentally also put to use. A case in point concerns a pointed piece of split bone displaying 'use retouch', rounding and polish at the tip. The striations indicate that the tool was used as a drill, but the contact material could not be specified (no. 5488, fig. 10.10). Another regularly shaped piece of waste was probably used to scrape pottery (no. 5033, fig. 10.10). It has a very bright, rough and striated polish that does not resemble hide-working traces. A large awl (no. 3147, fig. 10.3c) displays edge removals at its tip that are assumed to be impact fractures. This implement does not show any use-wear polish or striations and may actually have been a spearhead rather than an awl. A last piece of waste was used on a soft material that could not be further identified (no. 8611).

a 1351

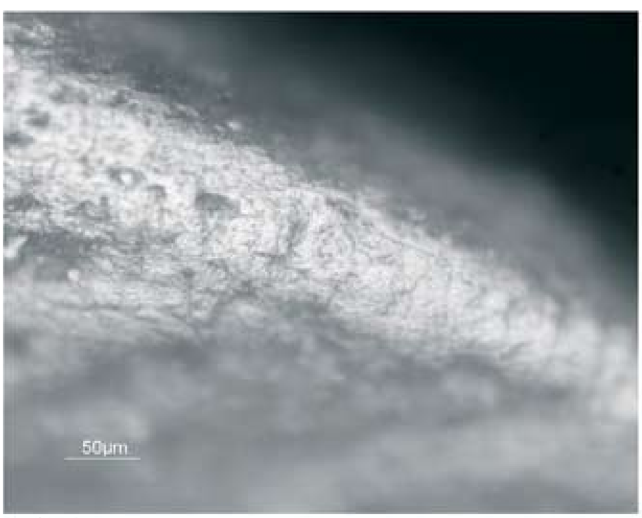


b 6138

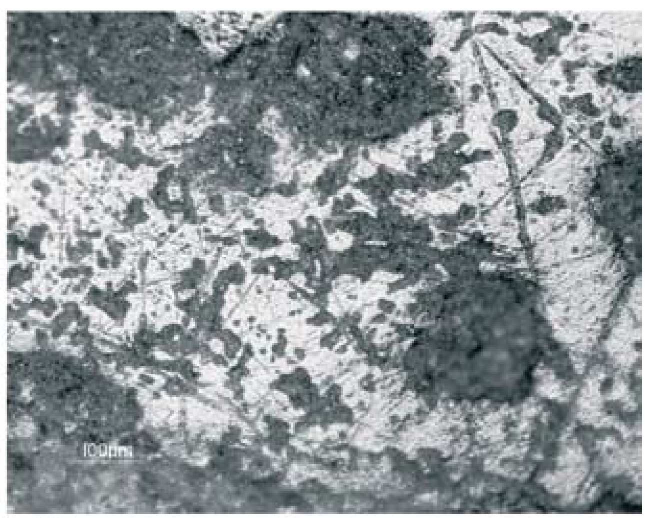


c 1465

d 8736



e 5033



f 7199

Handling or hafting traces were incidentally observed on some of the bone tools. Two awls displaying plant-processing traces for example also show extensive handling wear (nos. 1351, 5464). A possible chisel made on wood also shows handling traces (no. 7199, fig. 10.9f). A fourth tool classified as an awl (no. 3147, fig. 10.3) displays some striations on its proximal part that may be associated with hafting.

10.4.2 Antler tools

The antler tools less frequently display traces of use. One antler tine (no. 4570) that is rounded and has some worn fractures may have been used as a punch for indirect percussion during flint knapping. Some of the other antler tines however show no traces of use. Why they were removed from the main antler is not clear. The enigmatic antler axe (no. 7478) seems completely fresh. The manufacturing traces have not been worn away at all and traces of use are completely absent. This observation supports the interpretation that this object is a semi-finished axe that was possibly abandoned because its edge was not right. On the other hand, the absence of use-wear traces may also support a less functional explanation, for example for display during ceremonies. However, if the object had a symbolic value, it should display some wear – at least from handling – and this is not the case.

10.5 Diachronic differentiation

Almost 80% of the artefacts were found in the aquatic deposits along the dune's margin and could be dated to one of the occupation phases. The distribution over the phases roughly coincides with the distributions of all the other find categories, with phase 1 having a low score (table 10.4). Antler dominates the distribution in phase 2a (48%), while bone seems equally divided over the phases. It is not clear whether we should attribute meaning to this observation or whether it is a matter of chance. No obvious chronological trends are observable in the presence of different types of tools. Two of the three waste pieces deriving from the groove-and-splinter technique were dated to phase 2a, but then again the antler finds from that phase are the most frequent.

◂Figure 10.9 Use-wear traces (a-e magnification 200×, f magnification 100×)
- a, b traces interpreted as resulting from piercing and pounding siliceous plants
- c, d polish and striations probably formed in contact with wood
- e rounding and rough polish possibly formed in scraping clay
- f handling traces

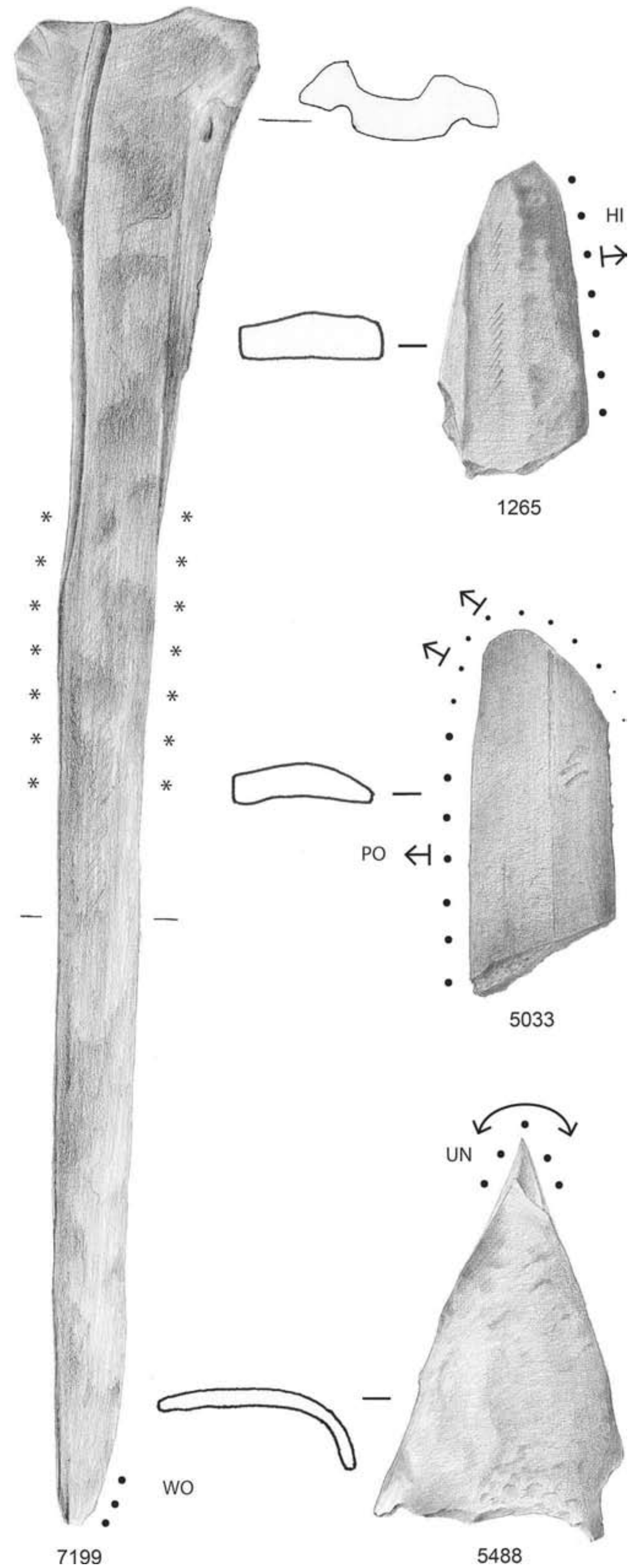


Figure 10.10 Production waste used as tools (scale 1:1). ▸

phase	1	2a	2b	3	1-3	total
awl	–	13	11	4	2	30
axe	–	–	–	–	3	3
bead	–	–	1	–	2	3
chisel	–	–	1	2	3	6
groove-and-splinter	–	2	–	–	1	3
hammer	–	1	–	–	–	1
sleeve	–	–	–	1	–	1
pointed spatula	–	–	–	–	1	1
indet.	2	7	11	5	3	28
waste	–	6	3	2	3	14
Totals	*2*	*29*	*27*	*14*	*18*	*90*

Table 10.4 Bone and antler implements, tool types per occupation phase.

10.6 Spatial distribution

The general distribution of the bone and antler artefacts corresponds to that of all the organic material: predominantly in the southeastern dump zones and to a lesser extent in the low-lying northwestern part of the dune. The awls appeared to be confined to the southern margin, whereas the antler axes were found in the north. It is not clear what this observation means. The spatial distribution of the activities demonstrated by use-wear analysis shows no patterning. There is also no spatial relationship between the pieces of bark fibre fabric and the awls (fig. 10.11).

10.7 Conclusion

10.7.1 Mesolithic roots

The bone and antler tools of Schipluiden show how strongly the Neolithic inhabitants were rooted in the old Mesolithic traditions as far as their technology is concerned. Antler and bone were still important raw materials for tool manufacture, and some of the main techniques used have their roots far back in the Mesolithic. The manufacture of awls and chisels from metapodials – mostly of red deer – clearly has its roots in the Mesolithic, but continued to be practised until the Bronze Age. At the Late Neolithic site of Hekelingen III, for example, the entire sequence of the production process based on red deer metapodials was represented, along with the employed flint tools (Van Gijn 1990). This 'metapodial industry' was also noted at the Early Neolithic sites of Hoge Vaart, Brandwijk and Swifterbant, and the Middle Neolithic site of Hazendonk (Van den Broeke 1983). The range of bone and antler tools is however quite limited in comparison with the Mesolithic range. Awls constitute the largest category, followed by chisels and antler axes. Pieces of production waste were sometimes opportunistically employed as tools. A pointed piece of broken bone displays traces formed in piercing hide. The use of such *pièces de fortune* was also observed at Hardinxveld-Polderweg and De Bruin (Louwe Kooijmans *et al.* 2001a, b), and need not at all be related to a shortage of raw materials for tool production. Rather, it points to a flexible attitude towards tool use, involving also the recycling of broken implements such as axes for other purposes.

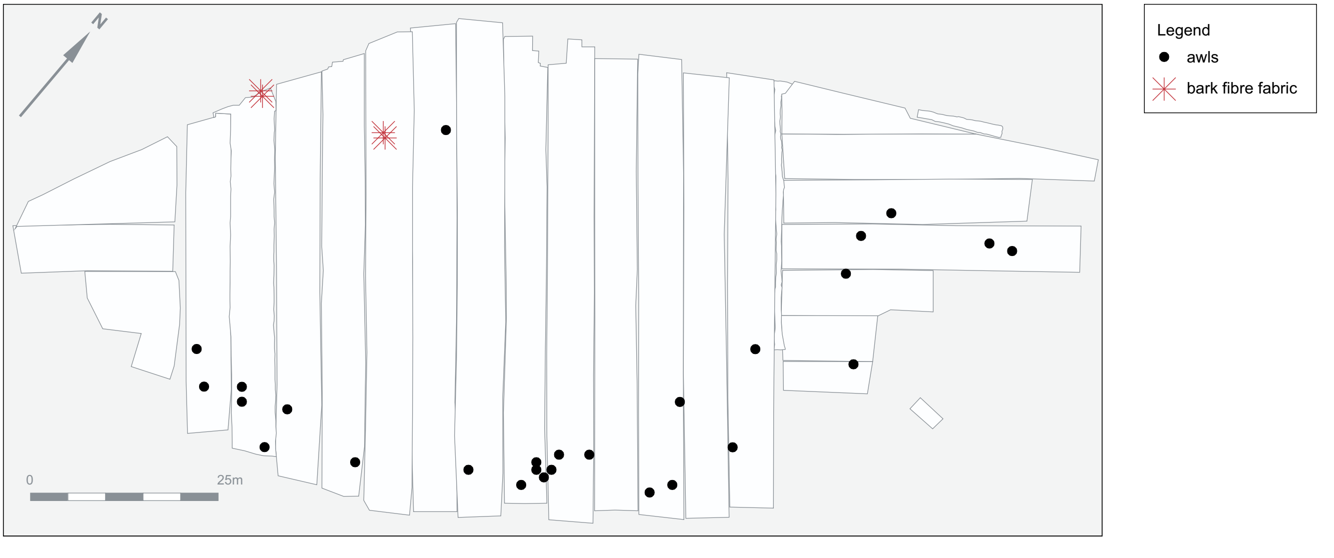


Figure 10.11 Distribution of the bone awls in relation to the pieces of bark fibre fabric.

Fragmenting red deer antlers by cutting and breaking is also a tool-making technique with roots in the Mesolithic. Numerous examples are known from the Late Mesolithic sites of Hardinxveld-Polderweg and De Bruin (Louwe Kooijmans *et al*. 2001a, b), but the evidence at Schipluiden is limited to one waste product and a small number of finished implements.

It is less clear whether the evidence for the groove-and-splinter technique should be interpreted as representing the continuation of an old Mesolithic tradition or re-invention of a formerly employed technique. The discovery of three pieces of antler showing evidence of the groove-and-splinter technique, used to obtain blanks of the compact outer tissue for the production of tools such as awls, chisels and points came as a great surprise. This technique has not been demonstrated for a Neolithic context before, and was considered to be purely Mesolithic, even Early Mesolithic. Only one example – a tool dredged from the Oosterschelde (Louwe Kooijmans 1970/1971) – is known from the Netherlands, suggesting that this was not a very common tool making technique in our region. The great chronological gap between the Early Mesolithic and the use of this technique at Schipluiden could imply that the technique was re-invented. However, we do not have a representative database and it may well be that future excavations in the wetlands will produce examples of the groove-and-splinter technique. Considering the continuity in the metapodial technique and the fragmenting of red deer antlers by cutting and breaking from the Mesolithic to the Neolithic, it is more likely that Neolithic tool makers were familiar with the groove-and-splinter technique, too. The use of hearth pits at Schipluiden is yet another example of the continued use of Mesolithic know-how. No remains of finished implements made on a splinter of antler were found at Schipluiden. Considering the small numbers involved, this does not necessarily mean that the implements were lost off-site, but the possibility of the production of hunting and fishing equipment is attractive in view of the presumed continuities.

10.7.2 Toolkits

The range of activities demonstrated by the use-wear analysis of the bone and antler tools is relatively restricted, with evidence of plant-processing and woodworking predominating. This outcome should however be viewed in relation to the small sample examined. Considering the fact that only a limited number of pieces of waste were studied, it cannot be excluded that a wider range of activities is represented in such *ad hoc* used tools.

Bone chisels, even very small ones, were used for fine woodworking, complementing the flint axes that were used to chop wood and the large quartzite flakes used as saws. We can consider this set of implements a woodworking toolkit (fig. 10.12).

The bone awls were for the most part used in a rotating movement on plants. They may have played a role in the 'looping around a core' technique for making baskets and other objects, remains of which were also found at Schipluiden (chapter 12). Together with the flint tools that were used to cut silicious plants, the awls may constitute a toolkit geared to the production of textiles, matting and

Figure 10.12 Toolkit used for fine wood working, consisting of small bone chisels and flint implements, such as the illustrated retouched blade of imported material.

basketry (fig. 10.13). There was however not a one-to-one relationship between awls and plant-processing. One awl may actually have served as a spearhead while another was used to work hide.

The use-wear analysis of the antler artefacts did not produce much information about activities that were carried out with the artefacts because the majority of the artefacts concerned were production waste and broken implements. One of the antler tines may have been used as a punch in flint knapping. Indirect percussion is a technique that is very useful for making flint axes – an activity that was most probably also carried out at the site, because some of the axes were small and made from – probably locally available – rolled pebbles (chapter 7).

The results of the analysis of the bone and antler implements and the production waste complement those of the technological and functional analyses of the other artefact categories, especially flint and stone, but also wood and vegetal fibres. Studying these various categories of material culture in an integral fashion makes it possible to reconstruct toolkits composed of different types of artefacts that were used for different specific tasks. In the case of the bone and antler tools these tasks included basket making, woodworking, hide processing, flint working and possibly hunting. This type of analysis therefore provides data that can be of help in reconstructing the daily activities carried out at a site. Those activities relate to the composition of the social group residing at the site, and also reflect the duration of the site's use. Some of the activities in which the bone and antler tools were used at Schipluiden imply a long-term stay at the site. It is moreover very likely that a complete social group was present. One enigma remains, and that is the interpretation of the freshly ground, modified large antler that has no parallel in any known assemblage. In the absence of supporting contextual or iconological arguments, we should resist the temptation to assign symbolic meanings to such an object. The series of equally enigmatic wooden artefacts of this same site reminds us that the sample of organic implements is very restricted, and that its variation and former importance can hardly be overestimated.

Acknowledgements

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Figure 10.13 Toolkit used for making fabrics and basketry – a task that involved a relatively large number of flint tools and bone awls.

Nieuwenburg-Bron made several of the experimental tools and shared her knowledge of bone and antler with me. Eric Mulder assisted in the preparation of the samples and the computer work. The photographs were made by Ben Grishaaver, AVC, Leiden University, and the drawings are by Erick van Driel.

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11 Wooden artefacts

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Several dozen wooden artefacts and large quantities of woodworking waste had survived in the settlement's wet peripheral zone. In addition, more than a hundred fence stakes had been preserved in varying conditions. These remains provide a remarkable insight into the important role of wood as a raw material in the community, and the people's technical capacities. The patterns of selection of different wood species for different purposes in this coastal environment with its limited diversity of wood show that the people were closely tied to this area. They may well have lived at this site throughout the year.

11.1 Introduction

11.1.1 Find contexts

Besides natural wood, (parts of) artefacts and pieces of wood with evidence of woodworking were unexpectedly found to have survived in the aquatic deposits bordering the former foot of the dune, some in remarkably good condition. This means that these objects became waterlogged immediately after deposition, and that this zone was consequently very boggy.

By Dutch standards, the assemblage is very abundant and varied. The remains recovered at Schipluiden almost double the number of Neolithic wooden artefacts found in the Netherlands, and enhance the range of known artefacts with a large number of new, technically advanced, but functionally puzzling shapes. This is all the more surprising because this is not a site with extreme wetland conditions. One of the main reasons why so many wooden remains were recovered here is that such a long strip of almost 180 m of former wetland margin was exposed in the excavation. Another is that the settlement was so large that the deposition of wooden artefacts intentionally or unintentionally extended into the adjacent wetland. In absolute terms, considering the duration and size of the settlement and the importance of wood as a raw material, the assemblage incidentally represents only a very small, random sample of the original quantity of wooden artefacts.

In addition to the remains associated with the settlement on the dune, another cluster of around 25 stakes with an average diameter of 7.5 cm was found in trench 22, at a higher level, in Units 1 and 2. These stakes have been dated to 'phase 4', a good 1000 years later than the settlement, 2300-2050 cal BC.

11.1.2 Research problem

We usually have only direct evidence telling us something about the role of wood in prehistoric societies: postholes indicative of house construction, arrowheads implying the use of bows and arrows, axe blades that of axes, and hearths that of firewood. That wood was an exceptionally important raw material is not under discussion, but we need the wood itself for further specification. Actual wooden remains provide insight into the range of artefacts employed, and that brings us directly to the problem of functional interpretation. It is often virtually impossible to identify synchronic or diachronic stylistic relations in this category of artefacts due to a lack of references. Wooden remains do however provide a good impression of the technical skills that could be achieved with a flint toolkit, and of technical craftsmanship in general. It is interesting to compare tools with use-wear traces with the tool marks observable on the surviving wood!

Another question concerns the purpose and necessity of working wood at the site. Important factors in this context are the selection of specific types of wood for specific purposes, and how this related to the availability of species in the site's immediate surroundings, and in the wider territory as a whole. Unexpected arguments pop up in the discussion of mobility and external contacts versus a stationary way of life of a community with strong ties with its occupation area.

11.2 Methods

All pieces of wood encountered in the trowelling of the find layers were in the field inspected for evidence of woodworking. In principle, everything that did not appear to be a branch covered with bark was collected and recorded. In addition, a random sample of unworked wood was collected for the reconstruction of the former vegetation (chapter 21). This means that no significance can be derived from the ratio of worked and unworked wood.

On conclusion of the fieldwork the two authors assessed and classified all the collected wood. The second author described all the objects according to the standard procedure employed for this purpose in the Netherlands. This means that the remains were measured, the part of the tree employed (trunk, branch) was determined and the position of the artefact in it, tool marks were described and the shapes of the points of stakes were coded. Wood species were identified with the aid of a transmitted-light microscope with enlargements up to 400x and the identification keys formulated by Schweingruber (1982).

The first author made actual-size drawings of all the artefacts, characteristic pieces of woodworking waste and stakes with sharpened ends. Most of the artefacts were professionally photographed in wet condition – before conservation. A large selection of the artefacts and characteristic objects was conserved by Archeoplan in Delft.

11.3 Remains and context

11.3.1 Remains, selection

In total, around 700 pieces of wood were collected. It is not really possible to make a clear-cut distinction between 'used' and 'natural' wood. More than half of the collected pieces showed evidence of burning, chopping and/or carving and there was a small quantity of split wood. Considering the former landscape and the intensive use of the dune as a settlement site, a large proportion of the 'natural wood' may well have been imported by the occupants, for example for use as firewood. With due respect for such considerations, the following were interpreted as artefacts:

- deliberately shaped utilitarian objects
- all stakes of the fences
- pieces of wood showing more than incidental tool marks
- indisputable woodworking waste.

On the basis of these criteria 209 pieces of wood were ultimately classed as artefacts, 24 of which came from the concentration of stakes in Unit 1.

11.3.2 Classification (table 11.1)

The selected remains were classified as follows:

1 *Implements/tools*. This group comprises first of all a number of functionally readily identifiable artefacts of the kinds already known – if in varying designs – from other Mesolithic and Neolithic sites in the Netherlands: a bow, paddles, axe hafts. Then there is a general group of 'sticks with carefully sharpened ends', which are assumed to represent javelins or spears. The third group is a fairly large collection of puzzling 'miscellaneous artefacts' – unique objects, mostly shaped with great care, for which no parallels are known. Some would seem to have formed part of larger, composite artefacts, but for the time being they can at best only be functionally interpreted with reservation (section 11.4.1-2).

2 *Waste*. The second group comprises different forms of waste formed in woodworking. Besides chips and split wood this group includes three remarkable 'tangential rectangles'. A few branches showing evidence of cutting and/or chopping of varying intensity may also be regarded as woodworking waste or semi-finished products (section 11.4.3).

3 *Wattle*. The third group consists of osiers showing evidence of deformation suggesting that they formed part of wattlework (section 11.4.4).

4 *Post and stake ends*. A last and large group comprises all the posts and stakes found at the site. Most have sharpened ends and formed part of one of the fences that stood at the foot of the dune; a few were recovered from other contexts in other parts of the site. The fence posts did not all show clear evidence of woodworking – some may never have shown such evidence in the first place, in other cases the wood had decayed too much for any evidence to have survived (section 11.4.5).

implements/tools		
bows	1	
paddles	2	
(axe) hafts	8	
functionally not interpretable	10	
pointed sticks	11	
pole	1	
subtotal		*33*
worked objects		
chopped round wood, branches	12	
osier, wattle	9	
subtotal		*21*
waste pieces		
tangentially split-off rectangles	3	
chips	4	
split wood, tangential	9	
split wood, radial	3	
subtotal		*19*
pointed posts		
of fences	104	
other	8	
total		*112*
Totals		*185*
post cluster Unit 1	24	
Totals		*209*

Table 11.1 Wooden artefacts, classification.

11.3.3 *Phasing* (table 11.2)

The great majority of the remains can be dated to phase 2a. They come from Units 18/17 on the southeastern and northeastern sides of the dune, and from the fills of the wells on the northwestern side.

A few artefacts were recovered from the clay of Unit 19S; that means that they date from phase 1: the end of an axe haft and a small 'ball'. Some of the artefacts recovered from the well fills in the northwest could however also date from phase 1.

Only one artefact dates from phase 3: a small part of an axe haft (no. 7826, Unit 11, trench 13).

The differences in the chronological distribution of the remains according to the distinguished phases are largely attributable to differences in the intensity of occupation and the favourable embedding conditions in phase 2a.

11.3.4 *Spatial distribution* (FIG. 11.1)

THE WOODEN ARTEFACTS FROM PHASE 2A SHOW A REMARKABLE SPATIAL PATTERN, WITH LARGE AREAS DEVOID OF REMAINS AND FOUR CLUSTERS COMPRISING 5-10 UNUSUAL ARTEFACTS AND WORKED PIECES OF WOOD. THESE CONCENTRATIONS ARE DEFINITELY NOT ATTRIBUTABLE TO ANY SELECTIVE ATTENTION TO WOOD DURING THE EXCAVATION, BUT REPRESENT A PRIMARY DEPOSITION PATTERN. FEW REMAINS CAME TO light along the southeastern edge of the dune, but trenches 19-20 did reveal a cluster (Ø 8 m) of seven unusual artefacts. Besides some remains of wattlework, a few pieces of roundwood and woodworking waste in trenches 28-29, no wood was found in the northern part of the site. Pieces of split wood and roundwood were found all over the area of the wells in the northwest, with a remarkable cluster of artefacts in trenches 16-17 and a somewhat less conspicuous group in trenches 12-13.

If we assume that the same preservation conditions prevailed in phase 2a along the entire southeastern side of the dune and at the foot of the northwestern slope, it would seem that the deposition of wooden artefacts was in that phase restricted to a small number of areas, and hence probably also to specific moments within this occupation phase. The distribution of split wood and worked pieces of roundwood seems to suggest a similar, though slightly less distinct, pattern for the woodworking activities. Large quantities of waste were discarded along the entire southeastern edge, from trench 3 to trench 18, *i.e.* over a stretch of 80 m. A lot of unworked, natural wood was collected here, too, but hardly any implements. Apparently different kinds of waste were deposited in different ways, and wooden objects were on the whole not deposited in the

phase	1	1-2a	2a	2b	3	1-3	totals	fences
Alnus	–	11	7	–	–	1	19	19
Cornus	–	–	–	–	–	–	–	–
Corylus avellana	–	2	2	–	–	–	4	–
Euonymus europaeus	–	5	–	–	–	–	5	1
Fraxinus excelsior	–	3	1	–	–	–	4	–
Juniperus communis	–	–	4	–	–	–	4	23
Lonicera	–	–	1	–	–	–	1	–
Pomoideae	2	9	4	–	–	–	15	4
Prunus	–	5	6	–	–	–	11	42
Rhamnus cathartica	–	1	–	–	–	–	1	–
Salix	–	3	2	–	1	–	6	2
Taxus baccata	1	–	–	–	–	–	1	–
Viburnum opulus	–	2	–	–	–	–	2	–
bark	–	–	–	–	–	–	–	–
indet.	–	–	–	–	–	–	–	13
trunk	–	12	3	–	–	1	16	–
trunk/branch	1	5	4	–	–	–	10	67
branch	2	21	18	–	1	–	42	34
twig	–	–	–	–	–	–	–	–
root	–	–	1	–	–	–	1	–
gnarl	–	–	–	–	–	–	–	–
indet.	–	3	1	–	–	–	4	3
Totals	*3*	*41*	*27*	–	*1*	*1*	*73*	*104*

Table 11.2 Wooden artefacts, identifications of wood species per phase.

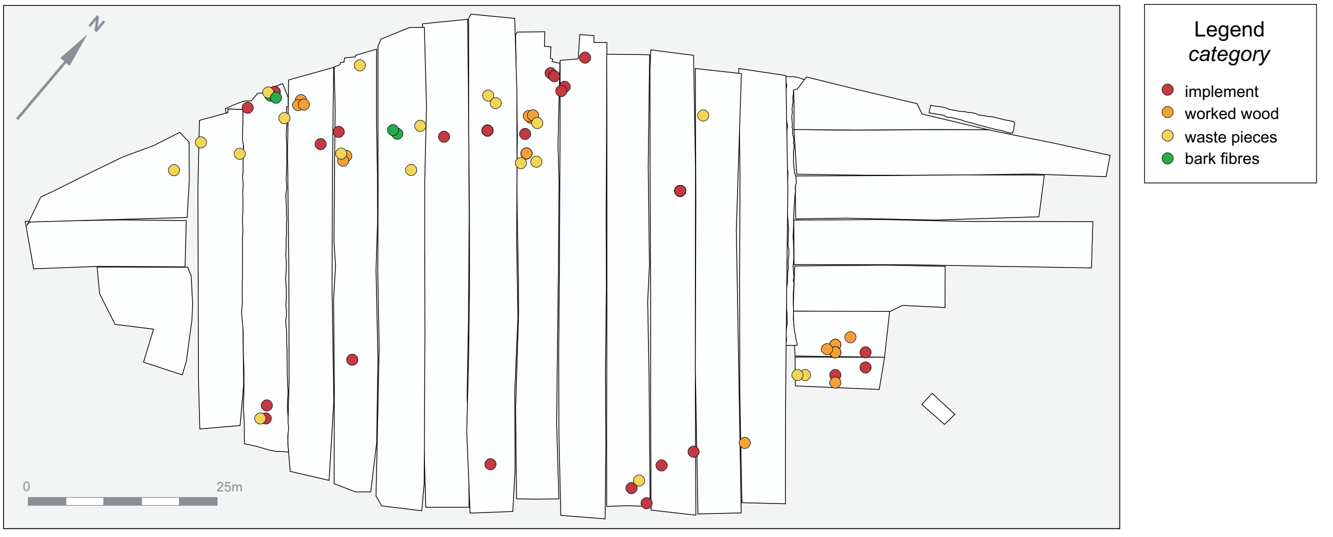


Figure 11.1 Findspots of wooden and bark fibre artefacts per main category.

general waste zone at the edge of the bog bordering the foot of the dune. This need not necessarily have any symbolic significance. It could simply reflect some 'ordinary' difference between (domestic) waste formed in women's work and waste formed in the men's activities (woodworking).

11.4 The artefacts

11.4.1 Functionally identifiable artefacts

Bow (fig. 11.2)

A 23-cm-long end of a bow made from a juniper (*Juniperus communis*) branch. The bark was stripped from the branch and the branch was given flat edges on the side where the string was attached. The bow has a maximum width of 2.1 cm and a thickness of 1.8 cm. A 2-mm-deep shallow notch was made for the string at 1.5 cm from the end.

The bow is of a different shape than the heavy, man-size bows of the Mullerup type with their broad curved parts and narrowed grips (Brøndsted 1957), parts of which were found at the two Hardinxveld sites (Louwe Kooijmans *et al.* 2001a & b) and the Hazendonk site (unpublished). A variant with a narrow curved part was found at Hekelingen (Vlaardingen group, Louwe Kooijmans 1985). In the Mesolithic and Neolithic use was also made of a lighter bow with a round or D-shaped cross-section, examples of which are known from Tybrind Vig and Ringskloster (Denmark, late Ertebølle, Andersen 1994/1995). In the Netherlands a complete Late Neolithic example of such a bow was recovered from peat at Noordwijkerhout (Clark 1963). The different types of bow will have been used side by side for hunting different kinds of animals, the heaviest for killing large game and the lighter ones possibly for fowling.

In the Mesolithic, bows were always made from elm (*Ulmus*), the best kind of wood available at the time. In the course of the Neolithic people started using yew (*Taxus baccata*), whose long fibres and elasticity make it ideal for use in bows. The bow that was found at Hekelingen (Vlaardingen group) was for example made of yew. The use of juniper at Schipluiden is exceptional. Juniper is also a long-grained wood, but it is not as resilient as yew. Apparently neither yew nor elm was locally available, and no efforts were made to obtain wood of these species from sources elsewhere. A branch of a local juniper was a satisfactory second-best option for this light bow.

Paddles (fig. 11.3)

Paddle 1 (no. 4270) is complete except for the top part of the handle. The surviving part is 94.5 cm long. The blade is pointed-oval in shape and highly asymmetrical in cross-section, with one convex and one slightly concave side. Its maximum dimensions are 44 × 10.5 × 1.9 cm. There is a marked constriction between the blade and the handle, which gradually decreases in width to 3.2 cm at the top. The handle shows a slight thickening 5 cm beneath the missing end, which may mark the beginning of the grip. The paddle's original length can no longer be determined. The entire paddle has a carefully finished, smooth surface, devoid of tool marks. The paddle was made from a tangential piece of split wood from the outer part of the trunk of an ash (*Fraxinus excelsior*) that was at least 12 cm thick.

Paddle 2 (no. 10,199) is almost complete, except for the tip of the blade. The surviving part is 94.3 cm long, the original length will have been about 104 cm. The maximum

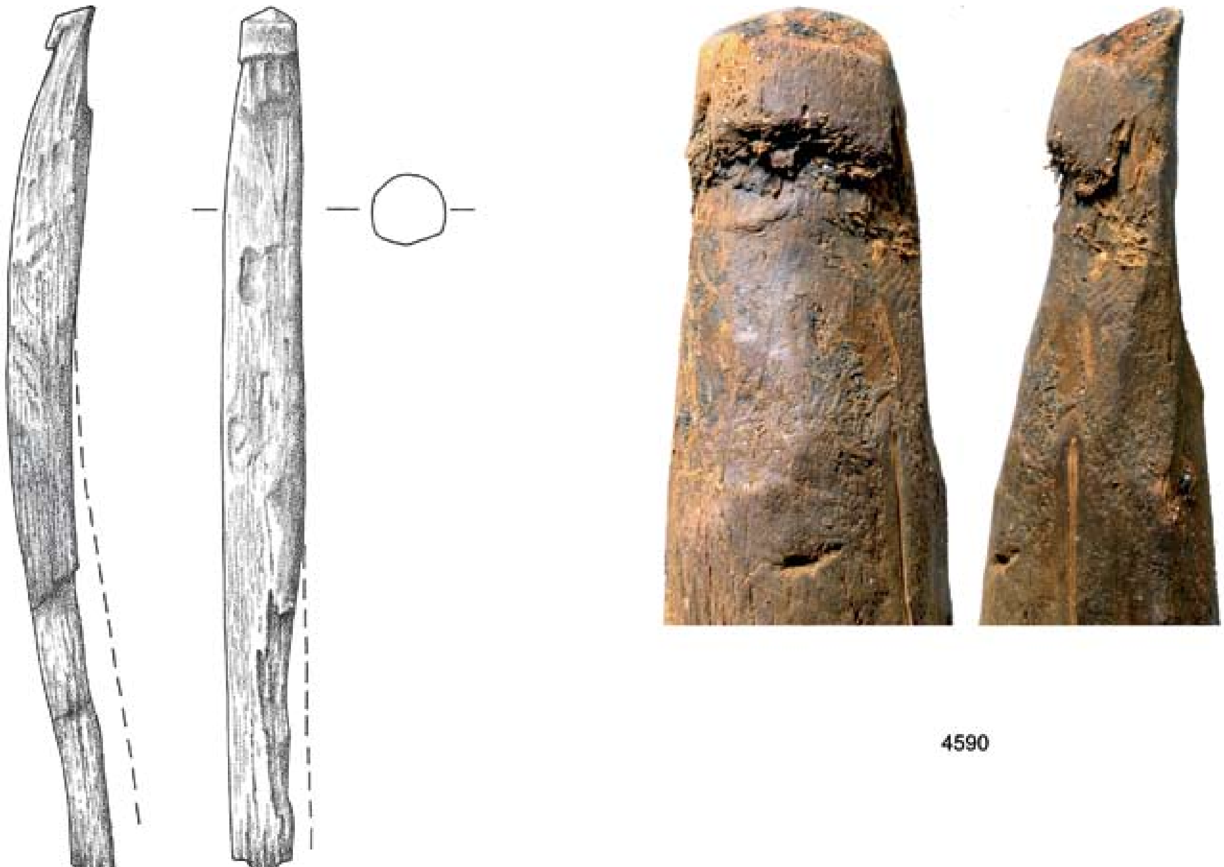


Figure 11.2 Bow fragment, *Juniperus communis* (scale 1:2, detail 2× natural size).

width of the long, narrow blade is 5.9 cm; the blade has an asymmetrical cross-section. There is a very gradual transition between the blade and the heavy handle, which gradually decreases in thickness to 3.0 cm at the top. At the top, the paddle has a broadened, carefully carved, U-shaped end, which will have afforded a good grip for the hand and thumb. The entire paddle has a carefully finished, smooth surface. The paddle was made from the halved trunk of an ash, which likewise had a diameter of at least 12 cm.

Aspects that the two paddles have in common is that they were both made from a thick branch or the trunk of an ash, they are both fairly heavy, but nevertheless elegant in design and they were both carefully finished. They differ from one another in particular in the shape and dimensions of the blade. They may well have differed very little in length originally.

Paddles from the Dutch Mesolithic and Neolithic vary considerably in shape (fig. 11.4). There seems to have been a development from long, narrow blades with pointed ends of the kind known from the late Mesolithic Hardinxveld (*c*. 5400 BC) to shorter, broader blades, also with pointed ends, as found at Swifterbant (4100 BC), followed by the heavier, subrectangular blades of the Vlaardingen group (Louwe Kooijmans *et al*. 2001a, 410-411). The two Schipluiden paddles date from between those of Swifterbant and the Vlaardingen group, but are in typological terms entirely in line with the older tradition. Paddle 1 is only a little shorter and broader than that of Swifterbant, which it otherwise closely resembles. With its long, slender shape and the gradual transition from blade to handle, paddle 2 comes closest to the almost 2000 years older Hardinxveld paddle. Even when we allow for differences in preservation, the Schipluiden paddles stand out from the others for the careful way in which they were finished and their sophisticated design, especially of the blade of paddle 1. The Hekelingen paddle however also has one flat and one convex side.

Paddles were in the Mesolithic and Neolithic almost always made from ash, as is indeed still the case today. Typical of ash wood are the long fibres, which make it resilient to substantial bending forces. This property makes it particularly suitable for paddles and oars, but also for axe handles. So the fact that ash wood was used to make these

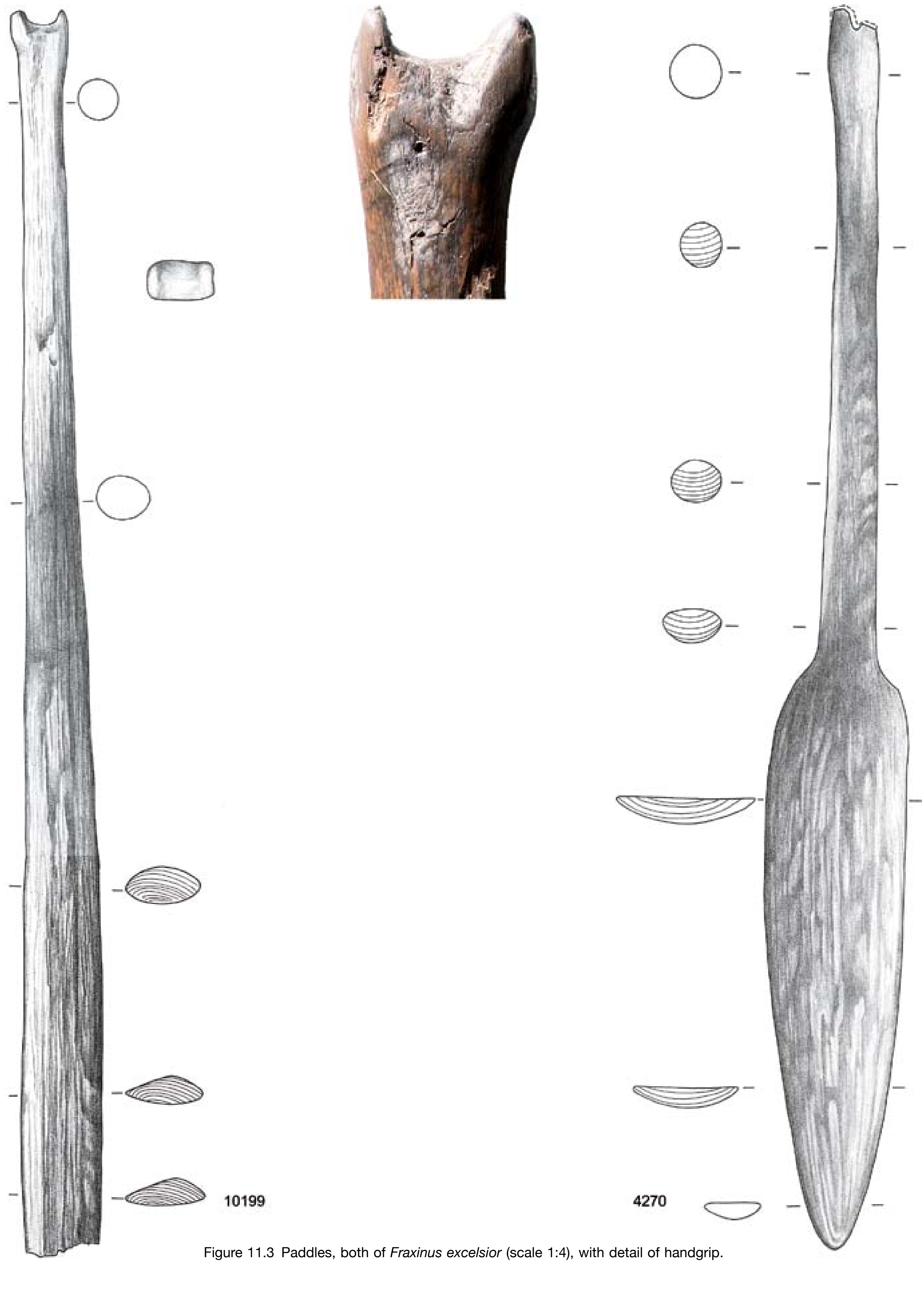


Figure 11.3 Paddles, both of *Fraxinus excelsior* (scale 1:4), with detail of handgrip.

paddles is not surprising *per se*. There are however strong arguments suggesting that there were no ash trees in the site's immediate surroundings: not one axe haft is made of ash wood, and apart from three large objects with a distinct shape and one large piece of split wood only two small pieces of ash wood were found at the site. This means that the wood must have been imported from a source outside the territory; the paddles may even have been carved elsewhere. The nearest possible sources of ash wood were riverine forests in the tidal rivers area or at the periphery of the southern sandy areas, both of which lay more than 30 km from the site, or possibly a large river dune like that of Hillegersberg, which lay less than 10 km away as the crow flies.

Axe hafts (figs. 11.5-6, table 11.3)
In total, eight parts of (axe) hafts were identified, six of which date from phase 2a and one each from phases 1 and 3. All remains are parts of the end that was held in the hand; no remains of the ends that held the axe blade or any transition to that end were identified. In two cases the end of the haft was fairly coarsely chopped on two sides, in three cases it was finished to a round-oval cross-section by careful carving allround and in two, or probably three, cases it had been broadened towards the base. The (axe) hafts were made from branches with cross-sections of 4-5 cm, from which the bark was stripped. The branch was then carved to an oval cross-section with a diameter varying from 2.3 × 3.5 to 4.0 × 4.5 cm. The employed wood species are spindle (*Euonymus europaeus*), hazel (*Corylus avellana*), alder (*Alnus*), willow (*Salix*) and apple or hawthorn (Pomoideae, 4×). The surviving lengths vary from just over 40 cm (3×) to 16 - 8 cm (5×). Of the employed wood species, alder and willow can be qualified as definitely unsuitable, the others as a good second-best after ash and maple (*Acer*).

Oval cross-sections and carefully shaped broadened ends are also known from axe hafts from Denmark – the well-known hafted axe from Sigerslev Mose for example (*e.g.* Andersen 1981, 49) – and from *e.g.* Egolzwil, Burgäschisee and Twann in Switzerland (resp. Wyss 1969, 1983; Müller-Beck

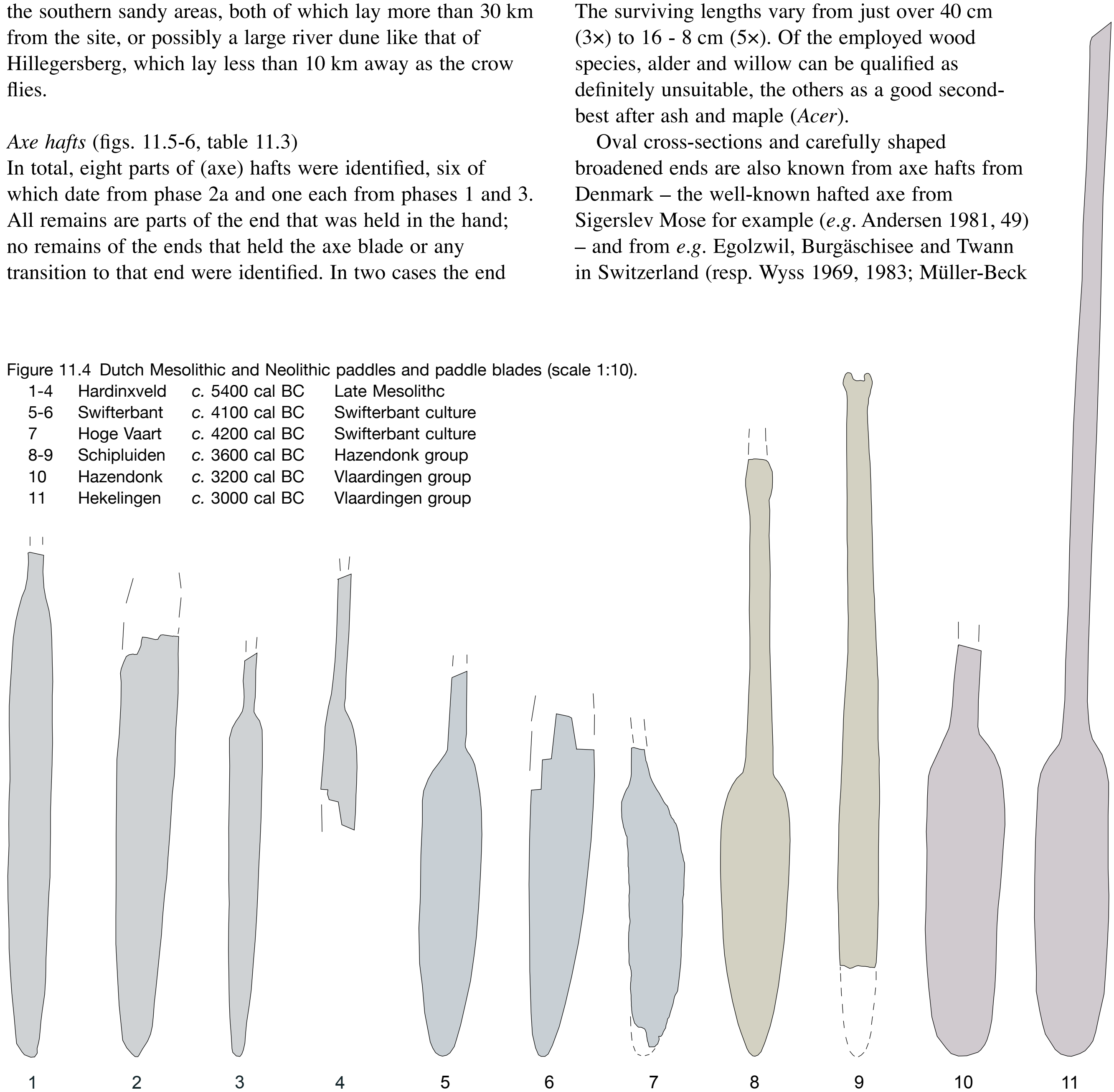


Figure 11.4 Dutch Mesolithic and Neolithic paddles and paddle blades (scale 1:10).

1-4	Hardinxveld	*c.* 5400 cal BC	Late Mesolithc
5-6	Swifterbant	*c.* 4100 cal BC	Swifterbant culture
7	Hoge Vaart	*c.* 4200 cal BC	Swifterbant culture
8-9	Schipluiden	*c.* 3600 cal BC	Hazendonk group
10	Hazendonk	*c.* 3200 cal BC	Vlaardingen group
11	Hekelingen	*c.* 3000 cal BC	Vlaardingen group

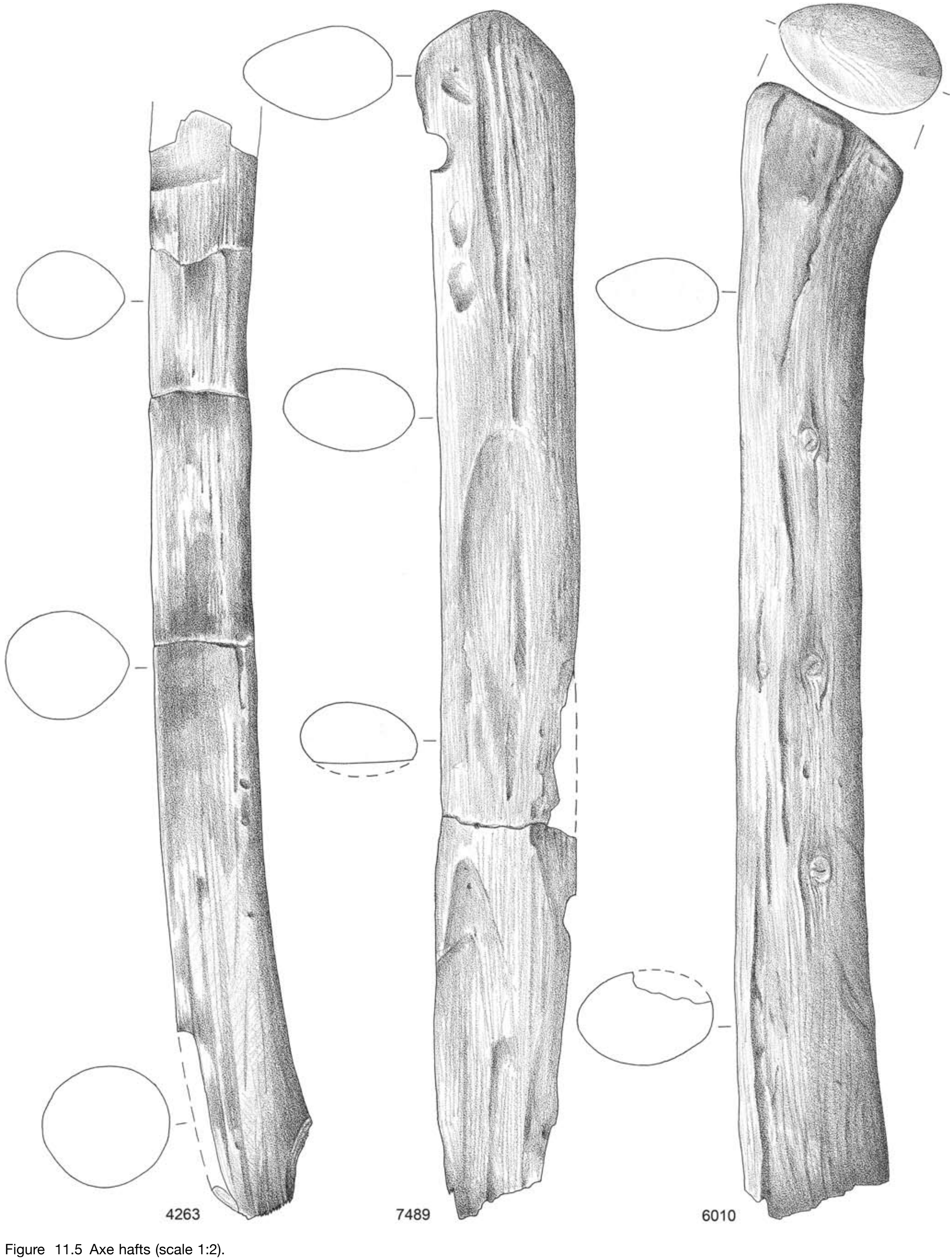


Figure 11.5 Axe hafts (scale 1:2).

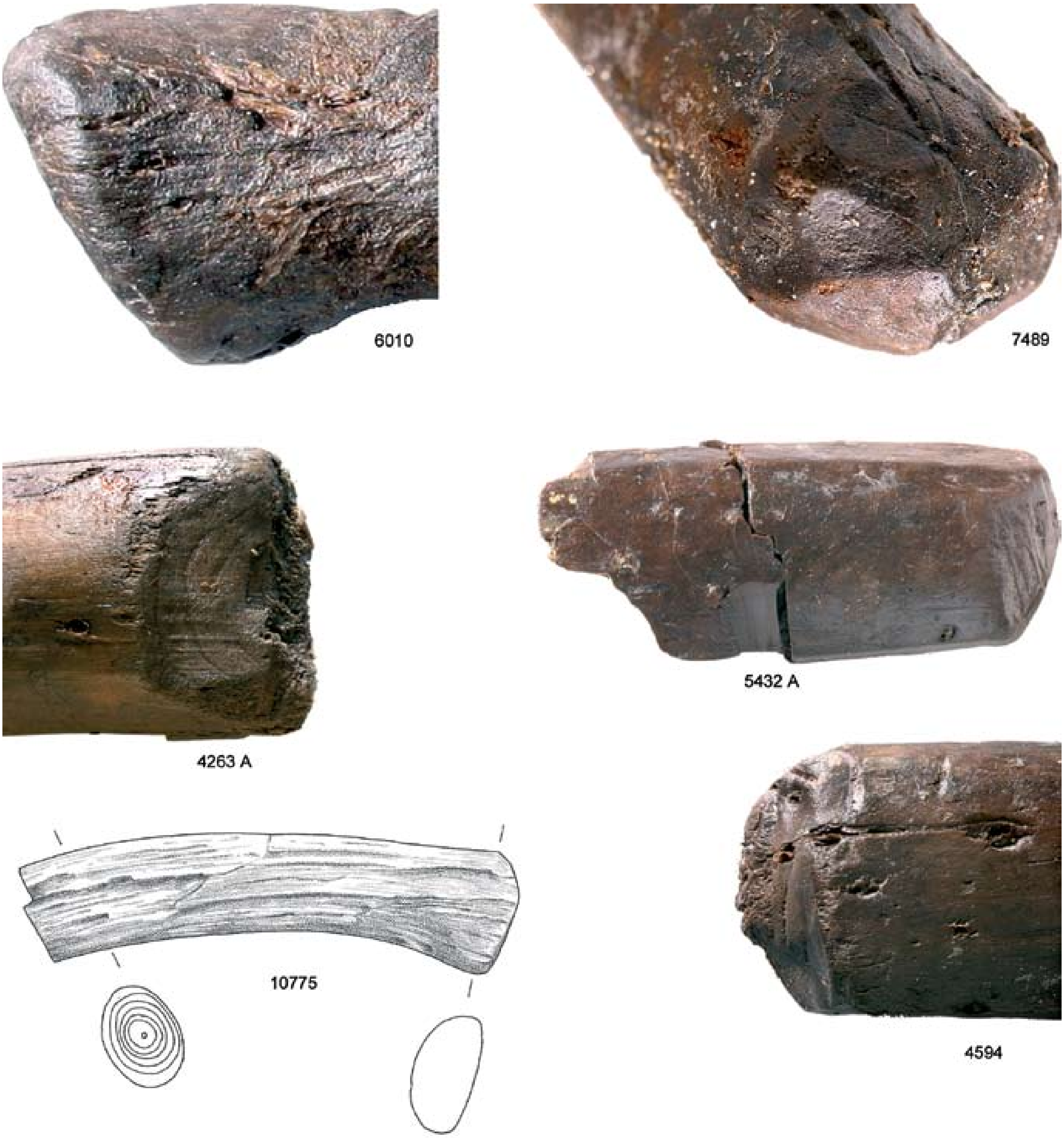


Figure 11.6 Small axe haft (scale 1:2) and details of haft ends (scale 1:1).

no.	phase	surviving length (cm)	cross-section w × h (cm)	wood species	shape of end
4263 A	2a	41,0	4.0 × 4.5	Euonymus europaeus	two-sided
4594	2a	13,5	3.7 × 5.0	Pomoideae	two-sided
5432	1	8,0	2.3 × 3.5	Pomoideae	round
6010	2a	42,0	2.9 × 4.5	Pomoideae	broadened
7489	2a	44,5	3.0 × 4.3	Corylus avellana	round
7826	3	10,0	2.8 × 4.0	Salix	round
10,775	2a	16,0	2.5 × 3.5	Pomoideae	broadened
10,778	2a	12,0	3.5 × 3.5	Alnus	broadened?

Table 11.3 Axe hafts.

1965; Wesselkamp 1980), all of which date roughly from around the middle of the 4th millennium, which means that they are contemporary with those found at Schipluiden. Such a design promotes a good grip of the axe; it is still used for hafts today.

Remarkably, not one of the hafts is made of ash, the species usually selected for this purpose. Moreover, the hafts are not made of wood from a trunk, but randomly of wood from branches of various species. This implies that the hafts were locally produced. Their makers presumably made the most of the available wood, and did not go to any effort to obtain ash wood via external contacts or expeditions. In this respect the hafts contrast markedly with the paddles. Another conspicuous aspect of the hafts is that the majority were made from a branch with a slightly thicker cross-section instead of from a trunk of the same species, which would have been much sturdier.

Straight sticks (fig. 11.7, table 11.4)
Eleven ends of straight sticks with a round or oval cross-section have a long, slender point (4×), a rounded (4×) or a chopped (3×) end. They vary in diameter from 1.5 to 3 cm and have surviving lengths of 5.5-35.5 cm. The bark was stripped from the branches. Tool marks consist of long, parallel facets. The employed species are *Prunus (3×),* purging buckthorn *(Rhamnus cathartica*), spindle (*Euonymus europaeus, 2×*), hazel (*Corylus avellana, 2×),* juniper *(Juniperus communis*), honeysuckle *(Lonicera)* and Pomoideae. Like the axe hafts, the artefacts of this category betray random use of the locally available wood.

All the sticks date from phase 2a. They were recovered from the various find areas surrounding the dune.

Sticks with sharpened ends, 'spears' or 'javelins', rank among the less conspicuous artefacts. They have been found in many Late Mesolithic assemblages in Denmark and were also encountered in different sizes at the two Hardinxveld sites and at Bergschenhoek (Louwe Kooijmans 1986; id. *et al.* 2001a, b) . There is however no mention of any such finds in the reports of the excavations of Swifterbant S3 and the Vlaardingen sites in the delta area.

We interpret the sticks with sharpened ends as unreinforced (= without a flint point) spears or javelins. They are too heavy for arrow shafts, and their ends are unsuitable for arrows, too. Spears of this type may well have been quite suitable for use in fishing.

no.	phase	surviving length (cm)	cross-section w × h (cm)	wood species	shape of end
4263B	2a	7.5	1.5	Rhamnus cathartica	pointed
4263E	2a	35.5	2.2	Prunus	pointed
4590C1	2a	16.0	1.7	Corylus avellana	pointed
4590C2	2a	9.0	1.7	Pomoideae	rounded
4593	2a	13.0	1.5 × 3.0	Prunus	rounded
7814	2a	9.0	2.2 × 1.4	Juniperus communis	rounded
10,409	2a	17.5	0.8 × 1.3	Lonicera	chopped
10,456	2a	9.5	2.6	Prunus	rounded
10,707	1-2a	45.5	2.2	Euonymus europaeus	chopped
10,709	1-2a	20.5	1.9	Corylus avellana	chopped
10.779A	1-2a	5.5	1.5	Euonymus europaeus	pointed

Table 11.4 Straight sticks.

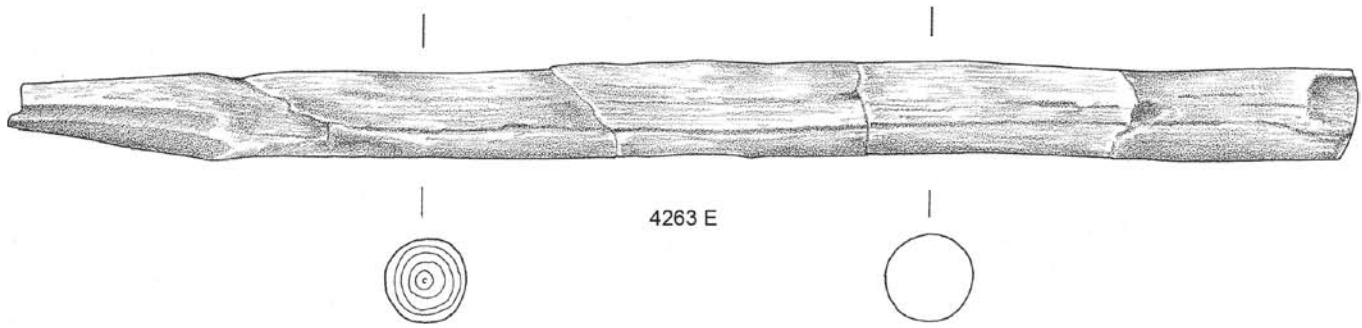


Figure 11.7 Straight pointed stick made of *Prunus* (scale 1:2).

11.4.2 New types of artefacts without an identifiable function (fig. 11.8, table 11.5)

The group of artefacts with an unidentifiable function comprises eight types of unique objects, or parts of objects, with highly diverse shapes for which we know of no parallels in the Mesolithic and Neolithic of northwest Europe. Two specimens were found of at least two of these types. The objects' function is on the whole unclear or unknown.

Crescent-shaped plank: canoe partition? (no. 4555)
A thick, crescent-shaped plank with a width of approximately 19.2 and a height of 16 cm. One of the projecting ends broke off in antiquity. The plank has one slightly concave and one slightly convex side and is a little thicker in the middle (3.9 cm) than at the edges. The plank is also substantially thicker on the convex side (3.7 cm) than at the end(s) (2.4 cm). It is beautifully symmetrical and has a carefully finished surface, almost entirely devoid of tool marks except for two facets at the side. The plank was made from half of the trunk of an ash, which must have had a diameter of at least 20 cm. The slightly concave side coincides with the split side across the heart of the trunk.

The plank was found in an open concentration of wooden artefacts in Unit 18, in the middle of the southeastern side of the dune.

For the same reasons as mentioned in relation to the paddles we assume that the object was not made at the site. In terms of its massiveness and design, this is an exceptional object. There are no devices for or evidence of attachment to other parts, but it is inconceivable that it had an independent function. On the basis of its shape and heavy design it has been suggested that it may have been used as a loose partition in a (dug-out) canoe, in which case its dimensions would imply that it was positioned in the canoe so as to reinforce one of the two bows. Such partitions were however not commonly used in prehistoric canoes. The Middle Bronze Age *Schotten* for dug-outs from Steinhausen-Chollerpark, Switzerland, (Eberschweiler 2004) differ in many respects. They are much larger (1 metre) less sophisticated in design and less carefully finished. Neither is their use attested for (sub)recent canoes, but an example of oak wood can be seen in the bow of one of the small Viking boats of Gokstad (McGrail (1998, 149). There is no clear reason why it should be necessary to make such an object from ash wood. If it was indeed a transverse element in a canoe, it will have had to absorb primarily forces in the longitudinal direction of the grain.

Horn-shaped plank with a hole in it (no. 4590A)
A horn-shaped end of a broad plank containing a large, perfectly round hole (diameter approx. 5.3 cm). The plank has a thickness of 1.9 cm, which decreases to 1.3 cm at the horn-shaped end. The edges of the plank and horn have been rounded to an oval cross-section. Its entire surface is smoothly finished and the end of the 'horn' is also carefully finished to two facets. The hole is perfectly round with a straight wall and a sharp edge. Parallel carving marks perpendicular to the edge are visible on the inside. At some stage the plank broke at its weakest point, at the hole.

no.	description	wood species
4555	canoe partition?	Fraxinus excelsior
4590 A	horn-shaped plank	Prunus spinosa
9411	plate-shaped end	cf. Alnus
3205	triangular point	Prunus
3554	triangular point	Prunus
9506	'ball'	Pomoideae
6013	'ball'	Pomoideae
4263 C	corrugated stick	Prunus
7006	(adze) haft?	Pomoideae
10,512	(adze) haft?	Prunus

Table 11.5 Functionally unidentifiable artefacts.

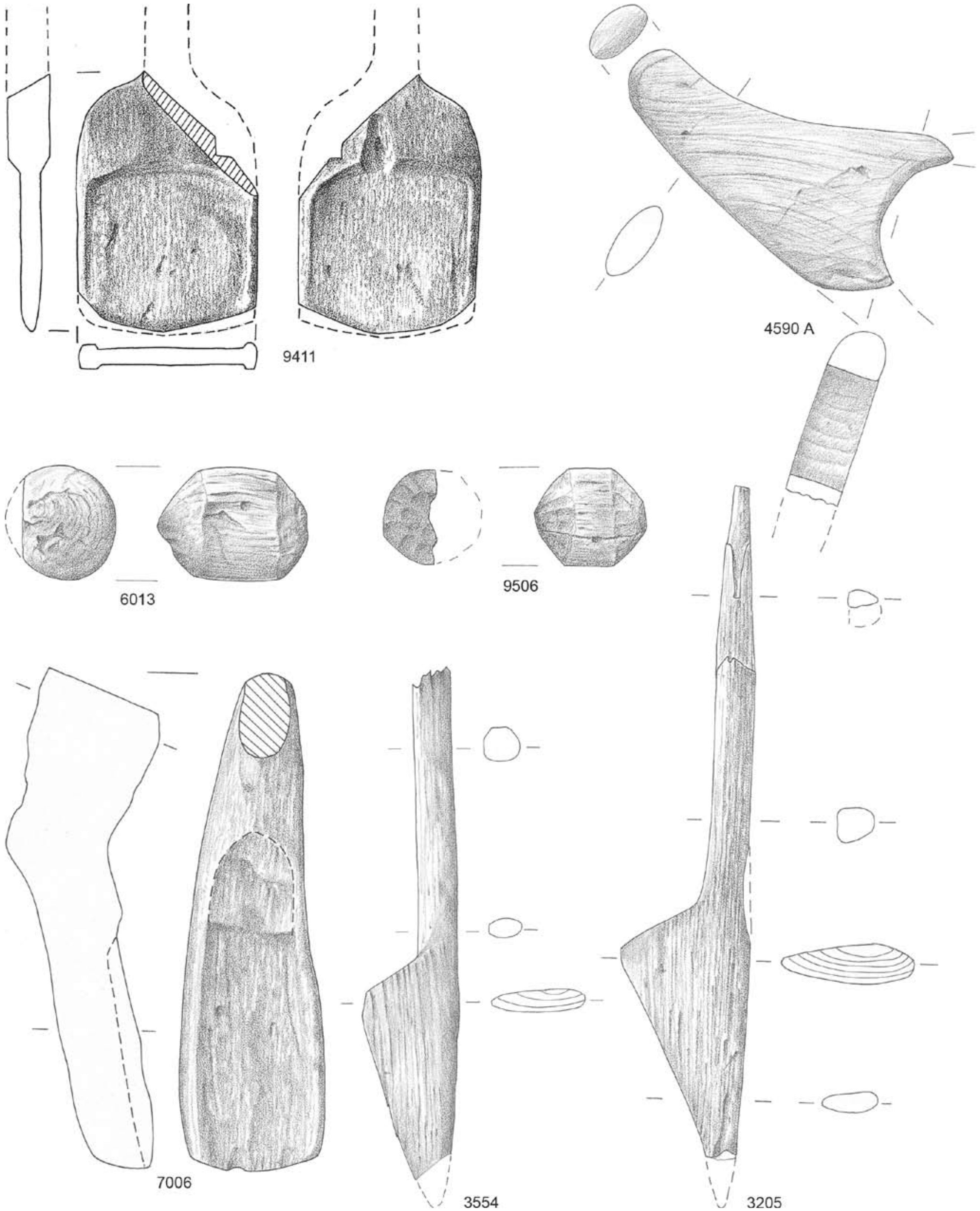


Figure 11.8 Functionally unidentifiable artefacts (scale 1:2).

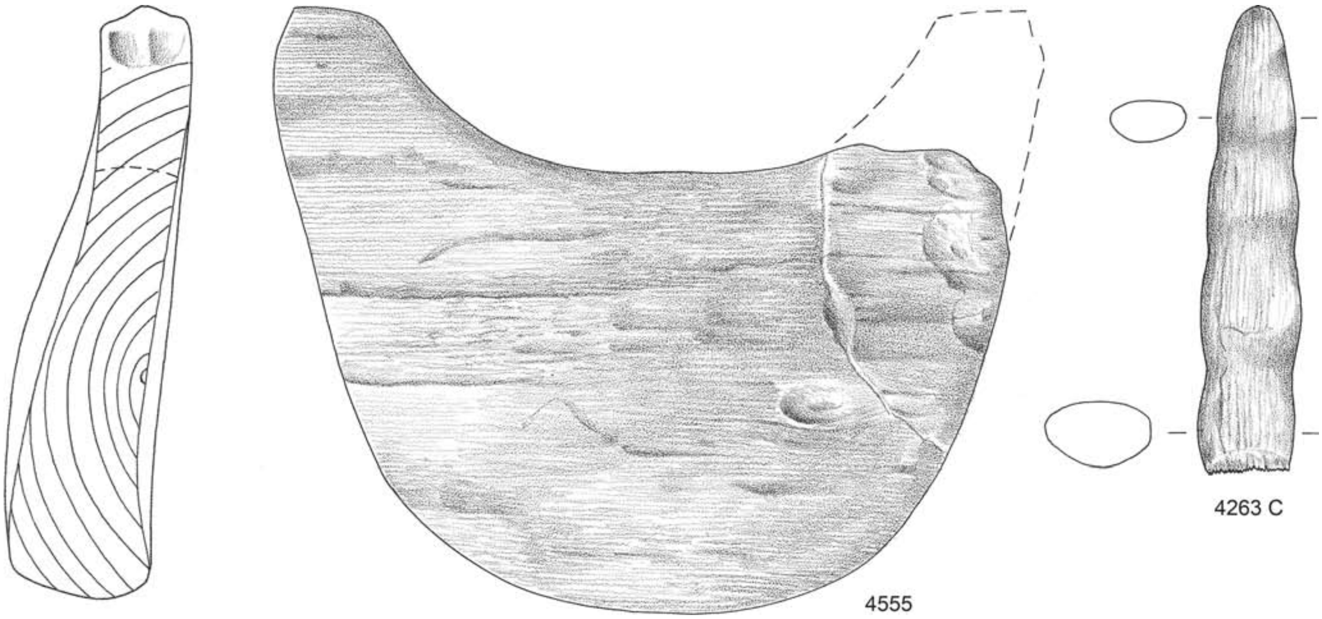


Figure 11.8 (cont.) Functionally unidentifiable artefacts (scale 1:2).

The 'horn' was made from the outer wood of a thick branch with a diameter of more than 5.5 cm or a thin trunk of a sloe (*Prunus spinosa*).

The object was found in the same concentration on the southeastern side of the dune, Unit 18, as the 'canoe partition'.

The object itself offers no clues as to its function. It shows no devices for attachment and no traces of wear, neither on the outside nor in the hole. It would seem that the horn had no specific function and was merely intended as an ornament. It is possible that 'something' was inserted through the hole, but, if so, it caused no wear. What the entire plank originally looked like can no longer be ascertained; it may have been the end of a much longer and larger object.

Plate-shaped end (no. 9411)
A small (9.5 × 6.5 cm) plank of a sophisticated design that must originally have been the end – substantially broadened and symmetrical in two directions – of a 1.5-cm-thick pole. The object was made from a 1.5-cm-thick plank, whose end was over a length of 6 cm thinned to 7 mm, except for a 1.5-mm-high flange. The transverse edge was sharpened. On the other side the plank was narrowed to a handle, the beginning of which is just visible on one side. At this point the object was damaged during the excavation, but its original shape could still be inferred through mirroring via the axis. The plank is assumed to have been made from the trunk of an alder. If so, the trunk was cleft into segments, and the object was made from one of the segments.

The plank was recovered from the fill of a well on the northwestern side of the dune.

Such a detailed, sophisticated object comes as a great surprise in the context of the Hazendonk group, and indeed in the entire North European Neolithic in general. It provides an astonishing impression of the possibilities of and skills achievable with flint knives, but it also raises an interpretative problem: what was the purpose of this object? It would seem that the end was intended to fix the object in or between something, between the two flanges. The sharpened (transverse) edge is badly damaged, especially at the corners. This suggests that it formed part of a composite object, but – in spite of the damage – it was probably not the working end of that object. In spite of these specifications the object's function sadly eludes us.

Triangular points with a handle (nos. 3205, 3554)
Two objects can be described as asymmetrical, triangular sharp points with a handle. They were both made from the outside of a thick branch or a thin trunk of a *Prunus* (sloe, cherry or plum). They differ slightly in size and are both incomplete: the larger misses its point, the smaller one its handle. The larger of the two (no. 3205) will originally have been 26 cm long. Its blade is 5.0 cm wide and 1.5 cm thick. The smaller one (no. 3554) is 3.3 cm wide and 0.9 cm thick and has a surviving length of 19 cm.

Both 'points' were found lying not more than 10 m apart in the clay Unit 18 on the southeastern side of the dune, in a zone that yielded hardly any other wooden artefacts.

A function as reinforcement of some stabbing or thrusting weapon ('spear') would seem to be the most obvious interpretation, but that is not entirely indisputable. The leaf-shaped triangular point was undoubtedly the working end. The tapered handle moreover suggests that it was inserted into something, possibly a shaft, but, if so, it must have been a fairly heavy one. Also remarkable is that the handle of both specimens is thinnest at the transition to the blade. This thinning seems to have been caused not primarily but secondarily – through wear. The blades – especially that of the smaller object – also look rather worn. That would imply that the 'points' were attached deep in something and were used in a scouring medium – the ground or water. An alternative interpretation is that the objects formed part of 'untended facilities', such as traps. The entire object, and the blade in particular, seem too fragile for a third option – the point of a digging stick.

'Balls' (nos. 6013, 9506)
Two more or less spherical objects made from a branch of an apple species (Pomoideae). The bark was stripped from the branch, after which the two ends of a short lump of wood were carefully carved to spherical contours. Both ends of both objects reveal an identical working method, involving the creation of two concentric rings of radially oriented facets, approximately ten in the inner ring and 12-14 in the outer ring.

One of the objects has a cross-section of 4.0 cm and a length of 5.3 cm and was damaged on one side during the excavation. Of the other only half has survived; it was slightly smaller, 3.4 cm long with a cross-section of 4.0 cm.

The two objects were found 60 m apart on different sides of the dune: in clay Unit 18 on the southern side of the dune and in a well dated to phases1/2a on the northwestern side.

We can only guess at the function of these 'balls'. They would appear to have functioned in this shape, for they show no traces of any form of attachment. They do show some signs of wear.

Stick with a corrugated end (no. 4263C)
Stick, ending in a blunt point with one flat side and a side with four transverse corrugations varying in length. The object is 12.5 cm long and measures at most 2.6 × 1.7 cm in cross-section. It seems to have broken off at a tool mark. The object was made from a thick branch of *Prunus*.

The object's function is a great mystery. Were the corrugations functional or merely decorative?

(Adze) hafts? (nos. 7006, 10,512)
Two, fairly unwieldy and rather worn pieces of wood, which may have been the hafts of a hacking implement. Both objects lack the sophisticated design and finish characterising many of the other wooden artefacts. But this could be largely attributable to severe weathering before the objects became buried.

The objects were found far apart, no. 7006 in a well fill in the northwest and no. 10,512 on the northeastern side of the dune.

The first (no. 7006) consists of a broad, concave part showing clear tool marks, which after an angle continues in what may have been the end of a haft. The latter was cut off in recent times, so its original length can no longer be ascertained. An adze blade may have been attached to the broad part. It has a low flange along both long sides, the hollowed-out part tapers upwards from a width of 4 cm to 3 cm and is 8 cm long. The 'haft' is at an angle of approximately 150° relative to the blade and has an oval cross-section (1.7 × 4.5 cm), with its main axis perpendicular to the broad blade. The object was made from a knee of an apple species, the broad part from the branch, the 'haft' from the trunk. The trunk had a diameter of at least 9 cm; the diameter of the branch was at least 5 cm.

The second object (no. 10,512, not illustrated) also has a slightly angular shape, with a long, flat part and a short, heavier part. The flat part is 14 cm long and increases in width from 3 to 4.5 cm from the bend to the end. The short part has a cross-section of 3.5-4 cm and was hollowed out to a depth of 4.5 cm. The raw material for this object was a branch, possibly of a *Prunus* tree.

The first object is certainly *not* the end of an adze haft, as the angle between the haft and the blade is far too blunt. It may however well have been the haft of a chisel, though its shape and dimensions also coincide with those of an average Neolithic axe.

We have our doubts about the second object. It is more irregularly shaped and shows no clear evidence of working. The hollow may well have been naturally formed; the same can actually be said of the entire object. The intriguing shape is best regarded as a freak of nature.

Long pole with a spatula-shaped end (no. 10,701, fig. 11.9)
A long, straight pole with a worked end. At the top the pole has a diameter of 3.2 cm, above the worked bottom part it is 4 cm. Its present length is 166 cm, but the pole was longer originally, because the top part was cut off in recent times. One of the facets at the bottom may have been formed in lopping the branch from a tree trunk. The facet in questions measures 6.5 by 6.5 cm and is on the concave side of the base of the branch. Two parallel facets are visible on the convex side, one having a length of 3.5 cm and the other a length of 5 cm. They were presumably not functional with respect to lopping the branch from the trunk, and must have been made after the branch had been removed from the trunk. The branch comes from a hazel (*Corylus avellana*).

The pole stands out on account of its length, straightness and its seemingly worked end. The end shows no traces of wear and the bark covering a large part of the pole also shows that it was used either very little or not at all. This makes it puzzling why this pole should have been lopped from a tree, brought back to the site and discarded – unused. Perhaps it was intended for use as a digging stick, a shepherd's crook or a punting-pole.

11.4.3 *Woodworking waste* (tables 11.6-7)

Besides discarded artefacts, different typical forms of waste and semi-finished objects produced in woodworking were found at Schipluiden. They provide useful information on the woodworking processes at the site.

- Waste is formed in trimming branches. This waste was classified as 'worked roundwood'.
- Chopping leads to the formation of chips. Chips were also found at the site.
- 'Tangential rectangles' are produced when a tree-trunk is prepared in a specific way.
- A trunk can be divided into planks either tangentially (parallel to the outside), or it can be cleft across the heart (radially).

These by-products formed in woodworking will be successively discussed below.

Worked roundwood (table 11.6)

The group of 'worked roundwood' comprises a number of fairly long parts (12-57 cm) of branches showing traces of carving and/or chopping in varying intensities. They are to be interpreted as woodworking waste or semi-finished products. Twelve pieces of wood from different tree species were classified as such. The remains of this group are fairly diverse, with a straight or curved shape, varying diameters (2.3-4 cm) and signs of woodworking ranging from modest tool marks at the end to a groove carved all the way round a branch (no. 10,180). Represented in this group are eight species of trees which all grew in the vicinity of the site.

A few of the remains deserve separate mention: 10,108 is the base of a spindle branch that was half lopped and half ripped from the tree. The other end was chopped all round and broken off. A groove was carved all round the branch a short distance above the base. This would seem to be a waste product: first the branch was lopped from the tree, then the groove was made with the purpose of shortening the branch, but it was finally decided to chop off part of the branch higher up.

Figure 11.9 Long pole of *Corylus avellana* and detail of the chopped base (scale 1:4, detail natural size).

no.	length (cm)	wood species
4757	23.5	Juniperus communis
6073 A	24.5	Viburnum opulus
6073 B	15	Salix
8083	24	Juniperus communis
9929 A	27.5	Pomoideae
9929 B	16	Salix
9929 C	30	Prunus
10,179	27	Euonymus europaeus
10,180	32.5	Euonymus europaeus
10.702 C	57.5	Prunus
10.702 D	28.5	Prunus
10.702 E	12.5	Viburnum opulus

Table 11.6 Worked roundwood.

Nos. 10,702C-D are two 3-4 cm-thick forked *Prunus* branches, each with one end showing small chopping facets all the way round. In this respect they differ from most of the fence stakes. It is hence more likely that the tool marks were made in lopping the branch from the tree rather than in an effort to sharpen its end.

Wood chips (fig. 11.10)
Four wood chips with lengths of 11-13 cm were identified. They are typical of the kind of chips formed in the initial stages of woodworking, for example in chopping down trees. It should be borne in mind that such chips are produced in large quantities in tree-felling, but that trees were felled predominantly in dry areas, and that such chips were moreover ideal firewood, so the great majority will have disappeared. With due respect for these restrictions, the four chips (3× alder, 1× Pomoideae) are evidence of tree-felling and primary woodworking in phase 2a.

no.	length cm	width cm	thickn. cm	Ø trunk cm	wood species
tang.split-off rect.					
7807	31	15	5	20	Pomoideae
10,702 A	16	8	3	15	Pomoideae
10,778 A	17	11	3	30	Pomoideae
tangentially split pieces					
378	17	4.5	1.4		Salix
1404	81	10	4		Alnus
1898	88	10	4		Alnus
2346	105	10	4		Alnus
2852	11	3	1.1		Alnus
2886	11.5	4	1.1		Alnus
3292	18	7	2.5		Alnus
8095	49	19	4		Alnus
10.377	17	6.5	4		Pomoideae
radially split pieces					
5432 B	16	3.5	1.5		Taxus baccata
6619	29	8	3.8		Alnus
8656	75.5	7	4.5		Fraxinus excelsior

Table 11.7 Woodworking waste.

Tangentially split-off rectangles (fig. 11.10)
One way of removing the outer part of a tree-trunk is by hacking notches of a few centimetres deep at regular distances around the trunk. The wood between two notches can then be removed in one piece with the aid of a wedge. Such pieces of wood are rectangular and usually a few centimetres thick. The marks of the notches are often still visible at the two transverse edges.

Three such tangentially split-off rectangles were found at the site: two in the northwest and one in the middle of the southeastern side; they were all dated to phase 2a. All three pieces come from the trunks of apple species with diameters of 15-30 cm. The split surface of one of them (no. 10,778A) shows marks formed by the wedge that was driven into the wood.

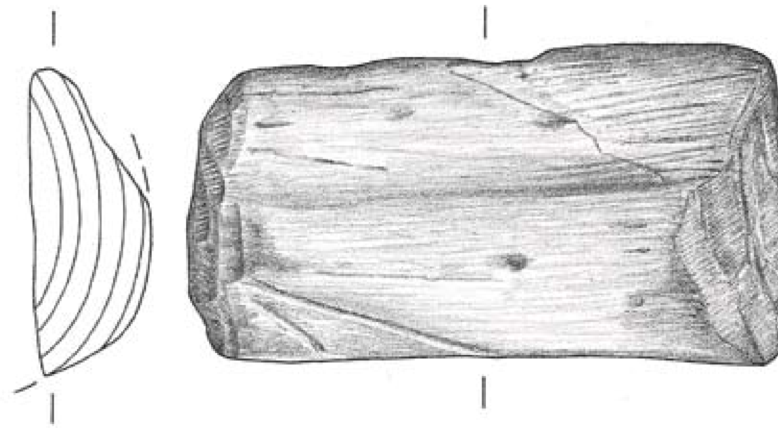
These rectangles may also be the semi-finished products of an artefact type that was found at Wateringen 4 (Raemaekers *et al.* 1997, fig. 17). The artefact in question is a comparable rectangle, but slightly smaller (12 cm long) and made of the wood of a maple (*Acer*). It shows signs of careful working over its entire surface on two sides and appears to show no traces of wear or damage caused during use. Remarkably, maple wood was used at Wateringen 4, but not at Schipluiden. Evidently the occupants of Wateringen 4 did have access to this species, which can be particularly well worked.

This technique was clearly not intended to obtain long, tangential planks as intermediate products for the manufacture of utilitarian objects, but as a preparatory act for manufacturing an object from the trunk itself. That object may have been a tree-trunk canoe (fig. 11.11) or structural elements, such as beams. The tree-trunks that were worked at Schipluiden were however too thin for the manufacture of tree-trunk canoes, but they may well have been used to make beams.

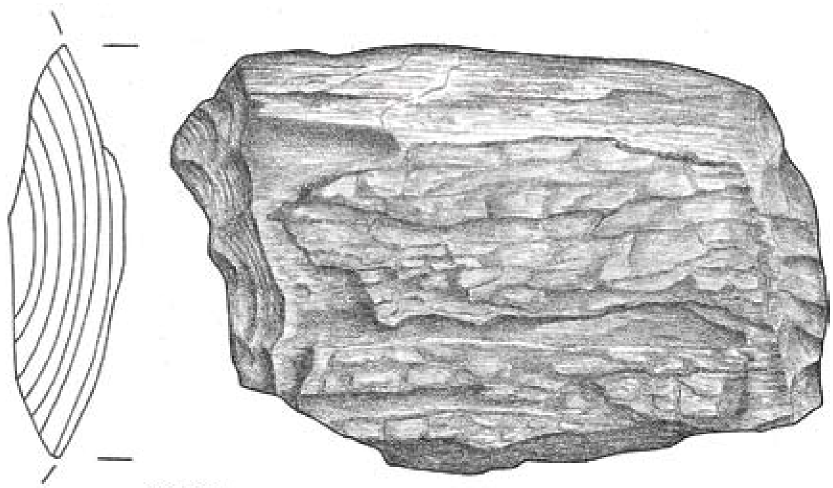
The tangentially split-off rectangles do show that trees of apple species with trunk diameters of at least 30 cm grew on the dune itself in phase 2a, for it is unlikely that this community, with its limited means of transport, should have imported such heavy tree-trunks from sources in the vicinity. They are also evidence of heavy woodworking at the site. It is only difficult to say what the intended end products may have been.

Tangentially split pieces of wood, the outer parts of tree-trunks
From the collected pieces of wood were selected nine indisputable pieces with bark and outer annual rings that had

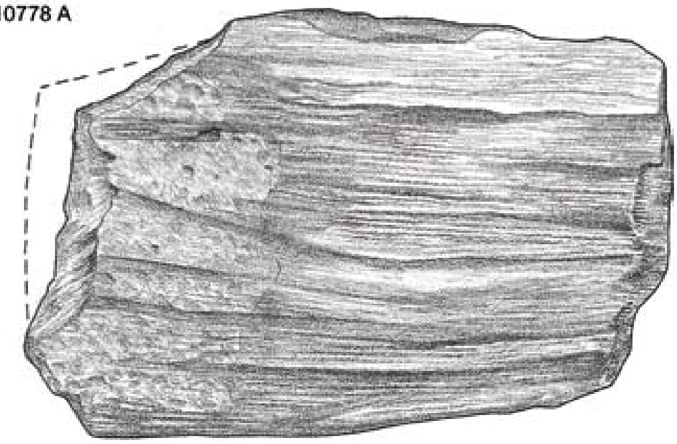
9929 D



10702 A



10778 A



10189

Figure 11.10 Woodworking waste: two wood chips and two tangentially split-off rectangles (scale 1:2).

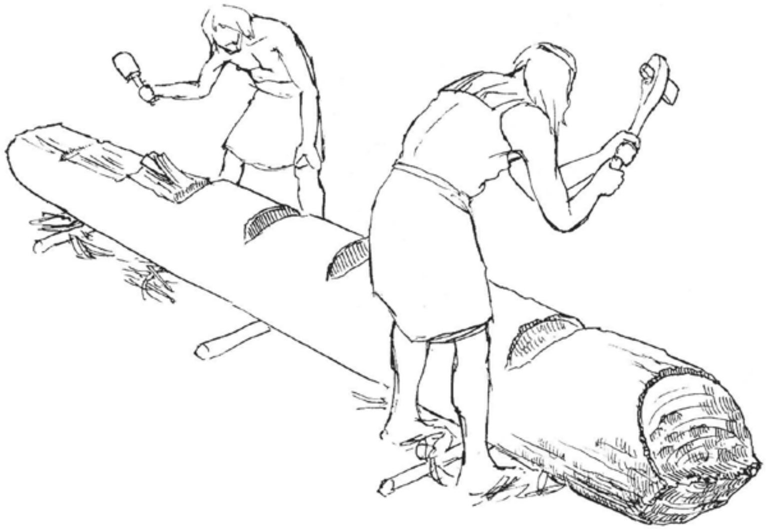


Figure 11.11 The first stage in making a dug-out canoe by producing 'tangential rectangles', as based on present-day experience. After Nielsen 1981, 57.

been split tangentially from the trunk. They vary tremendously in dimensions. There are a few long alder planks with lengths of 81-105 cm and widths of around 10 cm, which must have been split from trees with diameters of 15 to 20 cm. One of the planks was used to line a well (see section 3.4.2). There were also some smaller split pieces, the majority of which were of alder plus 1× willow and 1× Pomoideae. Among the less well-preserved wood remains were at least a few less clearly identifiable tangentially split pieces, which were left out of consideration.

The dominance of alder is remarkable. The fact that the long pieces in particular were split from sturdy tree-trunks makes it plausible that – besides apple species (see above) – sturdy alders were also to be found either on the dune itself or in its immediate surroundings in phase 2a.

In addition to these large pieces there were also some flat strips, which were only a few centimetres broad and thick. They were also of alder wood.

Wood split radially, across the heart

Three pieces of wood were split radially from a tree. Two of them deserve special attention on account of the wood species concerned.

The first is an 18-cm-long part of a branch of a yew with a thickness of more than 3 cm, which had been radially split into three parts. It shows signs of chopping at one end. The wood dates from phase 1 and was certainly imported from a distant source in the river dunes area, the southern sandy areas or the basin of the Scheldt. It may be a trimming from a much larger branch that was used to make a bow.

The second find is a trunk or thick branch of an ash with a diameter of 12 cm that was hewn into quarters. Its dimensions are 74 × 6 × 7 cm. At one end it shows some rather indistinct chopping facets. The wood would appear to have been suitable for the manufacture of a spear or even an axe haft, but it was not worked any further. Besides three finely shaped artefacts (the two paddles and the 'canoe partition') and this cleft trunk only three small pieces of ash wood were found at the site. They may all be waste formed in woodworking. Partly in the light of the results of other botanical research we assume that the ashes did not grow at or near the site, and that the wood was imported from a source elsewhere.

11.4.4 Use of unworked wood: wattlework

In two places – in a well fill in the northwest and at the northern end of the dune – a number of branches were found that showed traces of wear and deformation of the kind observed in the active elements in wattlework. The nine branches concerned have diameters of between 1 and 2.6 cm and comprise six alder (*Alnus*), two willow (*Salix*) and one apple species (Pomoideae).

11.4.5 Fence posts and stakes

Wooden post and stake ends

Section 3.8.2 discussed the features of fences that stood along the former foot of the dune. It was mentioned that many of those features were found to contain the surviving ends of the wooden posts and stakes. These remains provide information on the selected species, the trees growing in the vicinity of the site and the organisation of work.

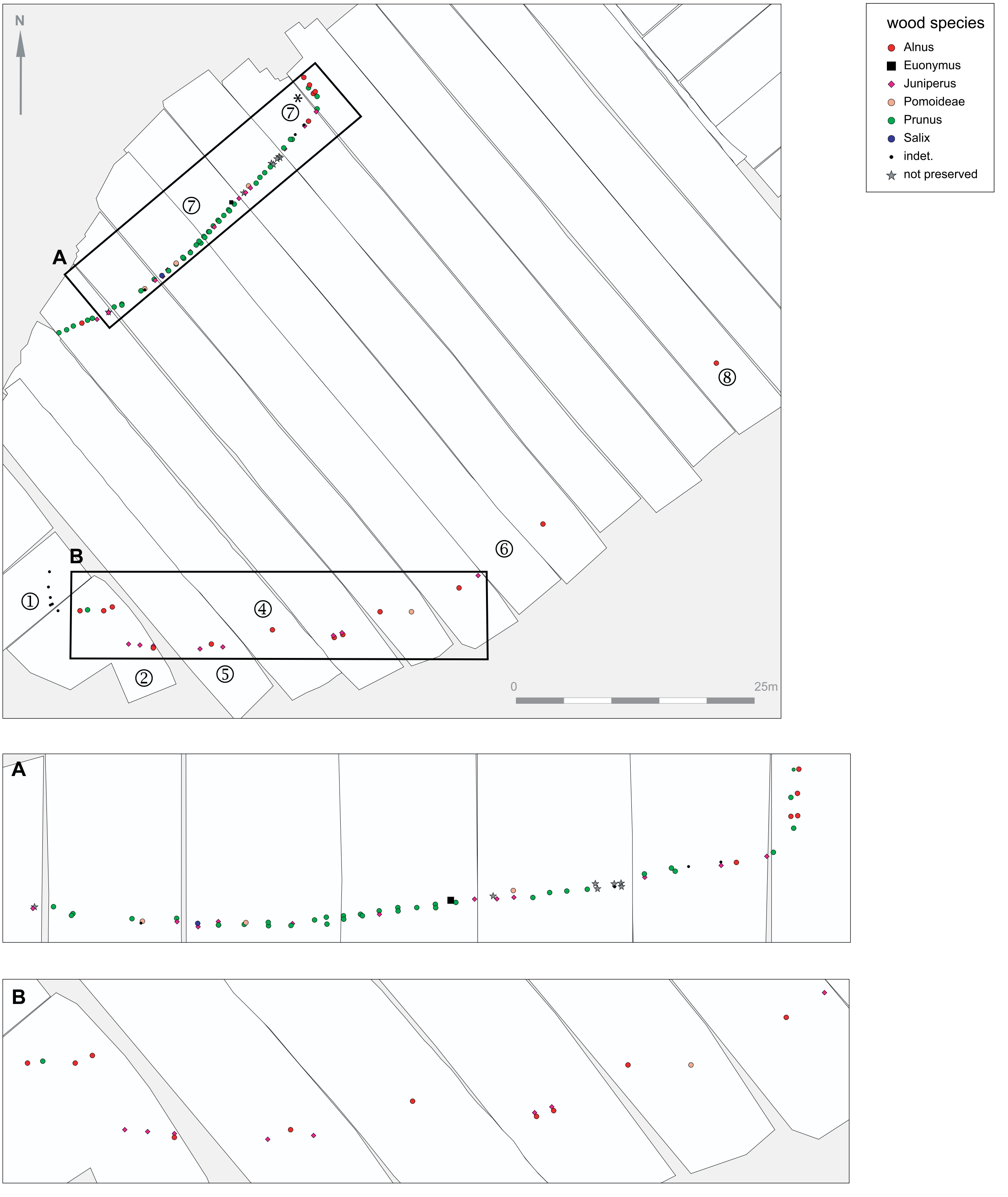


Figure 11.12 Preserved ends of posts of two fence stretches and their wood species identifications.

wood species / section	Juniperus	Prunus	Pomoidae	Alnus	Euonymus europaeus	Salix	indet.	totals fence posts	total fence features
youngest									
1	–	1	–	5	–	–	1	7	23
3	–	–	–	–	–	–	–	0	10
middle									
4	–	–	–	1	–	–	–	1	45
oldest NW									
7	13	38	3	3	1	1	11	70	91
7*	–	3	–	4	–	–	–	7	12
(7)	1	4	1	1	–	–	–	7	–
9	–	–	–	–	–	–	–	–	–
oldest SE									
2	5	–	–	2	–	–	–	7	9
(2)	1	–	–	-	–	–	–	1	1
5	4	–	1	4	–	1	–	10	71
6	–	–	–	–	–	–	1	1	34
8	1	–	–	–	–	–	–	1	3
Totals	*25*	*46*	*5*	*20*	*1*	*2*	*13*	*112*	*299*

Table 11.8 Fences, wood species per section. In brackets: pointed stakes from well fills.

In total, 299 features of the various fences were recorded. Of those features 104 were found to contain surviving wood and in 99 cases the species of the wood could be identified; another eight post ends were recovered from the fills of wells that lay next to the northwestern fence stretches (table 11.8-9). In 62 cases the post/stake end had survived in such good condition that aspects such as dimensions, tool marks and the like could also be described.

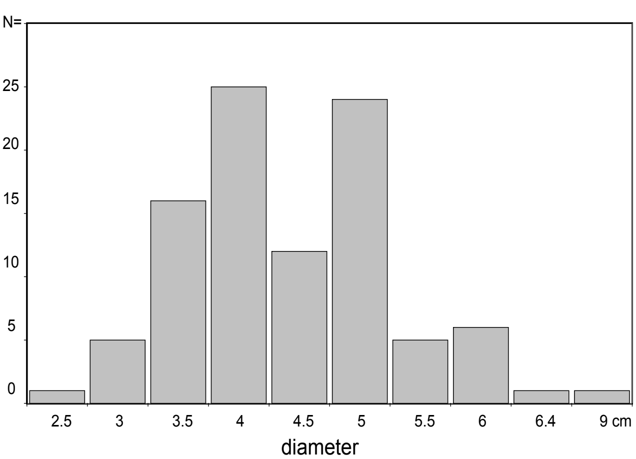


Figure 11.13 Diameters of fence stakes, N = 96.

The majority of the post/stake ends (N=77) had survived along the northwestern stretches (7, 7*), where 75% of the features were found to contain wood. In the case of fence stretches 2 and 5 only 22% of the features contained wood. The features of the younger fence stretches likewise contained only very little wood, which was moreover poorly preserved.

It is not so easy to explain these substantial differences. The differences between the early fence stretches and the later ones are most probably attributable to differences in preservation. The posts/stakes of the later fence stretches were probably not driven into the ground to a depth beneath the former groundwater level, which would explain why the majority had completely decayed. The posts/stakes of stretches 7 and 7* evidently did stand partly in the groundwater, and the fence was apparently not pulled down, but left to rot. With due consideration for the assumption that many of the features of stretch 2 were overlooked in the excavation, this does not – or at least not to the same extent – hold for the combined stretches 2 and 5. Many of the post/stake ends in question are longer than 30 cm and have survived in such good condition that we must assume that these posts/stakes were deliberately left in place, and that the others were pulled out of the ground, possibly for re-use.

Wood species

The identifications of the wood of all the fence posts/stakes together (table 11.8) provide a good impression of the tree species that grew in the dune's surroundings at the end of phase 2a. We assume that the occupants obtained their wood from their immediate surroundings in view of the quantities they required and the limited means of transport; carts were not yet known at this time. The represented spectrum is quite remarkable, with a dominance of *Prunus*, juniper and alder, and the complete absence of species such as hazel and ash. *Prunus* is remarkably the dominant species in the most complete spectrum of fence stretch 7-7* and is totally absent in the other fence stretches except for one post in fence stretch 1. Presumably the people who pulled down the combined fence stretches 2-5 deliberately left the juniper and alder stakes in place. Another possibility is that for these fence stretches they exploited a different nearby wood in which there were no *Prunus* trees (fig. 11.12).

Dimensions and sharpened points (fig. 11.13-14)

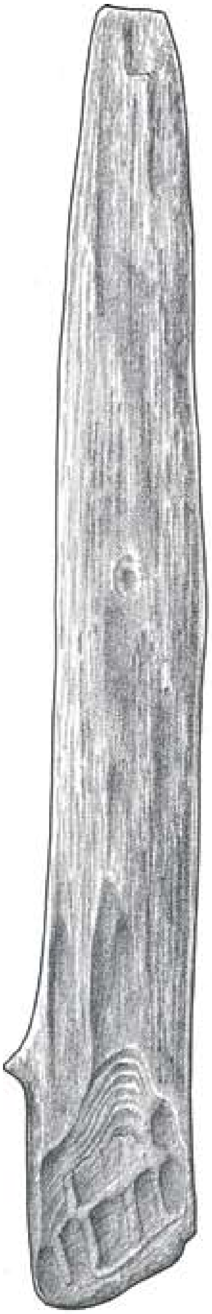
With the odd exception, the posts/stakes all have diameters of 3-5.5 cm (fig. 3.13). The thickest is an alder post from stretch 1, which has a diameter of 8 cm. Insofar as can be assessed, the fence builders used straight posts/stakes, though a few are clearly crooked. Most of the posts/stakes still show bark, showing that the wood was used in a fresh condition.

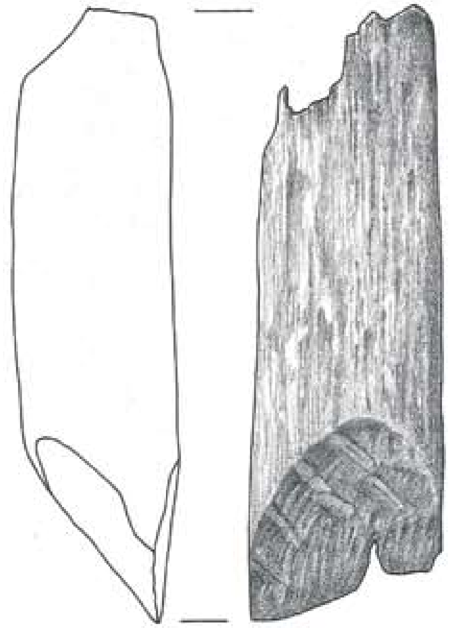
The surviving lengths are 7-50 cm, with an average of 20.4 cm from level C downwards, in which the soft wood was cut with the spade. Posts/stakes of the hard wood of junipers are relatively long because they could often be recovered intact in the excavation. This holds in particular for the posts/stakes of fence stretch 7, which were embedded in Unit 19N. The post/stake moulds and surviving ends show that the fence posts/stakes were on average driven 50 cm into the ground, which means that the fence was a good 1 metre high.

The ends of the stakes were fairly coarsely sharpened to points (fig. 11.14). A few show no signs of woodworking whatsoever; in those cases a broken-off branch or trunk was evidently driven into the ground without further ado. In many cases a branch or trunk was chopped to a third or half of its thickness and then broken off. That resulted in a crude, ragged point. A quarter of the posts (N=24) were driven into the ground without sharpened ends. In the case of half of the posts the end was sharpened, either unilaterally or bilaterally, and often asymmetrically or at an angle. One juniper stake end was shaped all round. Many of the stakes have quite sharp points, in the sense that the length of the point exceeds the stake's diameter. Various stakes, in particular those of juniper wood, however have a blunt point, presumably due to the hardness of the wood. There are no striking differences between the employed species except for one conspicuous exception: the stakes of alder wood in all the fence stretches were almost all neatly bilaterally shaped to a sharp point. Alder wood is fairly soft and can be comparatively easily worked. Creating a fine sharp point will have involved no extra effort, though it is possible that other, less practical motives played a part, the same motives that determined why the alder stakes of fence stretches 1-2-4-5 were not pulled down.

Marks of damaged axes and the chopping method (figs. 11.15-16)
In the case of four stake ends one of the facets showed that the stake had been chopped with an axe with a damaged cutting edge. The burrs are observable as short, straight parallel marks. In three cases the marks were observed on a bilaterally chopped point; the other cutting surface shows no such marks, and was apparently created with a smooth, undamaged axe. This shows that – in these three cases at least – the work took place in two separate phases: the chopping of the trees in the field and the sharpening of the ends at the time when the fence was built. The fact that this was done with two different axes implies that at least two persons (men) worked on the fence.

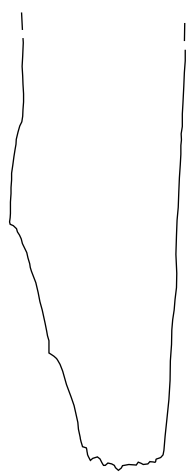
Figure 11.14 Fence stake ends, showing range of point shapes (scale 1:2).
994 *Juniperus communis,* carefully made two-sided point.
4606 *Juniperus communis,* curved stake, chopped on one side and ripped from the tree.
4274 *Prunus spinosa*, point with two facets.
2894 *Prunus avium,* curved stake with broken end.





6004

2327



4604

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1889

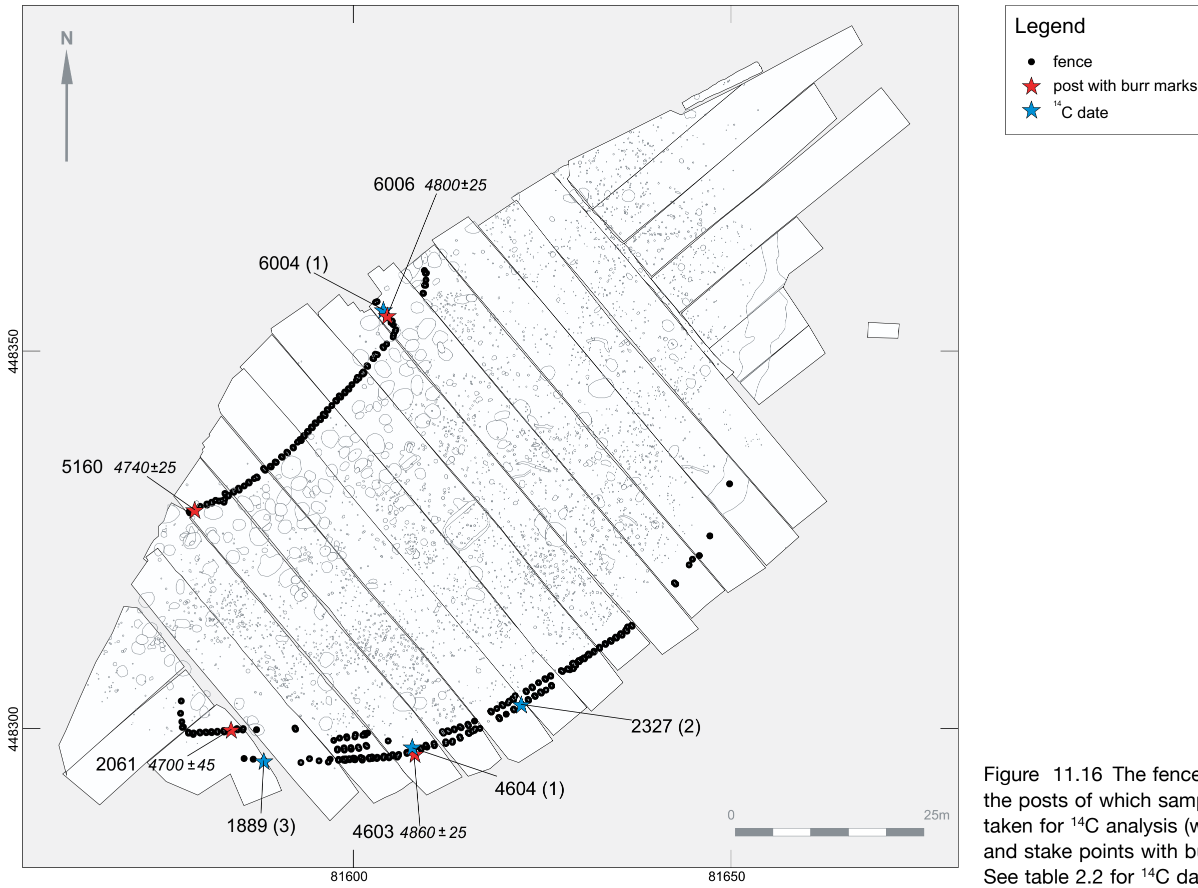

Figure 11.16 The fences showing the posts of which samples were taken for ^{14}C analysis (with dates BP) and stake points with burr marks. See table 2.2 for ^{14}C dates.

This is of course fairly obvious, but it is interesting to actually find evidence of it. The burr marks were not all made by the same axe. That is not surprising either when we consider that the fences appear to have been repaired and/or replaced on several occasions. At least three different patterns can be distinguished – all three on the comparatively scarce stakes that have survived in the combined stretches 2 and 5, within an overall distance of around 35 m. If we assume that such a fence stretch was built in one run, the conclusion is that at least four men will have worked on its erection.

The pattern of cutting edge damage on a stake from stretch 5 bears a remarkable resemblance to that on a stake from stretch 7*, one of the carefully sharpened alder stakes. The resemblance is indeed so great as to suggest that they were chopped with the same damaged axe, *i.e.* by the same man and within a very short space of time, before the axe was sharpened or discarded. This poses no serious chronological problem. It would simply mean that stretches 7 and 7* belonged together after all, and that the entire older fence stretch was built in one run.

11.6 Stakes from Unit 1-2, 2300-2050 cal BC

During the removal of the overlying layers, the ends of 24 thin stakes that had been driven vertically into the ground were found in a cluster with a diameter of 5 m in Unit 2 on the eastern side of the dune (see section 3.8.7).[1] They had

◀Figure 11.15 Four examples of ends of fence stakes, showing marks of the damaged cutting edges ('burrs') of the axes used in the chopping (scale 1:2, details scale 1:1). The marks on 4606 and 6004 are (almost) identical.

4604 *Juniperus communis,* blunt (broken) end with one facet.
6004 *cf. Alnus,* point with two facets, one with burr marks.
2327 *Juniperus communis,* point with two facets, one with burr marks.
1889 *cf. Alnus,* point with two facets, the larger one with burr marks.

been compressed like a concertina and distorted by the weight of the peat and heavy Dunkirk I sediments that were later deposited on top of them. Most of the stakes had diameters of 3-7 cm; two were substantially thicker (9 and 14 cm). The wood employed was exclusively alder (N=8) and willow (N=16), which will have been the dominant, if not the only wood species available in the reed swamp that surrounded the dune in those days.

The ends of the stakes had been sharpened in a different way than those of the stakes of the older fence that enclosed the dune: the length of the point was (much) greater than the stake's diameter and most of the points show one or two chopping facets.

11.7 Conclusion

11.7.1 General

Throughout the entire span of prehistory wood was indisputably a very important raw material, even at this site, which lay in a comparatively open landscape. This is not reflected in the archaeological record, certainly not in quantitative terms. Wooden artefacts are known from only a very small number of Mesolithic and Neolithic sites in the Netherlands, and then only one or a few objects per site. Even the finds from relatively rich sites such as Hardinxveld and Schipluiden represent only an exceptionally small, random sample of what the living community made and used. This is in marked contrast to other categories of objects, in particular earthenware and flint objects, which to a point may be seen as representative samples. This underrepresentation of wooden artefacts forces us to pay excessive attention to them in our interpretation of the prehistoric communities. What we see is actually only a small glimpse of the full picture.

The worked wood provides information in particular on the range of artefacts and use of wood in phase 2a. All that has survived from phase 1 is one axe haft of Pomoideae wood and a split piece of yew wood, and the only wooden artefact datable to phase 3 is a willow axe haft (table 11.2). This means that we are unable to present a diachronic development of the use of wood; we will have to make do with a synchronic impression. All that can be said with certainty is that the piece of yew from phase 1 constitutes evidence of external relations at this early stage already. The use of willow for an axe haft in phase 3 illustrates the poor availability of good wood in the swampy landscape of those days.

11.7.2 Typology, range of artefacts

Besides the traditional artefacts (bow, paddle, spear), the range represented at Schipluiden comprises a number of surprising, puzzling objects that cannot, or virtually not be functionally interpreted. They are objects with a sophisticated design ('horn', 'corrugated stick'), complex utilitarian objects ('handle with a plank-shaped end') and practical parts of equipment ('ball', 'point with a handle'). The 'canoe partition' may represent an otherwise virtually unknown type of boat. In terms of diversity and finish, the worked wood of Schipluiden, and in a broader respect that of the Dutch delta, is in no way inferior to that known from other sites with optimum preservation conditions, notably the Alpine lake dwellings (Wyss 1969) and settlements in southern Scandinavia. Their artefact ranges are comparable, but not identical. We should not assess the Neolithic delta communities solely on the basis of their simple pottery, but should re-evaluate them with due consideration for their woodworking skills.

What is surprising for a Neolithic community is that all the artefacts – insofar as they can be functionally interpreted – relate to 'Mesolithic' activities: chopping wood, hunting, sailing and possibly fishing. Perhaps the range of wooden farming and domestic implements was limited and/or these implements were not discarded at the swampy periphery of the site.

11.7.3 Technology

Equally surprising is the high level of technological expertise that was evidently achievable with a simple flint toolkit. The artefacts display a high standard of craftsmanship, good symmetry, close attention to detail and careful finishing, all of which were realised with simple flint axes, blades, drills and piercers. The surface of a few objects was in one way or another smoothed, possibly with quartzite or quartzitic sandstone flakes (see section 8.6.8), for example the surfaces of the 'horn' and axe haft no. 6010, but this was not usually the case. A few axe hafts (nos. 4263A, 4594) have only a roughly chopped end.

In this respect, too, we must upgrade the Dutch Neolithic. It is interesting to compare the Neolithic implements showing evidence of skilled woodworking techniques with the products that were made with them (sections 7.10.5 and 10.7.2). That the Neolithic people also handled wood in an entirely different manner – when no great attention to detail was required – is shown by the wooden stakes: they are the products of fast, crude mass-production, and it would be incorrect to regard them as representative of Neolithic woodworking techniques.

11.7.4 Woodworking at the site

The scarcity of semi-finished products and waste makes it difficult to say what fine woodworking activities took place at the site. Interestingly, the range of employed wood species closely resembles that represented by the fences, with high proportions of *Prunus* and Pomoideae. This makes local production plausible. The predominant use of less suitable types of wood, and of branches rather than trunks, is also a strong argument in favour of local manufacture of most of the artefacts. What should also be mentioned in this

	implements	worked	wattle	waste	total	fence posts
Alnus	2	–	6	11	19	19
Cornus	–	–	–	–	–	–
Corylus avellana	4	–	–	–	4	–
Euonymus europaeus	3	2	–	–	5	1
Fraxinus excelsior	3	–	–	1	4	–
Juniperus communis	2	2	–	–	4	23
Lonicera	1	–	–	–	1	–
Pomoideae	8	1	1	5	15	4
Prunus	8	3	–	–	11	42
Rhamnus cathartica	1	–	–	–	1	–
Salix	1	2	2	1	6	2
Taxus baccata	–	–	–	1	1	–
Viburnum opulus	–	2	–	–	2	–
indet.	–	–	–	–	–	13
Totals	*33*	*12*	*9*	*19*	*73*	*104*

Table 11.9 Artefact type versus wood species.

context is the waste produced in trimming branches, such as no. 10,180.

There are several indications of heavy woodworking at the site: the tangential rectangles of Pomoideae, the long tangentially split pieces of alder and a few large chips, which all ended up in the swampy zone entirely by chance. The greater part of the waste formed in woodworking will have decayed or been burned.

11.7.5 Selection of wood species (table 11.9)

It is generally assumed that prehistoric man obtained his wood from the immediate surroundings of his settlement (Groenman-Van Waateringe 1988). This holds in particular for heavy construction timber and wood needed on a daily basis, *i.e.* firewood. At Schipluiden this principle holds especially for the fences, for which a quick calculation (section 3.8.2) showed that roundwood with diameters of 4-6 cm and a total length of 2.5 km was used. It also holds for the house at Wateringen 4, which was built from alder (the central roof supports) and juniper (the wall posts) (Hänninen/Vermeeren 1995).

A second doctrine is that of the ‘native knowledge system’, according to which people critically and selectively chose the wood species that were most suitable for particular purposes. This holds to a point only in the case of Schipluiden. Many different wood species were randomly used in the construction of the fences, ranging from high-quality *Juniperus communis* to the moderate alder and even some willow wood. This we regard as an indication that wood was in scarce supply. The occupants of Schipluiden could not afford to make selective use of the available wood. This same principle of random, suboptimum use of wood is also observable in the artefacts, first of all in the bow, which was made from juniper instead of elm or yew, and also in the spears and even the more critical axe hafts, if to a slightly lesser extent: alder and willow were virtually not used. Other species, in particular Pomoideae (apple or hawthorn), hazel and spindle, were however good substitutes for alder in the manufacture of axe hafts. The occupants of Schipluiden were less critical than people elsewhere in a second aspect, too: they often made use of branches whereas people at other sites used the better-quality standing timber.

All this leads to the conclusion that the preferred wood species (ash, maple, yew) did not grow in the site’s immediate surroundings, and that external contacts or means of exploitation were not used to ensure an adequate supply of wood for the manufacture of artefacts. Not only was the selection of wood species not optimum, but use was also

Figure 11.17 Juniperus with its many slender trunks was a convenient potential resource for fence posts. Ginkelse Hei reserve, Veluwe, January 2006.

made of branches instead of the more commonly employed sturdier standing timber. There are only a few exceptions: the paddles, the 'canoe partition', a radially split piece of ash and a split piece of *Taxus baccata*, which must be waste formed in the manufacture of a bow. So the occupants of Schipluiden did incidentally import complete artefacts from elsewhere, or high-quality wood for the manufacture of artefacts.

11.7.6 Concluding remarks

The vegetation at and around the Schipluiden-Harnaschpolder site yielded only a limited range of wood for use in the manufacture of artefacts (chapter 21). Species that were commonly used in the Neolithic and Mesolithic did not occur in this region: no ash for axe hafts and paddles, no elm or yew for bows, no oak for use as construction timber. Whereas flint and stone were imported from distant sources, most of the wooden artefacts were made from locally available species, which were by no means always the most suitable. Exceptions are the two paddles of ash wood. This suggests strong regional ties and is an important argument against for example the option of seasonal mobility. The assumed limited 'external relations' are also in accordance with the local manufacture of the pottery. They however do conflict with the import of fairly large quantities of stone and flint from distant sources.

It is possible that a meaning that was more than utilitarian alone was attached to some species. In two places we observed special attention to two strongly contrasting species: the prickly *Juniperus communis* typical of the coastal area with its hard, straight branches, and the broad-leaved *Alnus* typical of swampy habitats, with its conspicuous orangey, soft wood. The juniper offered natural straight and strong stakes (fig. 11.17), the alder probably the largest straight trunks. These two species were combined in different structures – the fence at Schipluiden and the house at Wateringen 4. In the fence, the alder branches were the only ones with carefully sharpened ends. The stakes of both species appear to have been spared when the southeastern fence stretch (2-5-6) was pulled down. And precisely these two species were also used in the construction of the Wateringen 4 house – alder down the middle and juniper in the wall. The latter is quite understandable in a functional respect, and alder may have been selected for the central roof supports especially for its good, straight trunks. But such functional considerations aside, the two species may also have had an ideological significance, which partly determined their use.

notes

1 In the processing of the finds the label of a large stake of alder wood was evidently mistakenly switched with another label. The stake in question, which was 75 cm long and had a diameter of 6-8 cm, definitely derives from this cluster of stakes, judging from its characteristic post-depositional deformation and its typically sharpened end (fig. 3.27). It may be the missing stake no. 1865, but this could unfortunately not be confirmed.

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12 Fabrics of fibres and strips of bark

Laura Kooistra

The fills of two wells dated to phases 1 and 2a yielded two parts of a fine basketry-like fabric and four fragments of a fabric made using a twining technique. The first type was made from two single elements using the looping-around-the-core technique. The other was made by twining composite fibres. The raw material of both types of fabric was bark, possibly of willow (Salix). The fragments were sadly too small to provide any clues as to the fabrics' original functions. Although the employed techniques were widespread in the Neolithic, these finds are unique in the Netherlands.

12.1 Introduction

The former waterlogged conditions in the peripheral zone of the dune and in a large number of wells ensured the survival of a comparatively large amount of organic material. Chapters 11 (wooden artefacts), 19 (botanical macro-remains) and 21 (wood and charcoal) provide a survey of the remains, though it should be added that – considering the duration of the occupation – those remains represent only a fraction of what was once available. Among the organic remains were also some fragments of fabrics made from fine bark fibres using two different techniques, which were recovered from two well fills on the northwestern side of the dune. From fragments found elsewhere in Europe it is known that various techniques and raw materials were available for the manufacture of fabrics in the Neolithic, but information relating to the Netherlands and its wide surroundings is scarce. Little is also known about the function and the use of the objects that were made with the aid of basketry and fabric-twining techniques.

12.2 Materials

The two fragments numbered 3279 and 3280, which will for the sake of convenience be referred to as 'basketry-like fabrics' in this chapter, were contained in the secondary fill of a well dating from phase 1, which also yielded remains – likewise well-preserved – of plants deriving from both salt marshes and ruderal environments or fields (fig. 12.1).

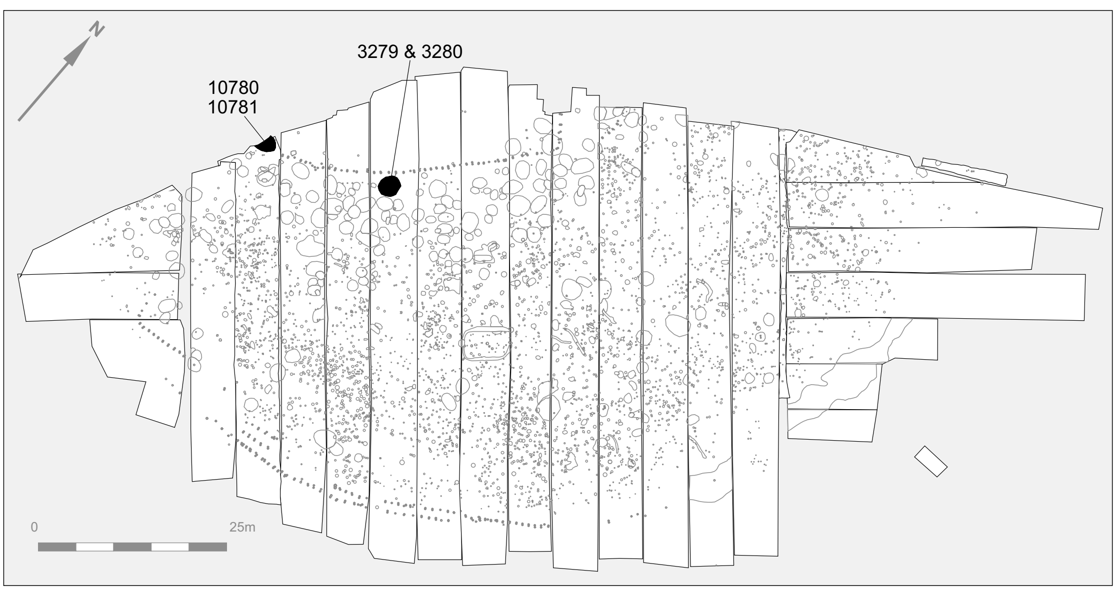


Figure 12.1 The features that yielded bark fibre artefacts and raw materials.

Some fifteen metres further west the fill of a well from phase 2a yielded remains of another type of very fine manufactured fabrics (no. 10,780). This fill contained a fairly large number of branches and twigs of alder (*Alnus*) and willow (*Salix*), plus some parts of wooden implements, waste produced in woodworking and nine strips of bark of Pomoideae (no. 10,781).

So both wells contained remains produced in several activities. The remains appear to represent waste or dumped material.

12.3 Methods

One of the parts of basketry-like fabrics was identified as such during the manual excavation of the well fill, the second was recovered from the sieve residue of one of the botanical samples. The fragments of fine fabric had been cemented together by post-depositional pressure. They were so indistinct in the soil and among other organic remains that it is quite possible that other fragments were overlooked.

The fragments were carefully cleaned with a soft brush and a pair of tweezers under water-saturated conditions under an incident light microscope (at 5x enlargement). Adhering soil was removed, and where necessary also plant roots that had at some later stage grown into the fabric. During the cleaning, the cemented package of fabrics was found to comprise at least four individual fragments of fabric (fig. 12.6). They were in fairly poor condition and penetrated by many roots. At a certain point the cleaning had to be discontinued due to the risk of the fabrics disintegrating completely.

The techniques employed to manufacture the fabrics were described by Willy Minkes, who based herself on Emery (1980).[1] The technique used for the basketry-like fabric could be readily identified. That employed in the manufacture of the fine fabrics was more difficult to determine due to the

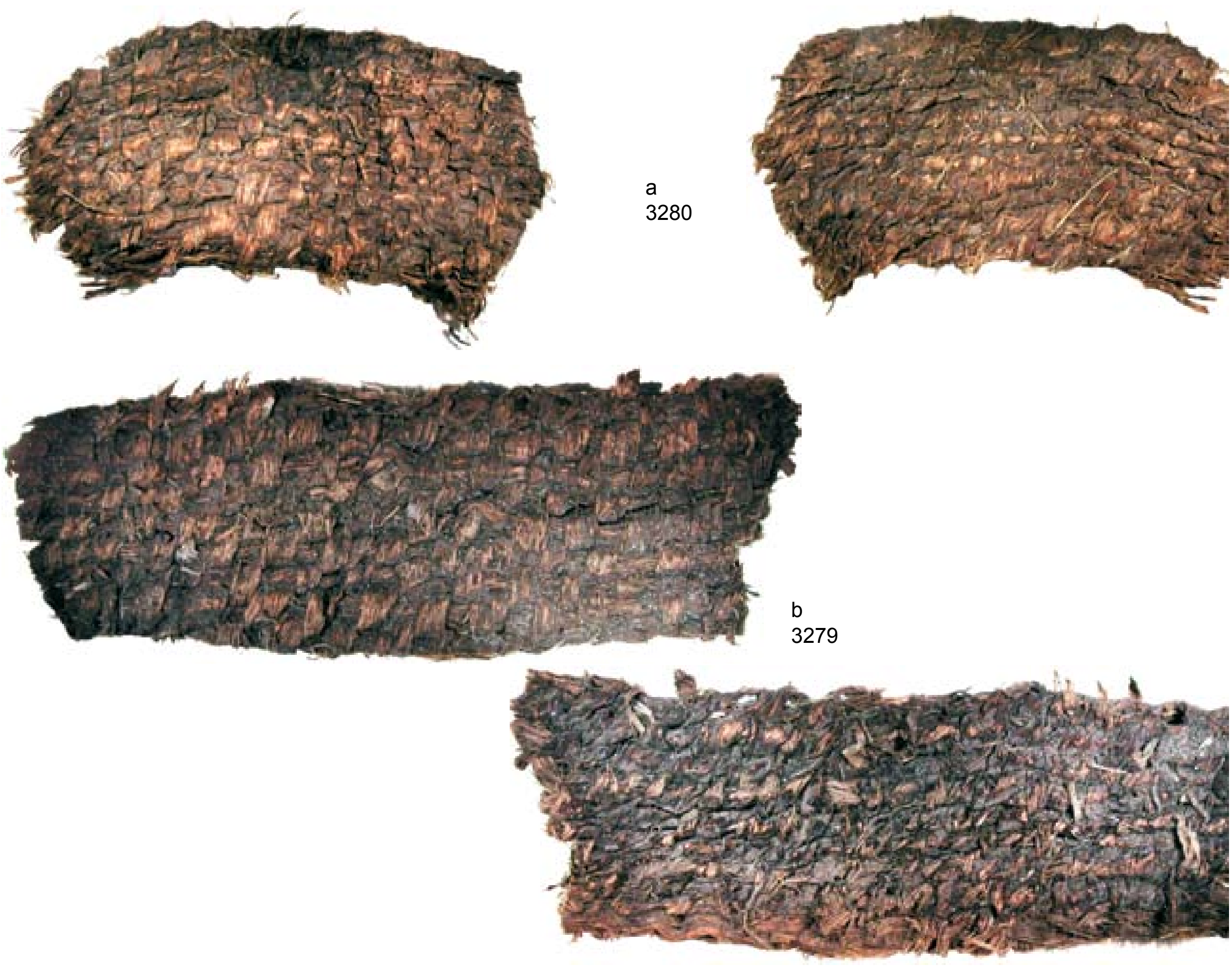


Figure 12.2 The two pieces of basketry-like fabrics viewed from both sides (scale 1:1).

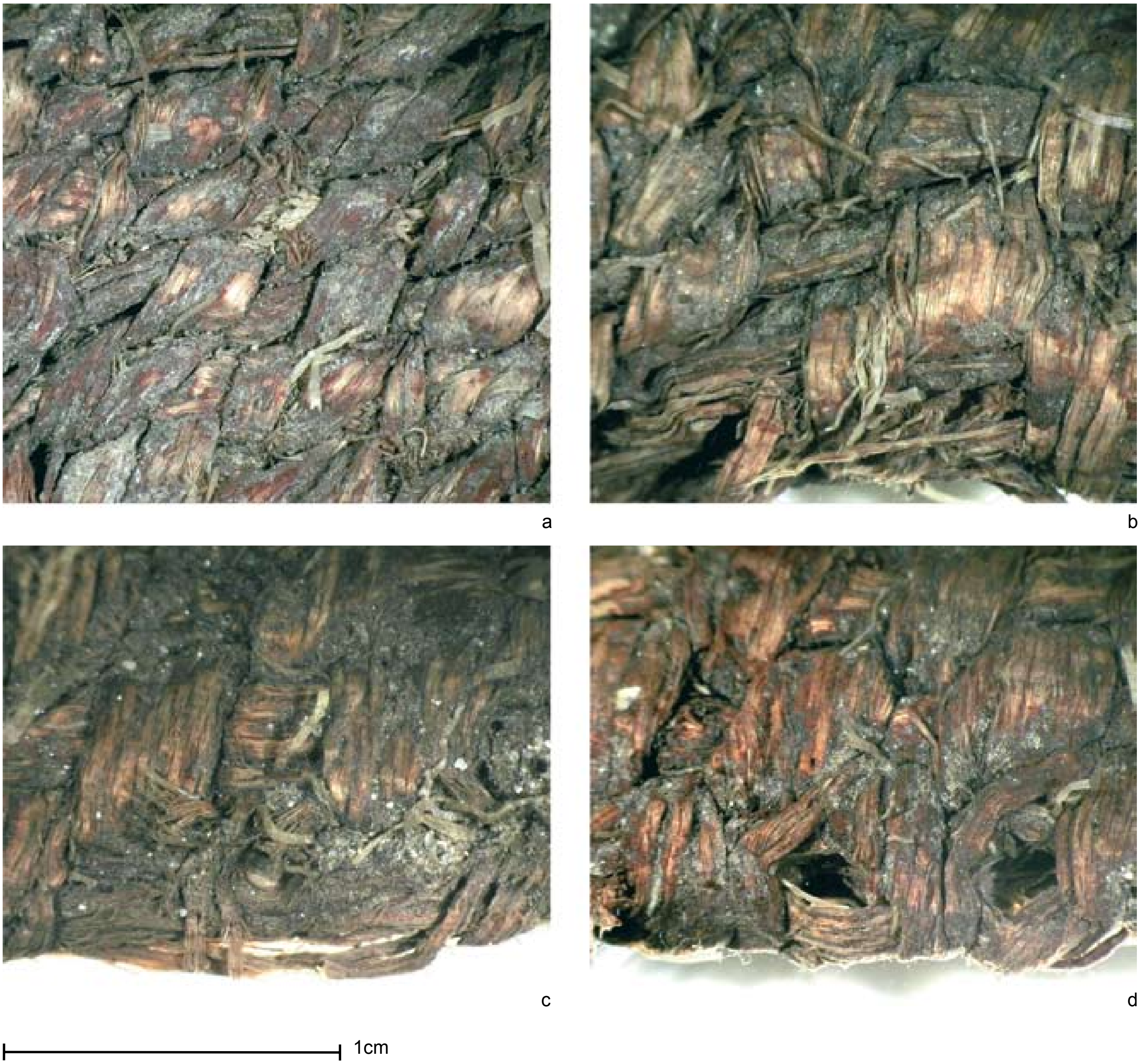


Figure 12.3 Basketry-like fabrics, details (magnification 8x).
a-c no. 3279
d no. 3280

poor preservation of the remains. To nevertheless form an impression of the technique, one of the fragments was picked apart and the process was recorded with a video camera.[2] Samples were taken of the different structural elements of both the fragments of basketry-like fabrics and the fine fabrics to identify the fibres. After the remains had been described and the raw materials identified, the fragments were conserved by Archeoplan at Delft.

12.4 Analysis

12.4.1 Fabrics made using the 'looping-around-the-core' technique (figs 12.2-4)

The basketry-like fabrics were made from two single elements, of which an active element (the looping) was as it were sewn round a second element (the foundation). Loopings can be sewn round foundations in various ways. In the case of the basketry-like fabrics from Schipluiden the

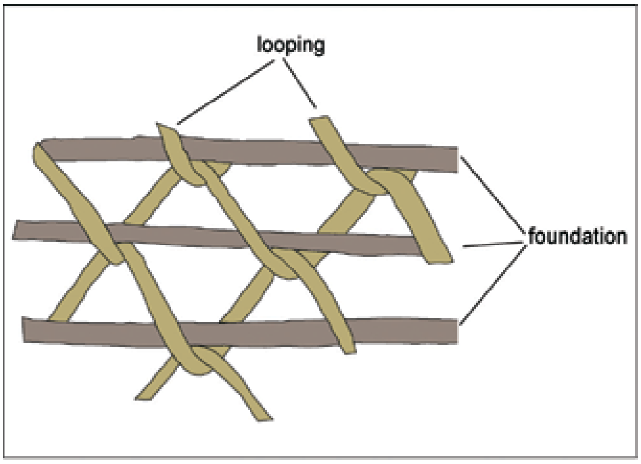


Figure 12.4 Schematic representation of the employed 'looping-around-the-core' technique.

loopings were each time inserted only through the underlying looping (so not through the looping and the underlying foundation together) and were sew around the adjacent foundation.

This technique involves almost exclusively spiral looping, rather than working to and fro as in weaving. Whether the fragments found at Schipluiden were also made by spiral looping is not entirely clear. The general appearance, with the loopings oriented diagonally on one side and more vertically on the other, indeed suggests spiral looping. If that is correct, the fragments probably derive from mats or tubular or cylindrical objects.

Fragment 1 (no. 3279) measures 10.5 × 3.5 × 0.4 cm. It comprises five foundations over a height of two centimetres and three loopings over a width of two centimetres. The foundation is slightly twisted; this was probably caused during manufacture. The loopings and the foundations are on average three mm in diameter. Regularly spaced small holes are visible on one side. They may have been made with an awl, presumably with the intention of inserting the loopings through them.

Fragment 2 (no. 3280) is a little smaller: 7 × 3 × 0.5 cm. It is finer in texture than the basketry of the first fragment: seven foundations are visible per two cm in height and four loopings per two cm in width. The foundation has an oval cross-section without any torsion and is thinner than the looping, which is flattened and varies in thickness from 2 to 4 mm.

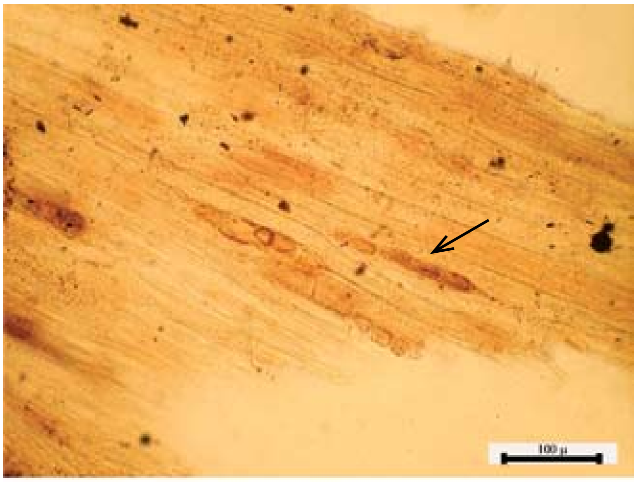
Samples of the foundations and loopings of both fragments were examined to study their anatomical characteristics. They were all found to consist of bark that was processed into strips of a few millimetres in diameter. Bark is often difficult to identify on the basis of anatomical features because properties that are invariable in wood, such as the width of the wood rays, vary in bark. The bark fibres however remarkably contain rays with a width of one cell that closely resemble those of willow (*Salix*) (fig. 12.5a). Due to the poor preservation it was not in each case possible to determine the width of the rays. Other characteristics of willow bark are chains of rhombic crystals in the outermost layers (fig. 12.5b) and rhombic and clustered crystals in the innermost layers (Gale/Cutler 2000, 236-241). No such crystals were observed in the fibres of the basketries, but the microscope did reveal chains of black rhombic structures (fig. 12.5c) that bear a close resemblance to willow bark crystals. In the case of crystals, polarised light would cause such structures to fluoresce, but no fluorescence was observed. The crystals could theoretically have dissolved and been replaced by organic matter during the long time they spent in the soil, but this was not the case here, because incident light did cause the black structures to fluoresce. Such structures could belong to pyrite if not for their shape, which is not characteristic of pyrite. The absence of evidence of clustered crystals makes it likely that we are after all dealing with the outer layers of willow bark; the rhombic crystals must have disappeared and been replaced by a different substance.

12.4.2 Fabrics made using a twining technique (figs. 6-7)

The four fabric fragments differ in size and thickness. The largest (5 × 3 cm) appears to have a wavy selvedge at the top. In spite of the poor preservation condition of the fabrics it could be ascertained that the technique employed in their manufacture was much finer than that used to make the basketry-like fabrics. The fabrics' function is not clear. The fragments could derive from bags or clothing.

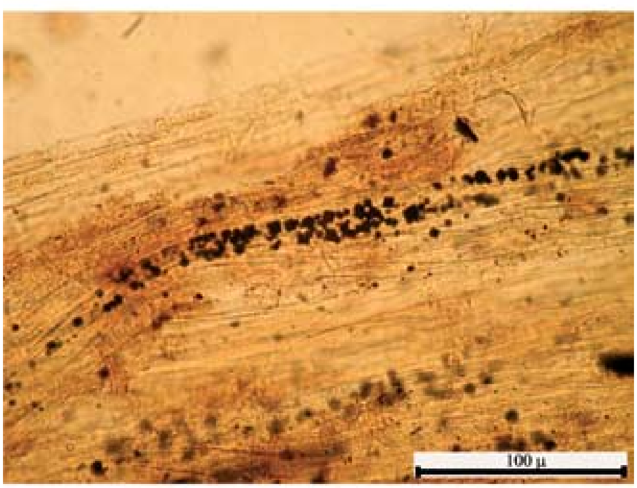
The passive elements in the investigated fabrics, *i.e.* the warps, consist of at least two thin fibres. The fibres themselves have an S orientation, but the warps are in Z orientation. The warps vary in diameter from one to one-and-a-half millimetre and probably lie parallel to one another. The warps were connected by twining two elements together (fig. 12.7). The distance between the twining elements seems to be about 3.5 millimetres. The twining elements are on the whole thinner than the warps, some consisting of a single fibre. Whether the twining elements investigated here consist of one or more fibres could not be ascertained. It was however clear that they were twisted, possibly as a result of the twining. Contrary to the technique discussed above, twining involves no implements such as piercers or awls.

Examination of the anatomical structure of the fibres led to the surprising conclusion that they, too, were made of bark, just like those used for the basketries. Even the structure of the bark fibres is comparable: the rays are one cell wide and



a

b



c

Figure 12.5 Fibre characteristics (magnification 250×).
a basketry-like fibres with uniseriate rays (no. 3279)
b presen-day bark of willow (*Salix*)
c black rhombic structures (no. 10,780)

the fibres contain chains of black rhombic structures (fig. 12.5c). So these fibres may likewise derive from the outermost parts of the bark of willow. These results show that Neolithic man was capable of processing bark into fibres with a thickness of less than half a millimetre.

12.5 Conclusions

The fragments of the different types of fabrics found at Schipluiden can be classed as highly unusual finds. Parallels of the Schipluiden fabric are scarce in northern Europe.

Fragments of basketry made using a similar technique and of a similar age (mid-fourth millennium cal BC) were uncovered in 1994 at the intertidal Neolithic site of Carrigdirty Rock, in the Shannon estuary, western Ireland (Maria Fitzgerald in O'Sullivan 2001, 78-82). They were not woven from bark fibres, but from thin (less than one-year-old) shoots of alder. The basket was made using a coiling technique in which 'a foundation coil, consisting of a bundle of shoots, was fastened together with a swing strip.' The technique is very similar to that used to make the somewhat finer fabric of Schipluiden. An exceptional textile fragment from Tybrind Vig, Denmark, Ertebølle Culture, was made using an entirely different, knitting technique (Coles/Coles 1989, 68).

In the Netherlands, comparable remains have been found only at the Hoge Vaart-A27 site, where they were recovered from the fill of a pit (no. 92, feature 901) that was dated 5710 ± 50 (UtC-4621, 4689-4409 cal. BC), *i.e.* an early phase of the Swifterbant culture, making them approximately 1000 years older than the Schipluiden finds (Hamburg *et al.* 2001, 17-21). There, the impressions of at least four mats with a minimum diameter of one metre were found in the clay. Parts of the mats were carbonised, which meant that the employed technique and raw materials could be identified. The technique used to manufacture the mats is the same as that used to make the Harnaschpolder basketry-like fabrics, but a different raw material was used. The Hoge Vaart-A27 mats were made from bundles of grass or rush with a thickness of between 1.2 and 10 mm, which were sewn together with twigs or bark of – most probably – birch (*Betula*). The technique according to which foundations were sewn together via loopings was widespread in the Neolithic and was used for the manufacture of a wide variety of objects (see for example Bender Jørgensen 1992; Rast-Eicher 1990; 1992). Insofar as can be ascertained, the foundation used in the case of this technique consisted of a single uninterrupted bundle or yarn, which was sewn onto itself with a different yarn, using an awl to make the required holes. The bone awls illustrated in figures 10.3 and 10.13 could have been used for this purpose. Wendrich (2000) calls this technique 'looping around a core'. It was used for manufacturing such objects as mats, baskets, hampers,

Figure 12.6 The four fragments of fine fabrics (no. 10,780), the largest with a wavy selvedge (scale 1:1).

quivers, hats and shoes. The raw materials varied, but bundles of grass and bark fibres were frequently used.

The twining technique was also commonly used to make a great diversity of objects from different raw materials. Many fish traps were for example made with this technique, but it was also used in the manufacture of fish nets and

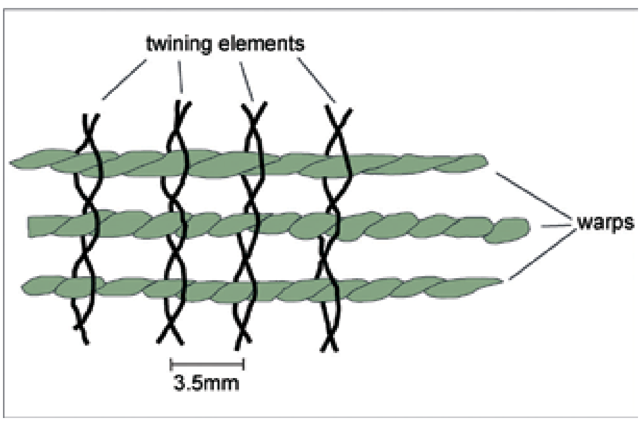


Figure 12.7 Schematic representation of the twining technique used to make the fine fabrics.

supple fabrics, as shown by the textile finds from Hornstaad-Hörnle I on the western shore of Lake Constance (Schlichtherle 1990, 124-131). The thickness of the warps and twining elements and the distance between the individual warps determines the texture and suppleness of the fabric. Flax (*Linum usitatissimum*) was usually used to obtain supple fabrics, but the use of bark in such fabrics is often underestimated. A surprisingly large proportion of the basketries and fabrics of the Neolithic lakeside settlement of Arbon were for example found to be made of the bark of lime (*Tilia*), whereas it had been assumed – partly on the basis of the many archaeobotanical finds – that flax was the main raw material used for the fabrics (Leuzinger 2002, 115).

The nine strips of bark (no. 10.781) found in the fill of a well dating from phase 2a acquire a deeper meaning in the light of the use of bark as a raw material for the manufacture of basketry and fabrics. Wood remains adhering to the strips of bark allowed the bark to be identified with certainty as deriving from Pomoideae. The strips are at most 13 cm long, 5.5 cm wide and 0.2-0.5 cm thick. They were stripped longitudinally from the tree. They may well be remnants of bark that was gathered for some specific purpose.

Little is known about the use of the bark of Pomoideae or that of willow in Neolithic contexts. From ethnographic studies it is known that occupants of British Columbia use bark, in particular willow bark, for many different purposes, including the manufacture of string and fish nets, baskets and clothing (Turner 1998). The inner part of the bark is even processed separately, to obtain a cotton-like substance that is used to dress wounds. The bark is isolated by stripping it from trees (sometimes even specifically dead trees) and drying it. It is then made soft and supple by rubbing it many times with a stone scraper.

notes

1 Willy Minkes is a specialist in the field of archaeological textile. She devoted her doctoral thesis, which she wrote at the Faculty of Archaeology of Leiden University, to fabrics of prehistoric Andes cultures (Minkes 2005). We would like to thank her for her help in the investigation.

2 With thanks to the *Laboratorium voor Artefactstudie* (Laboratory for the Study of Artefacts), Faculty of Archaeology, Leiden University, for making the necessary equipment available.

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13 Birch bark tar

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Jaap Boon

A piece of wood tar was found at Schipluiden, displaying teeth imprints. Mass spectro-metry showed that the piece of wood tar is most probably birch tar to which some fats or plant oil and some beeswax were added. It is a unique find and a very early example of this mixture. The tar may have been used as chewing gum, as suggested by teeth imprints, and/or as an adhesive as testified by the presence of traces of tar on a quite a few flint implements.

13.1 Introduction (A.v.G.)

One of the most remarkable finds from Schipluiden is a piece of wood tar (no. 8005), which initially found its way into the lithic assemblage because no one recognised it for what it was (fig. 13.1). The piece is especially interesting because it shows imprints of teeth, indicating chewing. The piece is also broken. It would seem that this was (intentionally) done in the past, as the fracture was not fresh.

Wood tar is a natural resin that has been heated. Resins are non-cellular plant exudates that are insoluble in water and serve to protect plants and trees when they are damaged. Resin is produced by various tree species all over the world, for example pine. In northwestern Europe pine resin and birch bark tar have over the centuries been used by man for various purposes.

The earliest known evidence of the use of birch bark tar as an adhesive dates from the Mesolithic (Aveling/Heron 1999). Slow heating of strips of birch bark in the absence of oxygen leads to a process of distillation in which the volatile compounds of the resin are released and the remaining resin is allowed to cool and set. The resulting product is called wood tar or wood pitch. The method for producing birch bark tar commonly known from the Middle Ages involved the use of two pots placed on top of each other, with the top one having holes through which the tar could trickle into the bottom one (Kurzweil/Todtenhaupt 1991). Several experiments have been carried out over the years to reproduce the tar-making process in attempts to answer the question how this could have been realised without using a ceramic vessel as the retainer (*e.g.* Czarnowski/Neubauer 1990; Weiner 1988). The pitch can be mixed with for example beeswax to give it flexibility and make it less brittle. Chopped straw may be added for the same purpose: the fibres make the pitch less fragile. Wood ash is known to have been added to tar, too. The resulting wood tar survives well under anaerobic conditions.

In the past, resins and wood tar were used for a variety of purposes. In the first place, they were useful adhesives for hafting flint tools. Being insoluble in water, they were also used for waterproofing objects such as canoes and for sealing wells. A well at the *Bandkeramik* site of Erkelenz-Kückhoven yielded a piece of birch bark pitch that was probably used in the well's lining (Ruthenberg/Weiner 1997). Birch bark pitch was even used to decorate ceramic vessels (Vogt 1949). From ethnographic sources we know that pitch can also be used as a disinfectant and for soothing toothache. It is probably the earliest chewing gum (Pollard/Heron 1996). Being particularly inflammable, it may also have been used as some sort of candle (see the sticks of pitch found in North America reported in Gibby 1997). In the last fifteen years a considerable amount of archaeometric research has

Figure 13.1 Piece of birch bark tar (no. 8005) viewed from two sides (scale 1:1).

focused on the analysis of wood tar (*e.g*. Beck *et al*. 1997; Bonfield *et al*. 1997; Hayek *et al*. 1990; Heron *et al*. 1991; Regert/Rolando 2002; Regert 2004).

13.2 Fingerprinting the sample (J.B.)

13.2.1 Method

Direct Temperature resolved Mass Spectrometry (DTMS) was used as the analytical technique to fingerprint the sample. In principle, this method entails the mass spectrometric monitoring of a sample that is heated on a Pt/Rh filament. Compounds adsorbed onto or sequestered in the sample are evaporated, after which the non-volatile residue is thermally decomposed to smaller fragments. The result is a dataset that consists of mass spectra (mass range 20-1000 Dalton) recorded as a function of time/temperature. This method has been used for the analysis of complex organic materials, often in association with inorganic substances. Typical recent applications concerned carbonised grains and peas (Braadbaart 2004), carbonised food residues and coatings on ancient pottery (Oudemans/Boon 1996; Oudemans *et al*. 2005a, b). The method has recently been applied to various archaeological objects in the Louvre (Regent/Rolando 2002).

Aliquots of about 50 micrograms of powder were homogenised in ethanol in a glass micro-mortar and applied to the filament probe. The instrument used was a JEOL SX102-102A tandem mass spectrometer. The MS conditions were 16 eV electron ionisation, 8kV acceleration voltage, scan range m/z 20-1000 at a rate of 1 s/scan. Data were processed in a JMA7000 data system and software.

13.2.2 Results

The sample was analysed twice: once using a smaller relative amount (run 4007) and once using a more concentrated sample (run 4008). The TIC of 4007 (fig. 13.2a) shows a narrow high peak in the temperature range of cross-linked condensed materials (scan 65-90). The ion current in the scan range of scan 50-65 is evidence of sequestered non-chemically bonded compounds, that evaporate from the sample. The summation spectrum at 16 eV of the cross-linked material is shown in figure 13.2b. The DTMS spectrum shows some typical fragment ions deriving from pentacyclic triterpenoids (m/z 189, 203) and some (near) molecular ions at m/z 394, 396, 406, 424, 438. Some of these peaks are also observable in the spectrum of birch resins presented in the paper by Regert and Rolando (2002), but they used different analytical conditions: in their 70 eV spectrum the relative number of fragment ions was greater than in our 16eV spectrum. There is also a possibility of shifts in the molecular ions due to water loss or other eliminations due to electron ionisation. Further confirmation of the presence of pentacyclic triterpenoids can be seen in figure 13.2b, which shows evaporating compounds in the range of m/z 390-460. Assignment of the resin fraction to a birch resin is reasonable, but would require confirmation by further GCMS studies to identify the individual compounds.

The DTMS spectrum also shows peaks representing C16:0 and C18:0 fatty acids (m/z 256 and 284). They imply the addition of drying oil (unsaturated plant seed oil) or fats that could have been used to thicken the pitch. Evidence of traces of beeswax was observed. The beeswax peaks are at m/z 592, 620, 648, 676 and 704. The mass peaks at 634 and 662 are not usually observed in fresh beeswax, but they could represent oxidation products (the addition of oxygen resulting in an hydroxyl group would add 16 Dalton; peroxidation and stabilisation of the radical would lead to loss of hydrogen and the formation of a keto group, *i.e*. 14 Dalton higher mass). Note that the relative amount of beeswax is small (magnification factor 30×).

To conclude, the sample of find number 8005 consists mainly of a pentacyclic triterpenoid resin, possibly birch resin. The substance may have been modified with fats or plant oil and some beeswax.

13.3 Conclusion (A.v.G.)

The presence of birch bark tar among the finds could imply that hafting and retooling took place at the site (Keeley 1982). The use of birch bark tar as glue is attested from the Mesolithic, possibly even earlier. Some of the stone tools found at Schipluiden show evidence of hafting (see chapter 7, fig. 13.3). In some cases small black specks were observed at points that may be assumed to represent the most obvious places for a haft (*i.e*. opposite a scraper edge or on the distal part of an arrowhead). Such evidence was observed especially on the arrowheads. Thirteen arrowheads show evidence of hafting and on nine of them black tar remains were observed (section 7.7.10). This makes it very likely that tar was used as an adhesive for fixing stone tools to their wooden, bone or antler hafts. Among the wooden artefacts found at Schipluiden are eight parts of axe handles and two possible adze hafts (chapter 11). The bone and antler assemblage however contains no hafts (chapter 10), contrary to for example that of the late Mesolithic sites of Hardinxveld-Giessendam (Louwe Kooijmans *et al*. 2001a, b). The number of hafts found at Schipluiden may therefore seem relatively small, but it should be borne in mind that wood was scarce on the dune, and many of the flint tools could easily have been used held in the hand. It is not sure whether tar was used in the hafting of the flint axes. No remnants of possible tar were observed on their butt ends. But then it was probably not necessary to attach an axe to a haft with the aid of wood tar, as such implements were usually hafted by means of impact, and were at most held in place with fibres. Hafting with an adhesive was probably

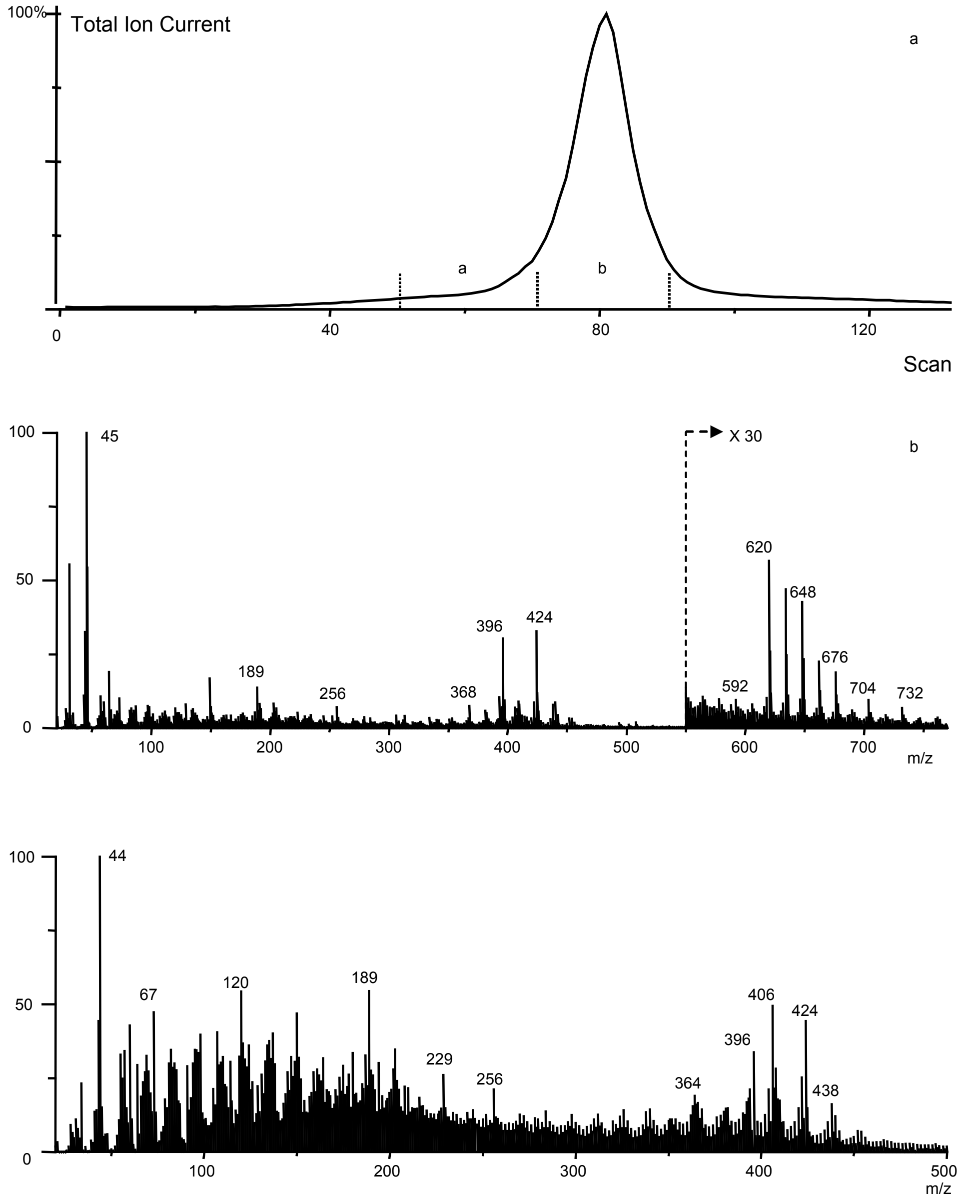

Figure 13.2 DTMS data of Schipluiden 8005 pitch sample showing a total ion current profile and the mass spectra summarised over in the scan ranges corresponding to evaporation of compounds (a) and thermally induced dissociation (b) leading to fragments of the cross linked pitch. The pattern of waxesters corresponding to beeswax is visible in the mass peak range from 590 to 740.

only relevant in the manufacture of arrows, and maybe incidentally in that of flake or blade tools.

Other uses have been proposed for tar, besides that as an adhesive (Aveling/Heron 1999; Pollard/Heron 1996). The chewing marks visible on this piece suggest that it served as chewing gum, possibly as a remedy for toothache. Tooth marks were observed on most of the pieces of tar found at Mesolithic sites in Scandinavia, as reported by Aveling and Heron (1999). To explain these ubiquitous tooth marks, they suggest that the tar was chewed to soften it prior to use, but they go on to argue that this is not very likely as saliva seems to diminish the adhesive qualities of tar. In four of the five cases analysed by Aveling and Heron the tooth marks are those of children aged 6-15. They note that this is the period during which children loose their milk teeth. This may well explain the tooth impressions observed on pieces of tar, but it does not exclude the possibility of the same material having been used as an adhesive, too. There is no reason why the birch bark tar should not have served multiple purposes.

The birch bark required to produce the tar was probably fairly readily obtainable. Birch may have grown in the catchment area of the Schipluiden occupants even though it is not represented among the wood and charcoal remains (chapter 21). The pitch could therefore have been produced locally, but we have no positive evidence to prove this. Being a very light, easily transported and preserved material, it may also have been brought to the site from elsewhere.

The practice of mixing resin with beeswax is known from ethnographic sources and has been studied in experiments (Van Gijn 1990). The relative amounts of resin and wax depend on the temperature: the higher the temperature, the greater the amount of resin that will be required, and the lower the temperature, the greater the amount of beeswax that will have to be mixed with it. Beeswax substantially enhances the flexibility of fixtures, as resin tends to be brittle. Birch bark tar is also very brittle without additives. Remains of beeswax have been found in ceramic vessels at various Middle Neolithic sites such as Bercy (Regert *et al*. 2001) and Chalain (Regert *et al*. 1999) and in the Middle Neolithic layers of the English site of Runnymede (Needham/Evans 1987). The authors who reported these findings attributed the presence of beeswax in the pots to its use as a sealant. The combined presence of birch bark tar and beeswax has recently been demonstrated in samples from ceramic sherds from Bronze and Iron Age contexts. The researchers interpreted this as the intentional mixing of birch bark tar and beeswax by Bronze and Iron Age peoples to obtain specialised adhesive products (Regert/Rolando 2002; Regert 2004). The lump of birch bark resin with beeswax admixture found at Schipluiden would push back the date of this specialised invention to the Middle Neolithic.[1]

The beeswax find has other implications as well. It indicates that the inhabitants of Schipluiden had access to honey to supplement their diet. Honey is rich in sugar, but it also has medicinal properties. The black honeybee *(Apis mellifera mellifera)* is indigenous in central and northern Europe, occurring as far north as Sweden and Norway (Millner 1996). It is highly adaptable to an adverse climate, will fly in drizzly weather and is capable of surviving harsh winters. It also forages over a long distance and is capable of surviving even where food resources are meagre (Millner 1996; T. Hakbijl, pers. comm.). There is no evidence to suggest that the honeybee had been domesticated by the time that the Schipluiden site was occupied, but the occupants may well have practised some sort of management of wild bee colonies. No lumps of birch tar were found in the contemporary assemblages of Ypenburg and Wateringen 4. Larger lumps of the fixing material have incidentally been found on tools, for example on one of the Sögel points from the Bronze Age barrow of Drouwen (Butler 1992). Small specks of possible tar have been observed on numerous flint tools during wear-trace analysis, also tools from Wateringen 4 (Van Gijn 1997). The Schipluiden find is however unique for this period. Such remains are very likely to be overlooked during excavation, as they resemble lumps of earth or clay. Usually a find like this leads to new finds, because people know what to look for. Whether this particular piece of tar was used as an adhesive or as chewing gum is not altogether clear. The teeth impressions do seem to point to the latter option. The presence of beeswax cannot be taken as proof that the wax was collected in the vicinity of the dune. It is equally possible that the inhabitants obtained the material

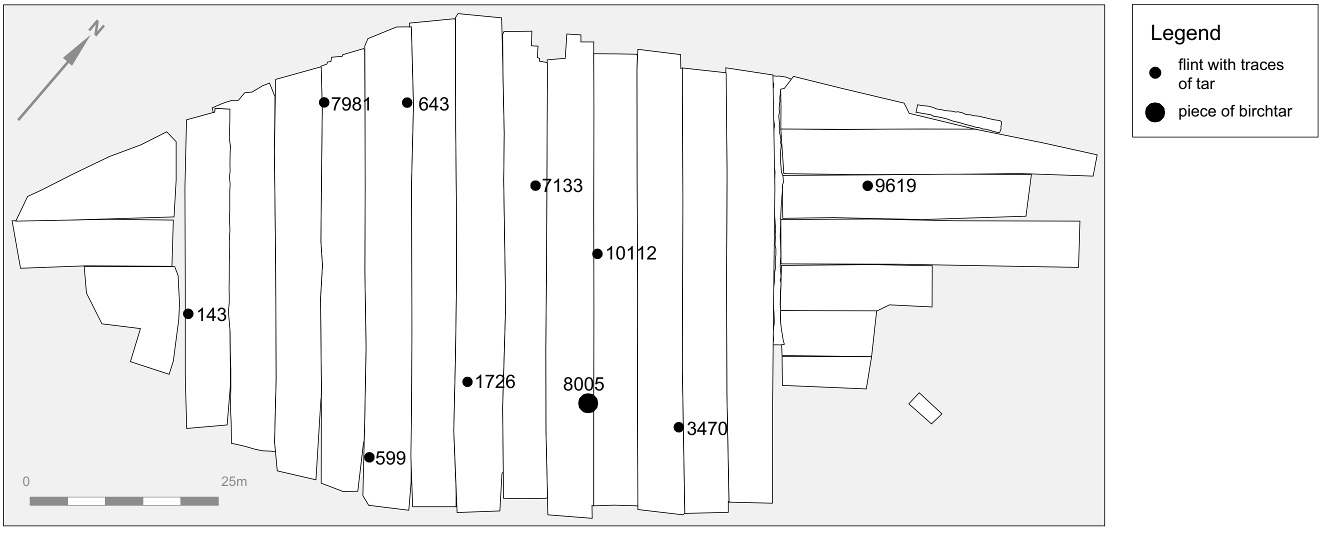

Figure 13.3 Findspots of the piece of birch bark tar and of flint with traces of tar.

from elsewhere. However, *Apis mellifera mellifera* is well adapted to fairly humid conditions, so there may well have been honeybees in the local environment. This would imply that honey could be exploited, too. Unfortunately bee remains are notoriously difficult to detect through entomological research due to their fragility and the unlikelihood of their remains ending up in a sample, but pollen analysis has proven successful in demonstrating beekeeping (Rosch 1999). The mixing of birch bark tar and beeswax had been demonstrated for Bronze and Iron Age contexts (Regert/Rolando 2002; Regert 2004), but the Schipluiden find indicates that this technological invention actually took place at least two millennia earlier, and probably has its roots in Mesolithic tool-making traditions.

Acknowledgements

The authors would like to thank Corrie Bakels for fruitful discussions about bees and their visibility in the archaeological record. We are also very grateful to Dr Tom Hakbijl, who provided relevant information on the occurrence of honeybees at northern latitudes.

notes

1 The 1987 Needham and Evans article mentions the discovery of beeswax on a Neolithic sherd and dwells on the issue of beekeeping by prehistoric peoples. Interestingly, table 1 of this article includes a sample that was found to contain traces of beeswax alongside resin (sample S2). This same sample also contained traces of glucose, which is the focus of the authors' attention. They do not discuss the presence of resin in the sample, but this may actually be another indication that resin was mixed with beeswax at much earlier times than claimed by Regert/Rolando (2002), who associate this "invention" with the advent of iron metallurgy.

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Part III

Ecology and economy

14 Coastal evolution of Delfland and the Schipluiden microregion in relation to Neolithic settlement

Joanne Mol

During the period of occupation the Dutch coastal plain experienced considerable changes. Coastal retreat had ceased only recently and a period during which the coastline closed and subsequently prograded seawards had just started. This newly developed landscape – a tidal lagoon behind a closed barrier system – provided excellent circumstances for settlement. Three palaeogeographic maps that show the landscape during the occupation phases were extracted from geological subsurface data. These data were obtained in augering where that was possible around the site. Together with data from earlier research, this information yielded a detailed picture of the situation in which the people lived.

14.1 Introduction

In the past few decades large infrastructure projects have been executed in the western part of the Netherlands, generating many exposures. The operations not only led to the discovery of archaeological sites, but also enabled sedimentological studies of the subsurface, which have resulted in a detailed picture of the complicated coastal development of the western Netherlands.

This coastal development is the key to understanding the prehistoric occupation history of this part of the Netherlands, because site selection was largely dictated by the natural environment. The main factor in the prehistoric selection process was the presence of natural elevations, since the greater part of the region was regularly flooded. Other factors related to subsistence strategies, as hunting, fishing, gathering and farming will also have been dependent on their natural constraints, such as the presence of water and water courses. Therefore, knowledge of the exact nature of the landscape will result in a better understanding of the archaeology of this area.

During the Holocene, a considerable rise in sea level combined with changes in sediment supply caused the coastline to periodically advance and retreat. Many prehistoric sites have survived in a thick sequence (approx. 20 m) of marine deposits extending inland beyond the present coastline. The oldest preserved sites in this region have been dated to the Middle Neolithic. They include Rijswijk A4 (Van der Valk 1992), Wateringen 4 (Raemaekers *et al.* 1993), Wateringse Veld (Oude Rengerink 1996b) and Ypenburg (Oude Rengerink 1996a; Cleveringa 2000). Schipluiden-Harnaschpolder (fig. 14.1) can now be added to this list.

The positions of these prehistoric sites, on top of low dunes, gave rise to wild speculations about the course of the former coastline. Every time a new site was found further inland the former coastline was pushed progressively further eastwards. But is this really how things were? Although the general development of the landscape is known, the natural settings of the settlements have not yet been studied in an integrated approach. Did the settlements indeed lie along a former coastline or were they perhaps situated further inland, in the extensive wetlands that bordered the coastal barrier system? This study aims to combine the vast amounts of archaeological and geological data available, and to provide a general geological framework in which all sites can be viewed within a single palaeoenvironment. The first part of the chapter gives an overview of the evidence available prior to the Schipluiden excavation. The second part covers the environmental data relating to the new site and its environs, which place the site within the established framework.

14.2 Coastal development of the Holland basin

The coastal development of the Netherlands was strongly influenced by the Pleistocene subsurface. The Late Weichselian surface was an east-west dipping plain with two shallow valleys: the Zeeland basin and the Holland basin. The river Rhine formed the boundary between these basins (Beets/Van der Spek 2000). The Zeeland basin lay in the south and is nowadays the main drainage basin of the Scheldt, Rhine and Meuse. Our study area lies just to the north of this basin.

The increase in temperature after the last ice age caused a rapid rise in sea level, which resulted in gradual flooding of the North Sea basin. By 8000 BP (*c.* 6900 cal BC)[1] the sea had reached the present coastline and the Holland and Zeeland basins were submerged. Large marshes formed, resulting in the development of an extensive layer of peat (Basal Peat) on top of the Pleistocene subsurface. The river Rhine however supplied sediment at the same pace as the rise in sea level (Beets/Van der Spek 2000).

The continuing rise in sea level led to the development of large lagoons within the basins, in which tidal back-barrier

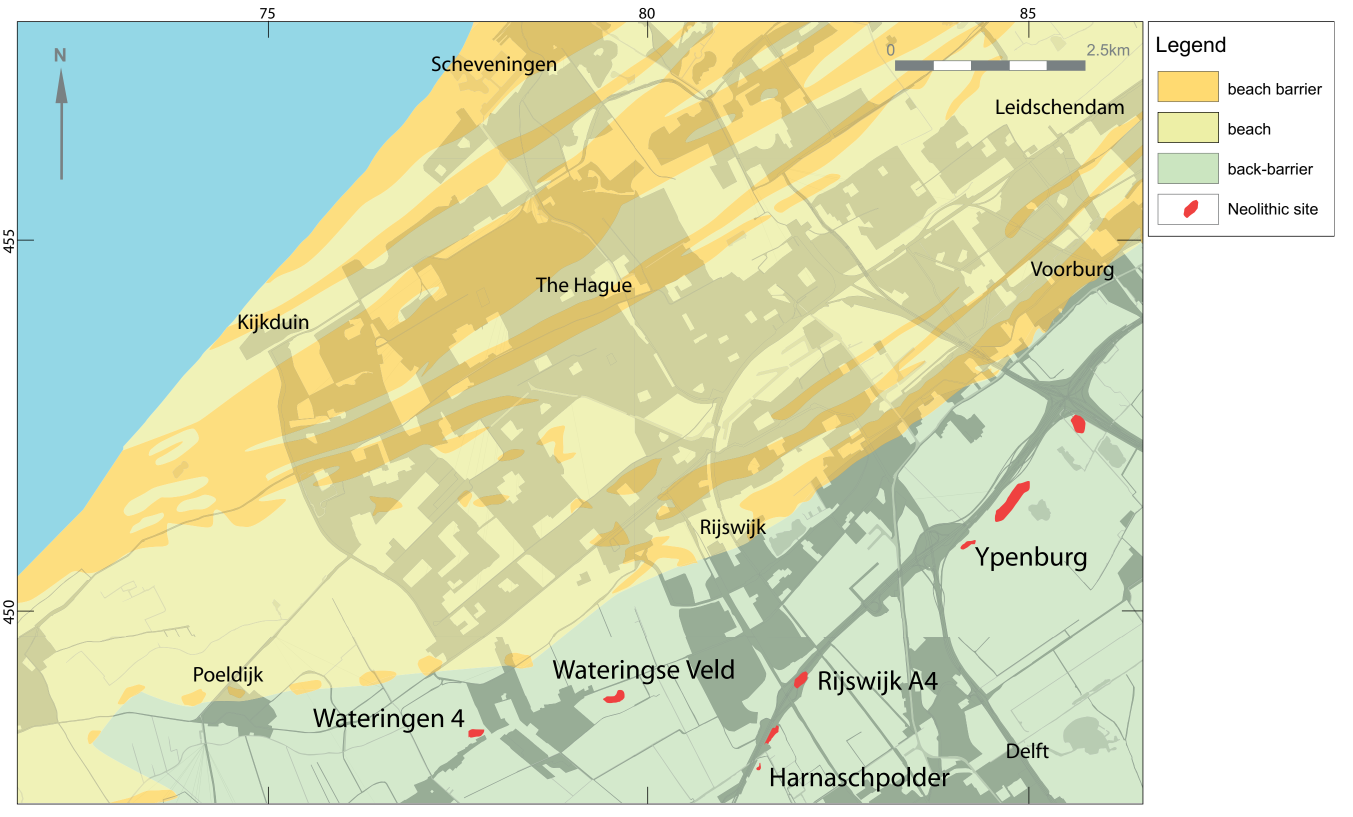


Figure 14.1 Location of Schipluiden-Harnaschpolder and four contemporary sites in the back-barrier area in between the oldest beach ridge (Voorburg-Rijswijk) and the marshes (After Van der Valk 1992 and Deeben *et al.* 2002, scale 1:100,000).

deposition dominated (Calais Member).[2] Apparently, a system of beach barriers shielded the mainland from direct influence of open marine conditions, but those barriers have not survived. Only around 6000 BP (*c*. 4850 cal BC) did the pace at which sediment was supplied begin to exceed the rise in sea level (30 cm per century at that time). Consequently, the tidal inlets filled up and the coast became fixed and began to prograde seawards (Beets/Van der Spek 2000; Cleveringa 2000). The start of this progradation varied from place to place, dependent on local conditions, such as the size of the tidal basin (Van der Valk 1992). All deposits laid down from this time onwards have survived, including the inactive beach-barrier systems, because the newly formed barriers that protected the coast lay seaward of the older ones. On top of these barriers, dune formation took place ('Older Dunes'), resulting in low elongated ridges. These dunes nowadays lie subparallel to the present coastline (figs. 14.1-2). The Neolithic settlements in this region all lay on top of such dunes.

During the Subboreal (5000-2900 BP, *c*. 3800-1100 cal BC) tidal inlets with marine influence were restricted to the areas of Rotterdam, Leiden and IJmuiden (Van der Valk 1992; Beets/Van der Spek 2000). The Holland basin consequently became a vast marsh with extensive peat formation (Holland Peat). The lowest-lying dunes were gradually covered by these aquatic deposits, whereas the ridges further west, which were younger and higher, are still visible as outcrops at the surface today. These ridges are separated by elongated depressions filled with peat.

The period of rapid and extensive coastal progradation came to an end after about two millennia, when large-scale erosion of the coastline started. This resulted in a straightening of the coastline. The protruding coastline in the southwest was eroded, its sand supplementing the central part (near Haarlem) until 1900 BP (*c*. AD 100). Near Wassenaar the erosion started relatively early, around 3500 BP (*c*. 1800 cal BC), but near Haarlem it did not start until after 1900 BP (*c*. AD 100) (Van der Spek *et al*. 1999). The duration of this erosion phase also differed from place to place, even lasting until 750 BP (AD 1270) near Kijkduin (to the south of The Hague; Roep 1984). It was accompanied by a steepening of the coastal profile and the development of an extensive dune system

('Younger Dunes'), which started *c*. AD 1300 near The Hague and several hundreds of years earlier near IJmuiden. These Younger Dunes are considerably higher (20-50 m) than the previously formed Older Dunes. They consist of a series of parabolic dunes characterised by a high ridge and a steep eastward-facing slope on their landward side. They originated as a migrating barren dune system (Zagwijn 1984). It is this system that forms the present coastline (not indicated in fig. 14.1). After the development of the Younger Dunes, marine influence in the Holland Basin was restricted to deposition near small tidal inlets (Dunkirk Deposits), one of which – known as the Gantel – influenced the landscape of our study area.

14.3 Previous research in the study area

The study area lies approximately 10 km from the present coastline, in the coastal back-barrier area (figs. 14.1-2). The base of the Holocene sequence (older than 5900 BP, *c*. 4800 cal BC) consists of Early and Middle Atlantic fluvial, tidal-flat and estuarine deposits, including Basal Peat (fig. 14.3). To the north of Rijswijk the Early Atlantic deposits comprise tidal flat deposits, some tidal channel deposits and lagoonal clays. In the south, however, estuarine and fluvial deposits prevail due to the presence of an estuary south of The Hague. A barrier island must initially have separated the northern tidal area from the southern estuarine area, but it has not survived. A layer of peat found overlying these deposits at Leidschendam has been dated to 5625 ± 45 BP (4550-4350 cal BC) (Van der Valk 1992, 1996).

By *c*. 5500 BP (4350 cal BC) the shoreline had retreated to its most landward position, extending to the Ypenburg and Rijswijk A4 exposures (Cleveringa 2000). By this time no large beach barriers had yet been formed, but a large sandy beach plain[3] dominated by wash-over deposits developed on top of the tidal and estuarine deposits. Deposition of such wash-over deposits is only feasible in the presence of a coastal barrier over which storm-driven deposits are funnelled. The barrier itself probably consisted of similar, older wash-over deposits that were remodelled by waves. The shore-face deposits have not survived. The barrier must have been fairly low and small, and not comparable with the later beach-ridge deposits (with foredunes).

From this time onwards, coastal erosion was replaced by coastal progradation and all younger sediments were deposited seaward (west) of the older ones. Towards the east, back-barrier deposits (mainly clay) were still being deposited and towards the north was a tidal channel that extended 12 km in an easterly direction (Van der Valk 1992, 1996; Gutjahr/Van der Valk 1996; Vos/Kiden 2005; fig. 14.2). These sands have been intensively investigated by Van der Valk (1996) and Cleveringa (2000). Van der Valk called them 'Rijswijk-Zoetermeer sands'. Sedimentary research showed that the base of these sands is wave-dominated, while the top is mainly aeolian. Shells preserved *in-situ* in these sands near Rijswijk have been dated to 5350 ± 80 BP (4340-3980 cal BC) and 5560 ± 80 BP (4590-4220 cal BC).

Continuing progradation led to the formation of a coastal system that comprised a beach ridge, a beach plain and a marsh. This system was associated with the development of dunes and led to the formation of the Voorburg-Rijswijk beach ridge around 4900 BP (*c*. 3700 cal BC) (Zagwijn 1965; Roep 1984; Van der Valk 1992) and progressively younger beach ridges further west. Their height and depth increased towards the west, in line with the rise in sea level (Van der Valk 1992; Cleveringa 2000). These beach ridges (which now support dunes) are still observable in the present-day landscape. They were several metres higher than the previously formed barrier systems and were able to shield the back-barrier area from direct marine influences.

During the next phase of coastal development, an extensive wetland developed behind the newly formed barriers, in which clay was deposited between the Old Rhine in the north and the Meuse inlet in the south. Eventually, all marine influences disappeared for a prolonged period and a vegetation cover developed, resulting in at least 3 m of peat (Cleveringa 2000). Near our study area the onset of this peat growth has been dated to 4670 ± 65 BP (3640-3340 cal BC; Rijswijk-Plaspoelpolder; Van der Valk 1996).

Around 300 cal BC peat development was interrupted by a phase of floods (Van Staalduinen 1979) resulting from a marine incursion in the Meuse estuary near Naaldwijk (south of The Hague). This led to the formation of a vast clay cover on top of the peat, followed by local erosion by the largest channels of this system (Van der Valk 1996; Asmussen 1992; Cleveringa 2000). The tidal deposits formed in this inlet – the aforementioned Gantel – can be traced in the subsurface of The Hague, Rijswijk and Delft. Asmussen (1992) mapped one of the large channels that ran north and east of our study area, with some smaller branches extending northwards. Van Staalduinen (1979) dated this tidal system to between *c*. 940 cal BC (2645 ± 65 BP) and AD 440 (1725 ± 65 BP) near its outlet.

Archaeological finds from Naaldwijk-Broekpolder (approx. 5 km west of Schipluiden-Harnaschpolder) suggest a later date, of around 300 BC, for the beginning of the system's formation in the study area (Van Staalduinen 1979). Asmussen (1992) suggested that there were no long significant episodes of flooding in this region from the Roman period until the Middle Ages, which would imply that this tidal inlet was active for a relatively short episode of flooding in the study area.

14.4 Previously studied Neolithic sites in the region

There are at least four more sites, likewise situated on top of low dunes, which were occupied during the same period as

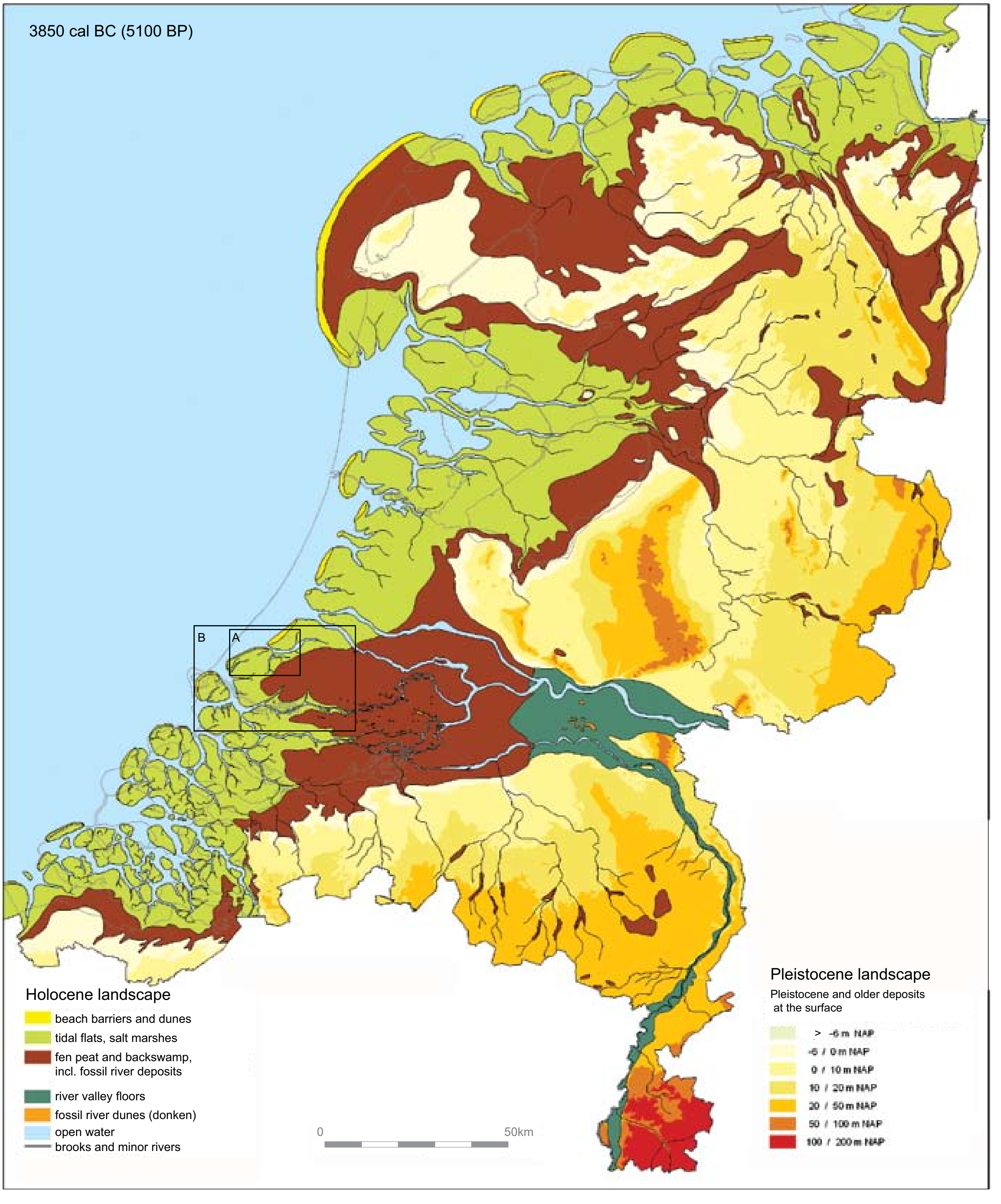


Figure 14.2 Palaeogeography of the Netherlands, c. 3850 cal BC (after Vos/Kiden 2005). Indicated are the Schipluiden site, the location of the maps of figs. 14.1 and 14.8 (A), and of fig. 27.6 (B). This stage is about two centuries earlier than the occupation at Schipluiden. The tidal inlet to the north of the site is still open. Please note that the (uninhabitable) tidal flats and the (inhabitable) salt marshes are indicated with the same green signature, which makes one easily overrate the conditions for occupation.

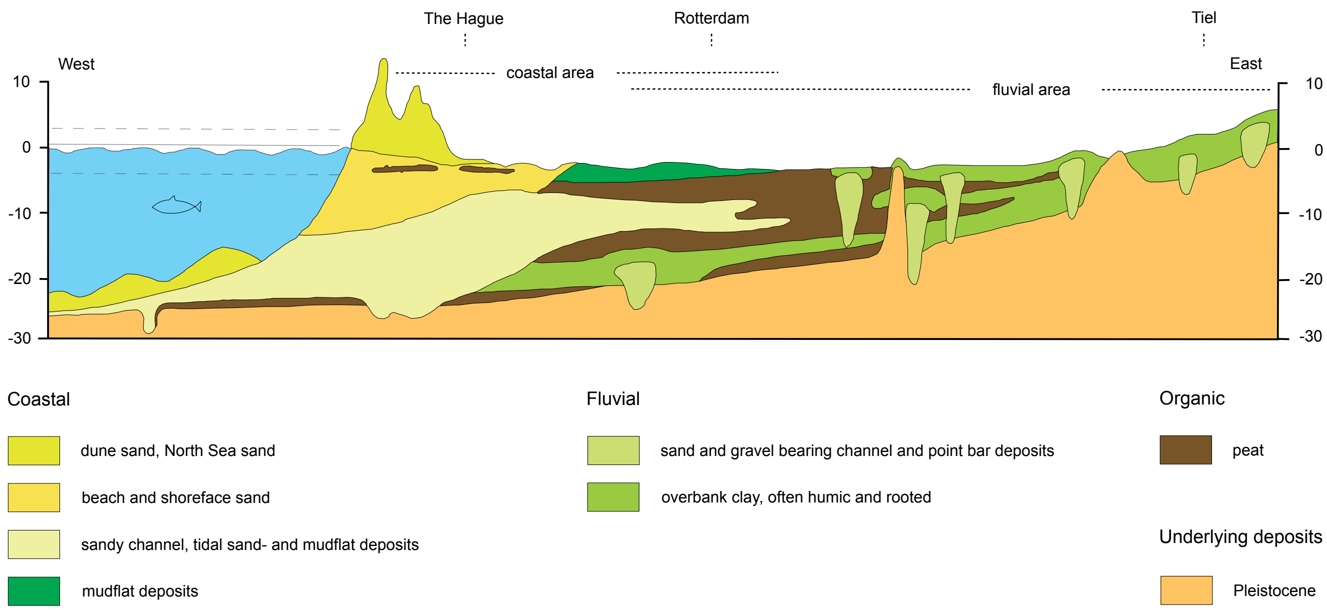


Figure 14.3 West-east section across the coast and the coastal plain between The Hague and the fluvial area indicating the location and stratigraphical position of the Schipluiden site. After Weerts *et al.* 2004.

Schipluiden-Harnaschpolder (fig. 14.1). Two of them have been studied sedimentologically: Ypenburg and Rijswijk A4 (Van der Valk 1992, Cleveringa 2000). They have provided valuable information on the environment in which their occupants lived, although the researchers concentrated on the earlier coastal development and paid comparatively little attention to the environmental conditions during the subsequent period of human occupation. The other studies conducted at these sites were mainly archaeological, but the archaeological surveys also yielded some spatial data that could be incorporated in the previously established framework (section 14.8).

14.4.1 Ypenburg

The Ypenburg site extended across the tops of several solitary dunes (Oude Rengerink 1996a). This site was studied by Cleveringa (2000). The Ypenburg area lies on the most landward palaeocoastline in this region. The subsurface comprises (tidal) channel deposits covered by wash-over deposits representing coastal erosion. They are overlain by beach ridges, a beach plain (the Rijswijk-Zoetermeer sands) and more distally situated marsh deposits representing the subsequent progradational phase in the history of coastal formation. Dunes were formed here and there on top of the beach ridges and beach plain, and they afforded suitable conditions for prehistoric settlement. The largest of the dunes has a length of 1 km and a width of 150 m; the others are much smaller (with lengths of up to 250 m). Some of them overlie the beach plain and marsh deposits, whereas others were formed directly on top of proximal wash-over deposits. These dunes have dates of *c.* 4000 cal BC and younger, as can be inferred from the dates ranging from 5522 ± 45 BP (4450-4250 cal BC) to 5358 ± 43 BP (4300-4000 cal BC) obtained for the underlying wash-over deposits. A channel dissecting the beach plain dates from 5019 ± 35 BP (3900-3700 cal BC).

14.4.2 Rijswijk A4

The Rijswijk A4 site was sedimentologically studied by Van der Valk (1992, 1996), who interpreted the subsurface of the dune as follows: at least 2 m of sand (the Rijswijk-Zoetermeer sands) was deposited in an open coastal situation. The sand is coarser towards the top, indicating a decrease in water depth and the formation of a beach plain at the top. The beach plain deposits are covered by fine sands with clay beds, covered by a layer of clay that is centuries younger. The fine sands represent wash-over deposits that grade into aeolian deposits with a dune morphology at the top. These dunes were formed in a more sheltered (back-barrier) environment and were used as occupation sites several centuries later.

A sample of the peat (Rijswijk Plaspoelpolder) covering the Rijswijk-Zoetermeer sand 900 m west of the exposure was dated to 4670 ± 65 BP (3638-3341 cal BC), which gives a *terminus post quem* date for the dune's formation. Cleveringa (2000) correlated the basal part of the Rijswijk-Zoetermeer sands with the wash-over deposits at Ypenburg on the basis of age and sedimentological characteristics. He suggested that the oldest coastline found at Ypenburg will have extended to the south of this exposure.

14.4.3 Wateringse Veld

Several lithological sections of the Wateringse Veld site show a dune and beach-ridge morphology, covered by thin layers of peat alternating with clay (Oude Rengerink 1996b). The nature of the underlying deposits is not clear because the sections extended no deeper than 60 cm into the sandy top. Comparision with Rijswijk A4 and Ypenburg showed that this site also lay on top of back-barrier deposits covering the Rijswijk-Zoetermeer sands.

14.4.4 Wateringen 4

The top part of the dune that bore the Wateringen 4 site was found to contain a thin layer of soil underlying the peat and clay (Raemaekers *et al.* 1997). Limited information is available on the natural setting of the site; the excavation report describes only the underlying dune and marine sand.

The dune lies on top of layers of fine sand alternating with clay. The clay points to a back-barrier environment. The deposits resemble those of the Rijswijk A4 site (Van der Valk (1992), suggesting that the sands were deposited in an environment similar to that at Rijswijk A4: a tidal or estuarine back-barrier with local dune formation.

14.5 Schipluiden-Harnaschpolder

The Schipluiden-Harnaschpolder settlement lay on top of a small dune (chapter 2) in an extensive tidal back-barrier environment. A survey conducted by Deunhouwer (2001, 2002) revealed a rough impression of the size of the dune, but at that time the dune's setting in the coastal landscape was not yet fully understood. His results moreover suggested that the dune extended further north, beyond the area covered in the survey. Therefore, a total of 419 manual corings were conducted around the site (fig 14.4) in the hope that they would provide a good impression of the stratigraphy within an area of approximately 1 km^2 and would reveal any new sites in that area.

Figure 14.5 presents a NW-SE transect through the study area showing the main characteristics of the stratigraphy of the subsurface. All units that were distinguished during the excavation and discussed in chapter 2 will be referred to below. Figure 14.6 shows a transect through the excavation site that was used to correlate the on- and off-site deposits. It should be borne in mind that the height of the dune indicated in this figure is not its maximum height, because the data on which this figure is based refer to the southern slope of the dune.

The following sediments were encountered (from bottom to top): the first deposit consists of at least 2 metres of weak silty clay containing shells preserved *in situ* and a few layers of peat. The clay was encountered only below approx. -8 m NAP and represents an early depositional phase, well before the period of occupation (not shown in figure 14.5). The shells preserved *in situ* in the sediment point to a tidal to brackish environment (chapter 16). This deposit can be correlated with the lagoonal clays dating from the Early Atlantic which were laid down during the flooding of the Holland basin.

On top of this clay is an approximately 3-m thick sequence of silty sand alternating with layers of clay containing shells preserved *in situ*, which was clearly visible at the base of both transects (figs. 14.5-6). The sand was encountered almost everywhere in the study area. Its height increases slightly from the southeast to the northwest, although local variations resulted in a microtopography which will be discussed below (fig. 14.7). It can be correlated with the Rijswijk-Zoetermeer sands, a large beach plain representing the first phase of coastal progradation in this region (Van der Valk 1992; Cleveringa 2000; fig. 14.1).

The Rijswijk-Zoetermeer sands are covered by a layer of silty clay with a thickness of approximately 1.5 m. This clay was clearly deposited in a back-barrier environment, protected from direct wave influence. Shells found in this deposit point to a saline to brackish environment, while diatoms indisputably indicate brackish conditions (chapters 15 and 16). It must therefore be regarded as an estuarine deposit, equivalent to Unit 40 at the site (chapter 2). The clay is in some parts intercalated with layers of sand (150-210 μm) of varying thickness, one of which represents the dune bearing the Schipluiden-Harnaschpolder site (fig. 14.5). Thin intercalated layers of clay at its base point to aquatic deposition (Unit 26), though the upper part is clearly aeolian (Unit 25), with a soil in the top. Van der Valk (1992) and Cleveringa (2000) made similar observations and interpreted the base of these sands as wash-over deposits and the top as dune sands. The presence of wash-over deposits points to a back-barrier environment, shielded from direct influence of the sea.

Clay sedimentation continued after the dune's formation, as could be inferred from the fact that clay was encountered up to -3.8 m NAP (chapter 2). This unit was not easy to identify in borings, mainly because in most areas it lay directly on top of the older clay (Unit 40). It can be correlated with Units 19 and 18 discussed in chapter 2. This clay contained the lowermost archaeological finds. Diatoms in this clay likewise point to estuarine conditions (chapter 15).

The entire sequence is covered by a layer of peat, which has oxidised in most places. This layer can be followed over long distances. It can be correlated with Unit 10 at the site (occupation phase 3) and covers almost the entire study area, except for a small part of the dune bearing the Schipluiden-Harnaschpolder site and two other small dunes to the north and south of the site (fig. 14.7a). The oxidised peat is covered

Figure 14.4 The study area showing the boring points and the excavation (scale 1:10,000).

by a thin layer of clay with a maximum thickness of 20 cm (equated with Unit 2). It represents a short flood event representing the last phase of marine influences in this region for a long period. After the deposition of this clay peat development continued, ultimately resulting in a layer with a maximum depth of 2 metres consisting mainly of reed and sedge peat here and there mixed with wood peat (chapter 18).

The final deposit overlying the peat in this region is clastic and has suffered erosion. Its thickness varies from 30 cm in the southwest to at least 6 m in the north of the study area. This upper unit can be correlated with Unit 0 and shows a sequence of sand alternating with layers of silty clay and reworked peat that becomes finer towards the top, grading into silty clay mixed with layers of sand. The unit was deposited by the Gantel, a tidal inlet that removed a large part of the underlying deposits along its course, including the top of the dune.

14.6 Palaeoenvironmental reconstructions of the surroundings of the Schipluiden-Harnasch-polder site

14.6.1 Method

The palaeolandscape of the microregion has been reconstructed entirely on the basis of the data obtained in the borings in

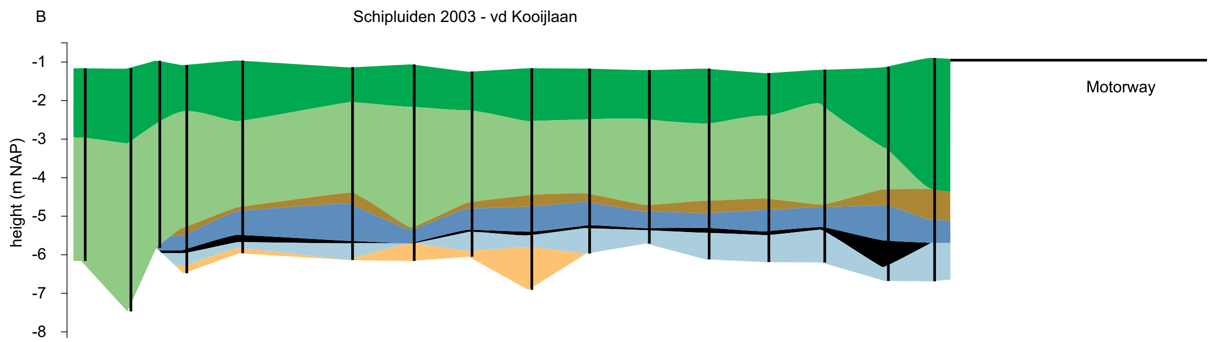


Figure 14.5 Transect B-B’ through the study area. Horizontal scale 1:4000, height exaggerated 20×. See fig. 14.6 for the legend.

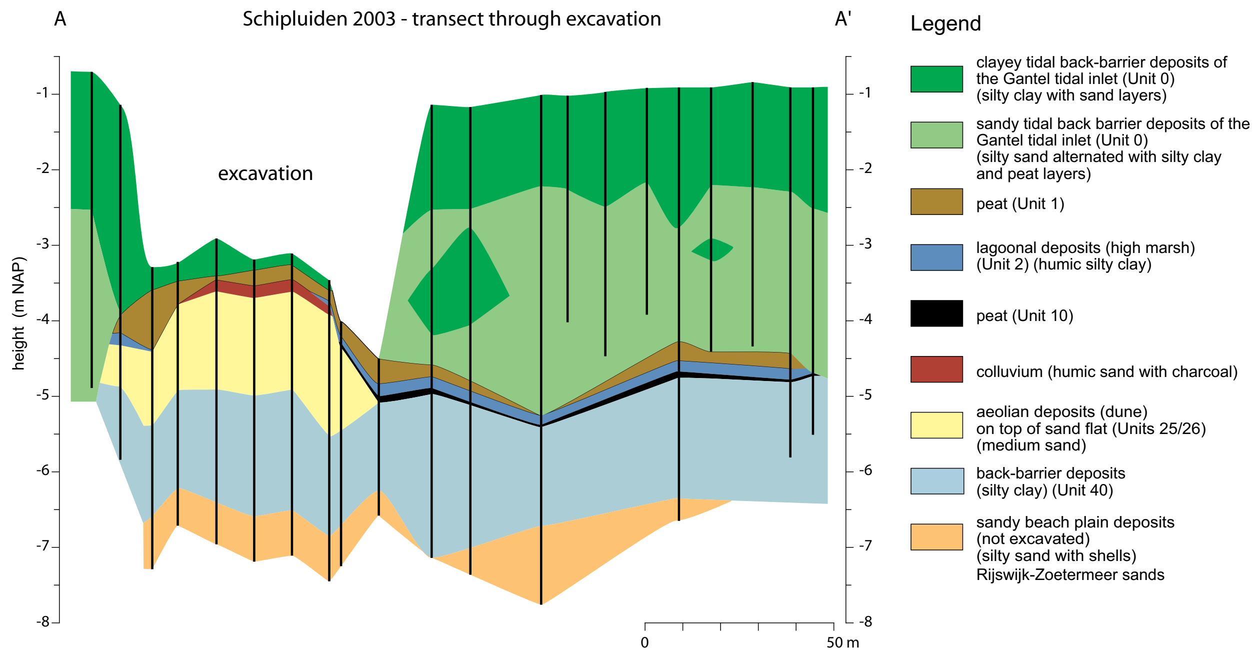
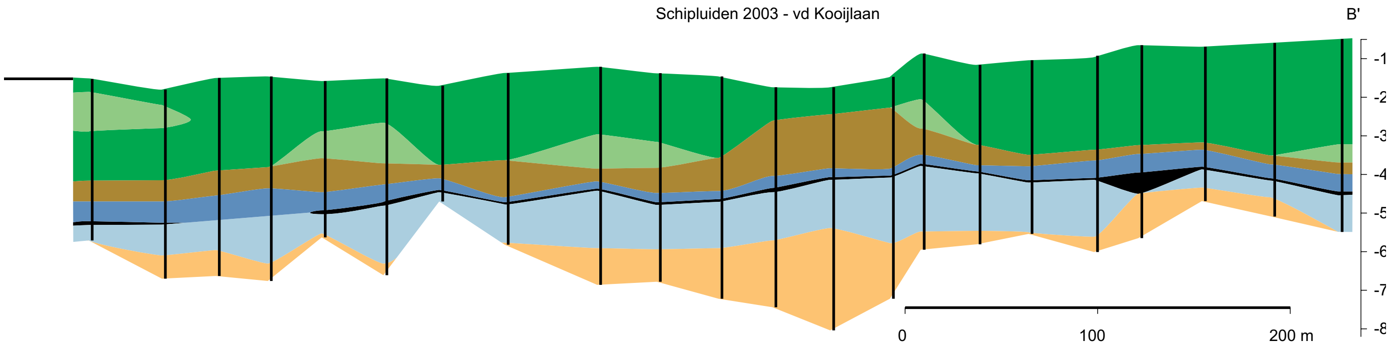


Figure 14.6 Transect A-A’ through the excavated dune. Horizontal scale 1:2000, height exaggerated 20×.

relation to the chronostratigraphic subdivision of the site. A contour map of the clay cover overlying the Rijswijk-Zoetermeer sands was reconstructed with the aid of the Surfer program. The original map was smoothed to obtain a general survey of the variations in height. As a result of this smoothing, the indicated height of the Harnaschpolder dune is lower than the actual height (*cf.* fig. 2.4).

As observed at the Schipluiden-Harnaschpolder site, the clay cover in the site’s surroundings also includes some sandy intercalations and shows substantial variations in height. Although this clay has probably undergone some degree of compaction, its settling appears to have responded not so much to the non-uniform sediment cover (thick layers of sand or peat), but mainly to the variations in height of the underlying Rijswijk-Zoetermeer sands (fig. 14.5). This means that variations in the height of this clay cover are entirely due to different sedimentation levels, and may represent subfacies such as a salt marsh, a tidal flat or a channel.

Whether the sandy elevations represent (marine) beach barriers or dunes is not clear in all parts. Beach barriers consist of slightly clayey (beach) sand (approx. 210 μm) that grades into (aeolian) sand of a similar grain size but without clay. The boundary between the aeolian and the marine deposits is difficult to establish (Van Staalduinen 1979; De Groot 2001). The barriers were observed in the borings only as morphological undulations. Beach-plain deposits may



contain more layers of clay, but it is difficult to distinguish between the two on the basis of data obtained in augering.

The size of the dune during each occupation phase was determined by combining the depth variations of the subsurface with the maximum sedimentation level of the find layers preserved *in situ*, which is -4.5 m in the case of phase 1, -3.8 m in the case of phase 2b and -3.4 m in the case of phase 3 (chapter 2). All morphological elevations above these depths must have been exposed and suitable for occupation during the phases concerned.

It should however be noted that the densities of the data points differ considerably due to the presence of buildings, roads and many cables below the surface. This resulted in unequal coverage of the area. The positions of the borings are therefore indicated in all the reconstructions, to give an impression of the reliability of the reconstruction in each part of the area.

14.6.2 Occupation phase 1 (fig.14.7a)

The landscape during the first occupation phase is reflected by the contour map of the clay cover overlying the Rijswijk-Zoetermeer sands, though it should be noted that in some places the clay contains sandy intercalations. The oldest archaeological finds came to light at a depth of -4.5 m, which represents the mean sea level and was used as a marker in figure 14.7.

The Schipluiden-Harnaschpolder dune projected well above the mean water level during this phase, but the greater part of the surrounding area did not: clay was deposited there. The clay was not deposited as a horizontal blanket covering all the underlying deposits. Variations in the height of the clay layer can be attributed to differences in sedimentation levels: the deep-lying clay was deposited in tidal channels, whereas higher clay deposits can be seen to represent a tidal flat that was exposed during low tide. The clay that was found above the mean sea level must be regarded as a supratidal deposit representing a salt marsh, though the exact nature of the water (fresh or salt) is not clear.

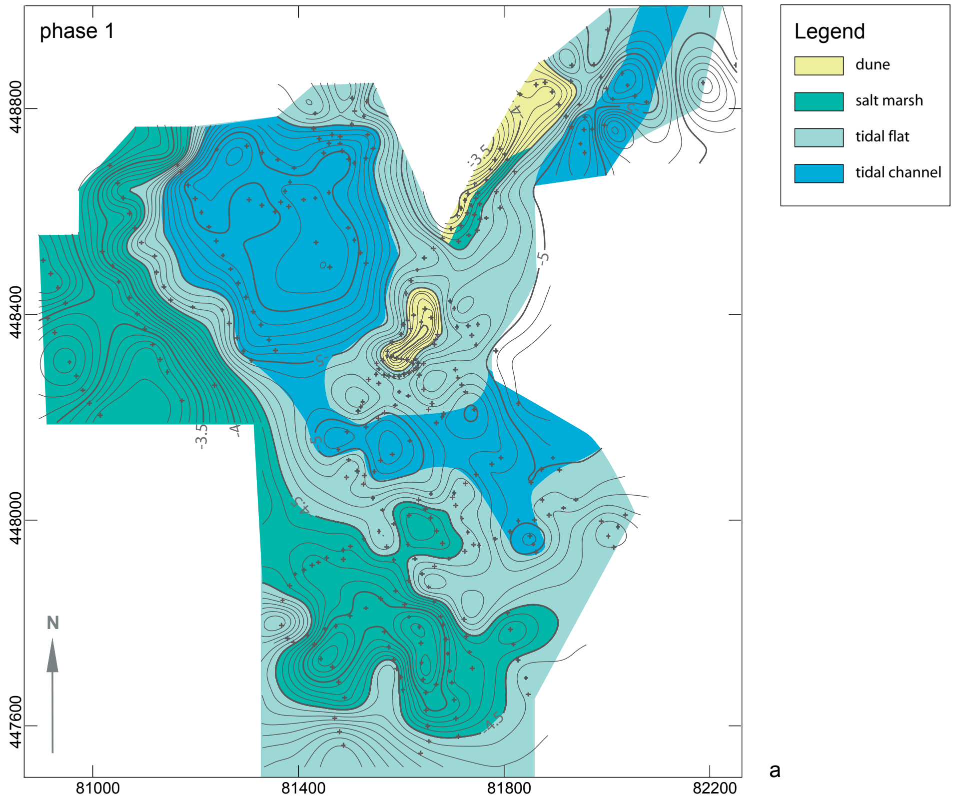
The origins of these clay sediments cannot be inferred from the geological data, but the molluscs and diatoms clearly show that the water was not entirely salt (chapters 15 and 16). The area must be regarded as estuarine, with influx of fresh water resulting in brackish conditions, though with a tidal influence.

Only two other elevations were also exposed: one directly to the north of the Schipluiden-Harnaschpolder dune and another large elevation to the south and west of the site. The northern elevation was obviously the continuation of the dune previously observed by Deunhouwer during the survey of the site (2002). It was half a metre lower than the dune that was chosen for occupation – that may have been a relevant factor in the site's selection – but it nevertheless appears to have held some attraction for the occupants of Schipluiden. Several borings revealed the presence of a colluvium similar to Unit 20 in the excavated area. Sieved samples however yielded nothing besides charcoal dust, making it uncertain whether this dune was occupied at the same time.[4] Oude Rengerink (1996b) likewise found charcoal without any other archaeological evidence on top of two dunes near the Wateringse Veld site. Small-scale excavations revealed only a few archaeological features on one of the dunes and nothing whatsoever on the other one.

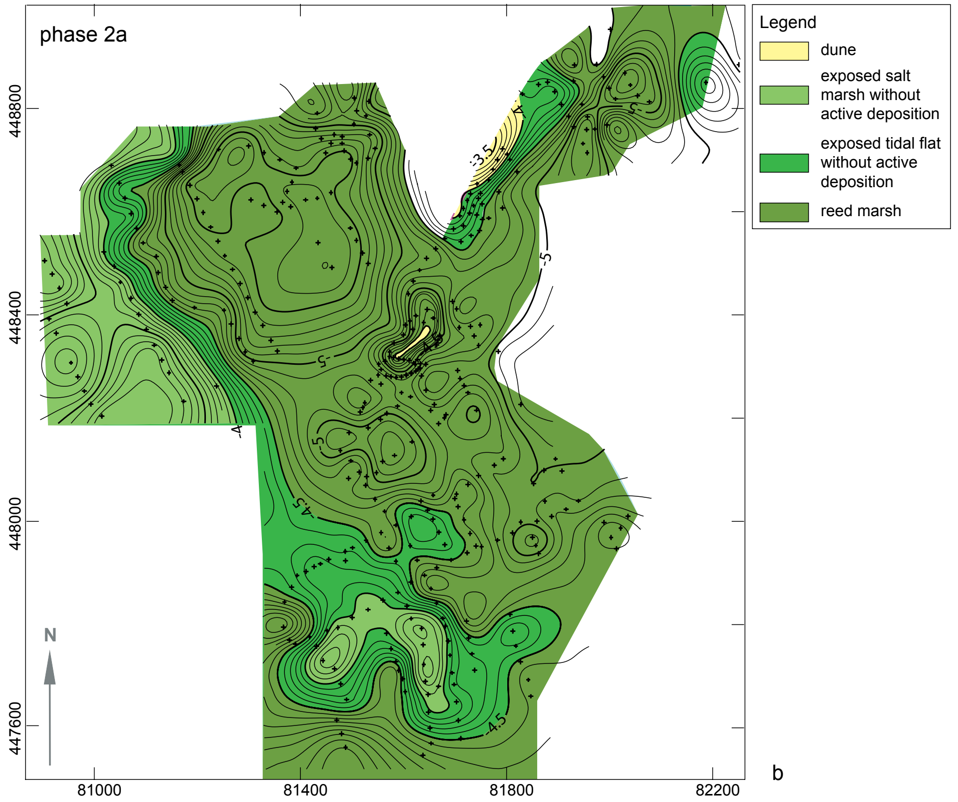
The other elevation comprised a large area in the west, where the underlying Rijswijk-Zoetermeer sands lay at a relatively high level. These sands are now completely covered by clay, but lay above the mean sea level during occupation phase 1. This area evidently represents a (brackish) salt marsh on which clay was deposited only during spring tides.

14.6.3 Occupation phase 2a (fig. 14.7b)

Occupation phase 2a has no synchronous sedimentation phase. Occupation started during a break in deposition: the deposition of the clay of Unit 19 on the tidal flat and the tidal (salt) marsh had ceased and the growth of peat around the site had


phase 1
Legend
dune
salt marsh
tidal flat
tidal channel
N
448800
448400
448000
447600
81000
81400
81800
82200
-3.5
-4
-5

a


phase 2a
Legend
dune
exposed salt marsh without active deposition
exposed tidal flat without active deposition
reed marsh
N
448800
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448000
447600
81000
81400
81800
82200
-3.5
-4
-4.5
-5

b

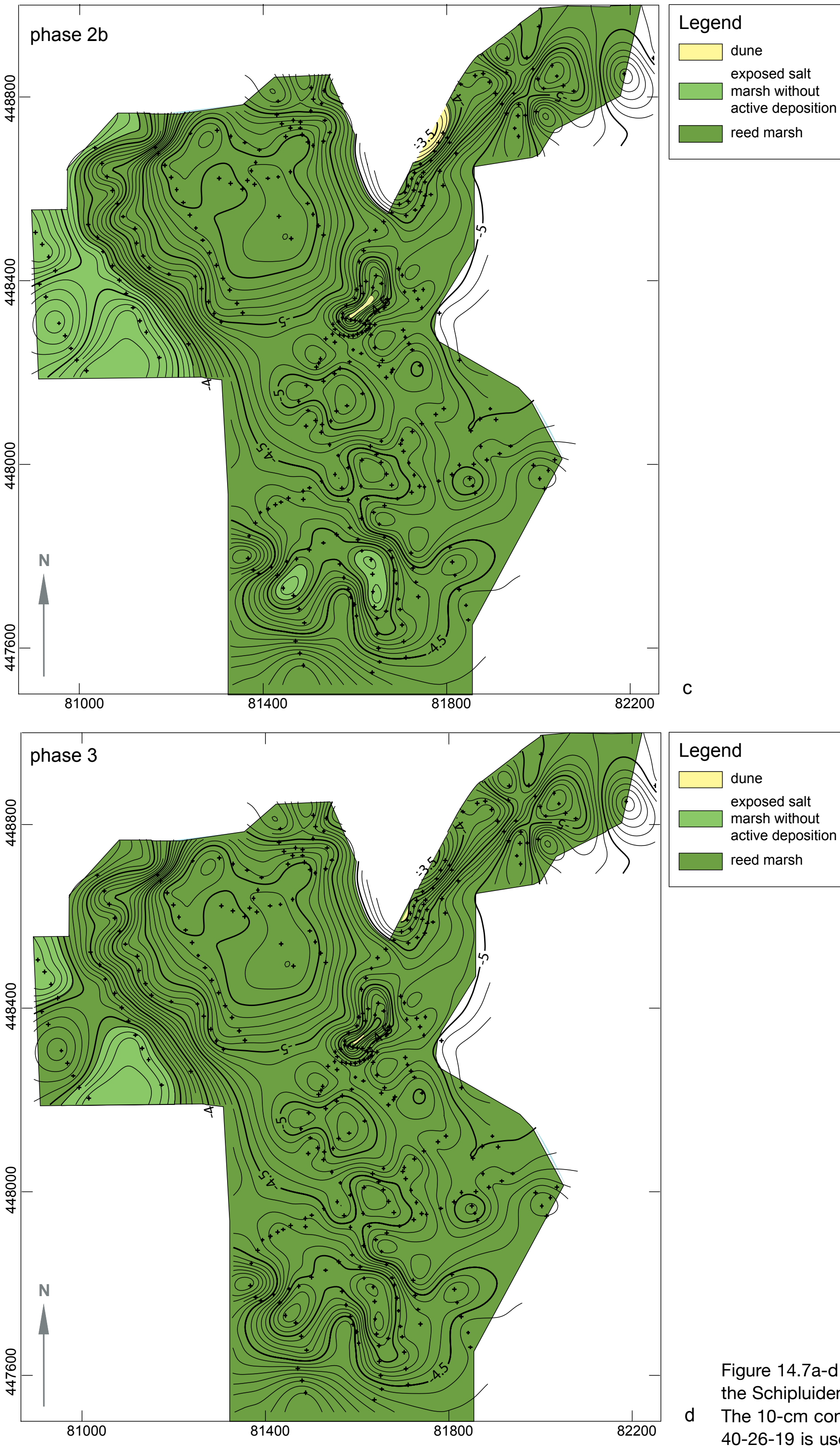

Figure 14.7a-d Reconstruction of the landscape around the Schipluiden-Harnaschpolder site during phases 1-3. The 10-cm contour line map of the top of the clay Units 40-26-19 is used as background.

not yet started. It is difficult to reconstruct the contemporary landscape because this phase cannot be linked to deposits. Figure 14.7b should therefore be regarded as a tentative impression. The higher parts of the top of Unit 19 will have been covered by a pioneer vegetation, while a reed marsh had by this time presumably already developed in the lower parts. The three areas that lay above sea level in phase 1 had by this time decreased in size, but were still prominently present. There was no more active sedimentation; the inactive salt marsh may have been suitable for agricultural activities, but the subaerially exposed tidal flat was probably too wet.

14.6.4 Occupation phase 2b (fig. 14.7c)

The landscape during the last two occupation phases (2b and 3) was quite different from that which preceded it. By the beginning of phase 2b a large reed marsh had expanded from the lowest parts to cover the entire area. The palaeogeography of this phase is fairly easy to reconstruct. The maximum height of the sedimentation level of phase 2b was -3.8 m (chapter 2), which is the level that the groundwater-dependent peat growth will have reached. By this time the entire area had become covered by this peat marsh, with variable depths, and only the tips of two dunes still projected above it. The more swampy parts of the landscape will have been unsuitable for agrarian use.

14.6.5 Occupation phase 3 (fig. 14.7d)

The maximum sedimentation level at the end phase 3 was found to be -3.4 m. Whether or not the dune was occupied throughout the entire period of peat formation is difficult to ascertain as the peat has suffered severe compaction. The archaeological remains however suggest that this was indeed the case (chapter 2).

During phase 3 peat growth continued at a steady pace with the peat reaching a thickness of 1.2 m. It covered the greater part of the dune, leaving an area of around 30 × 100 m exposed. The landscape must be envisaged as a large swamp, in which grew sedges, reed and in places also willow and alder (chapters 18, 19 and 21). Whether the marsh contained open pools or channels affording better access to the site is not clear. Additional information could not be obtained from the geological data due to the severe compaction in combination with oxidisation of the peat.

14.7 Palaeoenvironmental reconstructions of the macro-region

The Schipluiden-Harnaschpolder settlement lay on top of a small, low dune in an extensive beach plain that developed during a period of coastal progradation. On the basis of a series of stratified radiocarbon dates in combination with the exclusive presence of Hazendonk pottery, the dune is assumed to have been occupied from 3630 until 3380 cal BC (chapter 2). By this time, the northeastern part, at least, of the Voorburg-Rijswijk beach barrier had already formed along the coast. This beach ridge, which lay approximately 3 km northwest of the Schipluiden-Harnaschpolder site (fig. 14.8), protected the hinterland from direct influence of the sea. It is not clear whether the barrier extended further to the southwest. The patchy appearance of the barrier in that area may be attributable to later erosion, as observed by De Groot (2001) in the case of the Naaldwijk-Wateringen barrier, or to the presence of an estuary to the south of The Hague (Van der Valk 1996) that prevented further barrier formation in this area, or to a combination of the two. This lack of certainty hinders the reconstruction of the coastline in figure 14.8.

During the formation of this barrier, the complex sedimentation around the Schipluiden-Harnaschpolder site was controlled by this estuary. Clay was deposited in the low-lying parts, while aeolian dunes continued to be blown up on higher parts, such as beach ridges, but also sandflats adjacent to channels. The formation of these dunes can be dated to the period of coastal progradation, up to the development of peat in the entire back-barrier area following the closure of the Voorburg-Rijswijk beach barrier. The dunes were probably formed between *c*. 4000 cal BC – the minimum age of the wash-over deposit at Ypenburg (Cleveringa 2000) – and *c*. 3550 cal BC, by which time clay deposition at Schipluiden-Harnaschpolder had ceased (this study). This is in good agreement with the date of 4670 ± 65 BP (3640-3340 cal BC) obtained for the base of a peat deposit in the nearby Plaspoelpolder (Van der Valk 1996). So dune formation in the entire back-barrier area was probably restricted to a period of around 400 years: from *c*. 4000 cal BC to 3550 cal BC at the latest. Occupation prior to 4000 cal BC is moreover highly unlikely due to the assumed absence of dunes before that date.

All the Neolithic features found in this area came to light on the tops of similar dunes in this beach plain. The sites in question all lay behind the Voorburg-Rijswijk barrier and their environmental conditions must hence have been comparable with those of the Schipluiden site. Figure 14.8 shows the positions and sizes of the dunes in the beach plain on which the sites concerned were found. The positions of the three dunes (with archaeological finds) near Ypenburg were determined in a study by Oude Rengerink (1996a) and were later confirmed by data obtained by Cleveringa (2000). The exact size of the dune of site Rijswijk-A4 is not clear; the dune is schematically represented in the map.

It should be borne in mind that the dunes indicated on this map probably represent only a small proportion of the original number in this area. The geological study of the surroundings of the Harnaschpolder site revealed three dunes occupying approximately 12% of the investigated area. These

Figure 14.8 Palaeogeography of Delfland, *c.* 3600 cal BC showing contemporary Neolithic sites (scale 1:100,000).

results suggest that there are many more similar dunes concealed beneath several metres of younger deposits in this back-barrier area. They may have been exploited as sources of wood or used for the cultivation of crops. Some may indeed have borne other settlements.

Figure 14.8 represents the landscape during the first occupation phase of Schipluiden-Harnaschpolder, during which this area was still under estuarine influence. The Rijswijk-Voorburg barrier is assumed to represent the coastline at this time, although the coast prograded further west during the later occupation phases. The exact position of the coastline during each occupation phase is not known and difficult to ascertain, especially since Cleveringa (2000) estimated that the rate of progradation near Wassenaar was 800 m per 100 radiocarbon years! The estuary gradually became inactive and the ingression of seawater came to an end. The tidal basin became overgrown with reed and sedges, except for the higher parts, *i.e.* the small dunes, which were probably wooded (chapter 21). Schipluiden-Harnaschpolder remained occupied throughout this development, even though the outcrop became very small during the final occupation phase, with dimensions decreasing to 30 × 100 m (section 2.4).

14.8 Conclusions

The study has shown that the Schipluiden-Harnaschpolder site lay several kilometres behind the coastline in the period of Neolithic occupation. By the time of the arrival of the first settlers, the Voorburg-Rijswijk beach barrier had already been formed, and behind this barrier a wide beach plain had been cut off from the open sea. Small beach ridges, some supporting dunes, had formed in this plain during the earlier period of coastal progradation, and more developed in the later estuarine environment. During the first occupation phase salt water could still enter the back-barrier area via an estuary in the south, resulting in clay deposition in low-lying places. The higher parts of this beach plain were all suitable for occupation. All the sites of known Neolithic settlements experienced similar formation processes and were situated in the same natural system.

It should however be borne in mind that we have only limited detailed information on the subsurface. The patchy nature of the geological data may very well obscure other dunes and associated archaeological sites in this area. After all, all the sites that have so far been discovered came to light only as a result of large infrastructure projects. The spatial information obtained in this study suggests that around 12% of the back-barrier area consists of buried dunes.

notes

1 The majority of the geological papers refer to non-calibrated radiocarbon dates. In this study all dates have been calibrated with the aid of the OxCal program (Bronk Ramsey 2001).

2 A new stratigraphic subdivision of the Dutch Quaternary deposits has recently been developed. In particular, the Holocene marine deposits have been placed in a new formation (the Naaldwijk Formation), in which the Calais Member has been renamed the Wormer Member and the Dunkirk Member the Walcheren Member. (http://dinoloket.nitg.tno.nl/dinolks/SilverStream/Pages/LksNomShMainFS.html).

3 A beach plain can be regarded as an intertidal-supratidal flat behind a beach ridge where sediments are deposited during spring floods and storms. Beach-plain deposits consist of sand-mud intercalations. Marsh deposits (root-bearing sand-mud laminations) are the lateral equivalents of beach-plain deposits (Cleveringa 2000).

4 In October/November 2004 a small-scale excavation yielded pottery, indicating that this site was also occupied during the Neolithic.

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15 Diatoms

Hein de Wolf
Piet Cleveringa

Diatom analysis of sediments made it possible to follow in detail the environmental changes that took place during the period of occupation, in particular the changes in salinity and tidal influence. The settlement lay between the saline and freshwater spheres of influence. In the course of time the freshwater conditions began to prevail. The presence of Hantzschia amphioxys *and* Navicula cincta *shows that humans and cattle had an impact on their environment. The only pit whose diatom content was analysed was found to have been humid, and to have been quickly filled with wind-blown sand. A selection of 22 potsherds shows that the pottery was made from local clays; in the case of one of the sherds this is not clear.*

15.1 Introduction

15.1.1 Research questions

The study of the diatoms (algae that secrete silicious skeletons) comprised three components.

The first aim was to find answers to specific questions relating to the sedimentary environment and the changes that took place in it. The composition of the remains of the diatom flora in samples provides information on hydrodynamic conditions, the palaeoenvironment, the sedimentation conditions, and in particular salinity.

Secondly, it was hoped that the diatoms would provide information to show whether the interpretation of the many pits dug at the site as 'unlined wells' is correct. The pits in question could for example also have been dug to obtain clay for the manufacture of pottery.

The latter option brings us to the third – archaeological – component of the study, which concerns the question whether the diatom composition of the clay used to make the pottery would enable us to determine whether all or some of the pottery was manufactured locally (or regionally) or elsewhere, *i.e.* outside the region. This question was inspired by the remarkable differences in the employed types of temper, which, besides indisputably local material (crushed shell), also include crushed quartz and other types of rock, incidentally even granite. Could the pottery tempered with the latter materials have been produced elsewhere?

The answer to the last question is of substantial importance in determining the exact function of the site, and in particular whether it was occupied on a year-round or a seasonal basis. Local pottery production is a strong argument in favour of a basic site function, implying the presence of entire households. That does however not automatically imply year-round occupation. Pottery manufacture is a typical summer activity (on account of the drying process), which may in the case of a more mobile community in principle have taken place at summer camps.

15.2 Data, materials

In consultation with the excavation supervisors two sampling points were selected for the purpose of determining the former environment. A point was selected on each side of the dune – the northwestern and southeastern – so as to be able to assess any differences in sedimentation conditions. The samples were taken as far away from the dune as possible, to ensure that they would provide the most reliable natural signal, beyond the direct anthropogenic influences. It was moreover ensured that both samples covered the entire excavation stratigraphy, from the deposits predating the period of occupation (Unit 26) to those postdating it (Units 2 and 1). Section D1 was taken on the southeastern side of the dune. The sample taken on the northwestern side was obtained from two sections to enable us to benefit from the optimum conditions of the separate units. Section D2 covers the lowermost units and section D3 the units dating from the end of the occupation period and the subsequent deposits (fig. 15.1).

Only one pit interpreted as an 'unlined well' was sampled. A pit (no. 12-314) lying relatively high up the dune slope was selected, as the questions concerning these features related most specifically to those areas. The bases of the primary and secondary fills of this pit were sampled.

The pottery analysis was carried out in two phases. The analysis started with a pilot study involving 12 sherds. The results of this study were so promising that it was decided to increase the number of sherds to 22. In view of the limited number of sherds concerned, the analysis focused on tracing any differences between phases 2a and 3, *i.e.* the beginning and end of occupation, and on any differences between the pottery tempered with shell fragments and that tempered with crushed quartz or other types of rock.

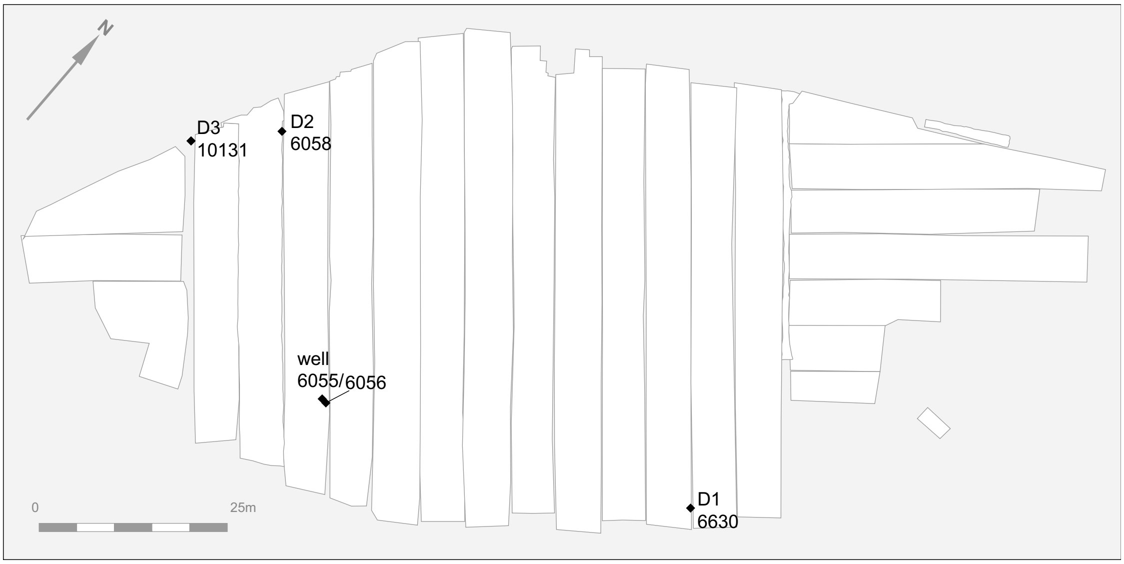

Figure 15.1 The sections analysed for diatoms.

15.3 Methods

The samples (weighing about 5 grams) from the sections and the pit fill were both prepared in the usual manner (Van der Werff 1955). The sherds were first thoroughly cleaned and mechanically crushed. The residue was treated and prepared in the same way as described above. The preparations were analysed with the aid of a Leitz Orthoplan microscope at 400 and 1000× magnification. Where possible, more than 100 diatoms were counted in a sample. A distinction was made between complete silicious skeletons and fragments. Besides information on transport, this distinction in the proportions of complete and fragmented diatoms would also provide insight into postsedimentary processes such as partial dissolution of diatoms in the sediment caused by the vegetation that developed on it, as diatoms (biogenic silica) serve as nutrients for grasses and herbs.

A total of 22 samples were taken from the sections, 16 of which were subjected to complete analysis and the other interim six samples to a quick scan to check whether the diatom data were in accordance with those of the preceding and/or succeeding analysed samples. This was done to prevent the risk of any transitions, hiatuses, *etc*. being overlooked.

Each of the identified types of diatoms has its own distinctive life conditions, which can be characterised with the aid of the environmental variables specified below. This classification system was set up several decades ago to group the abundant ecological data available on the species. The environmental variables are specified in different ways to enable them to be used by different disciplines. Classifications may vary from one discipline to another. A scientist measuring the quality of water will use diatom information in a different way than a researcher interested in the development of a coastal landscape.

In connection with the diatoms' great sensitivity to different environmental variables, the following classification system is used in practice and in diagrams:

salinity	marine	– polyhalobous
	brackish	– mesohalobous
	fresh	– oligohalobous halophilous
		– oligohalobous indifferent
		– halophobous
tidal influence	ampotixen – indifferent – pseudoampotiphil	
nutrients	eutrophic – mesotrophic – oligotrophic	
pH	acidophilous – indifferent – alkaliphilous	
life form	planktonic – tychoplanktonic – benthonic – epiphytic – aerophilous – euterrestrial	
temperature	cold – temperate – warm	
current	rheophilous – indifferent – limnophilous	

The most important differentiating factors in the case of the Schipluiden flora are salinity and life form, and the diatoms were therefore grouped as follows:

- salt – marine, allochthonous coastal
- brackish – estuarine (pools, wet/dry transitions, banks)
- fresh – fluviatile (pools and ditches, wet/dry transitions, banks)
- aerophilous – terrestrial

Section D1 (6630)

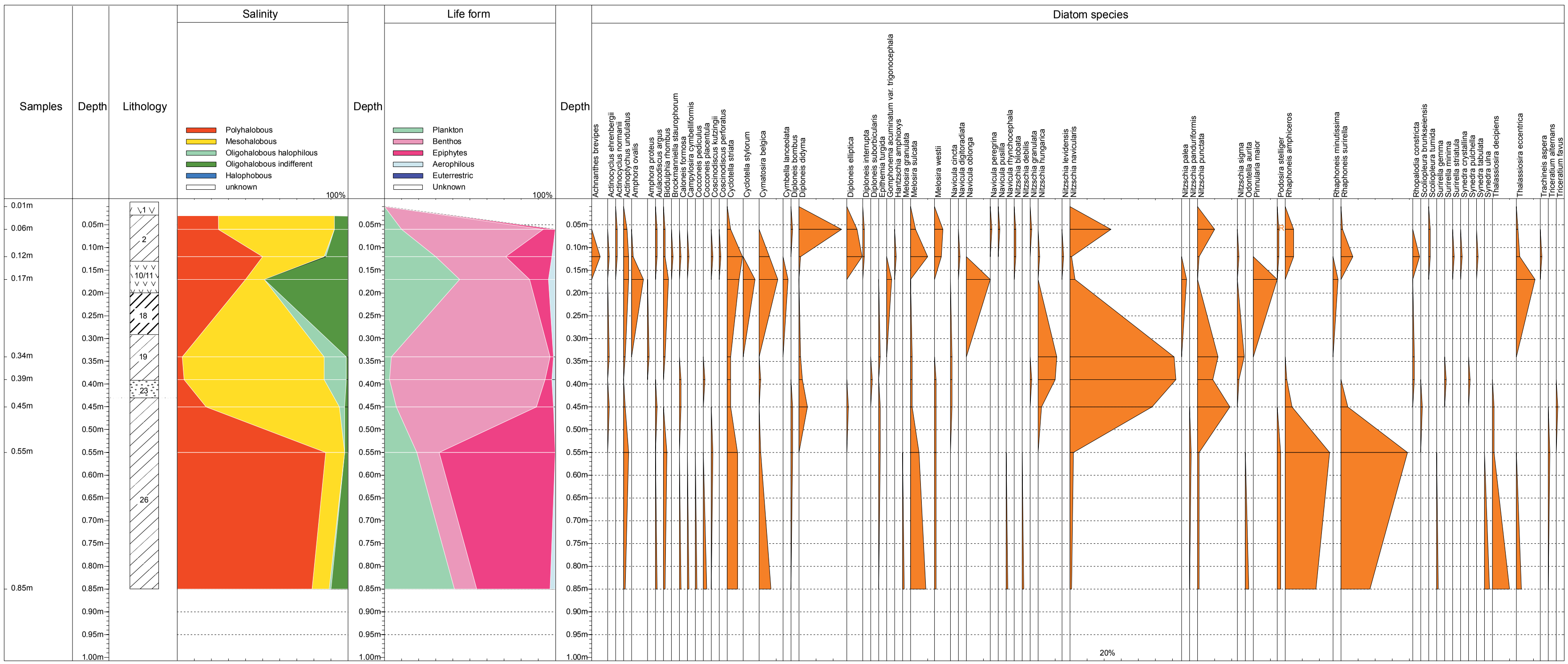

Figure 15.4 Diatom diagram D1, no. 6630.

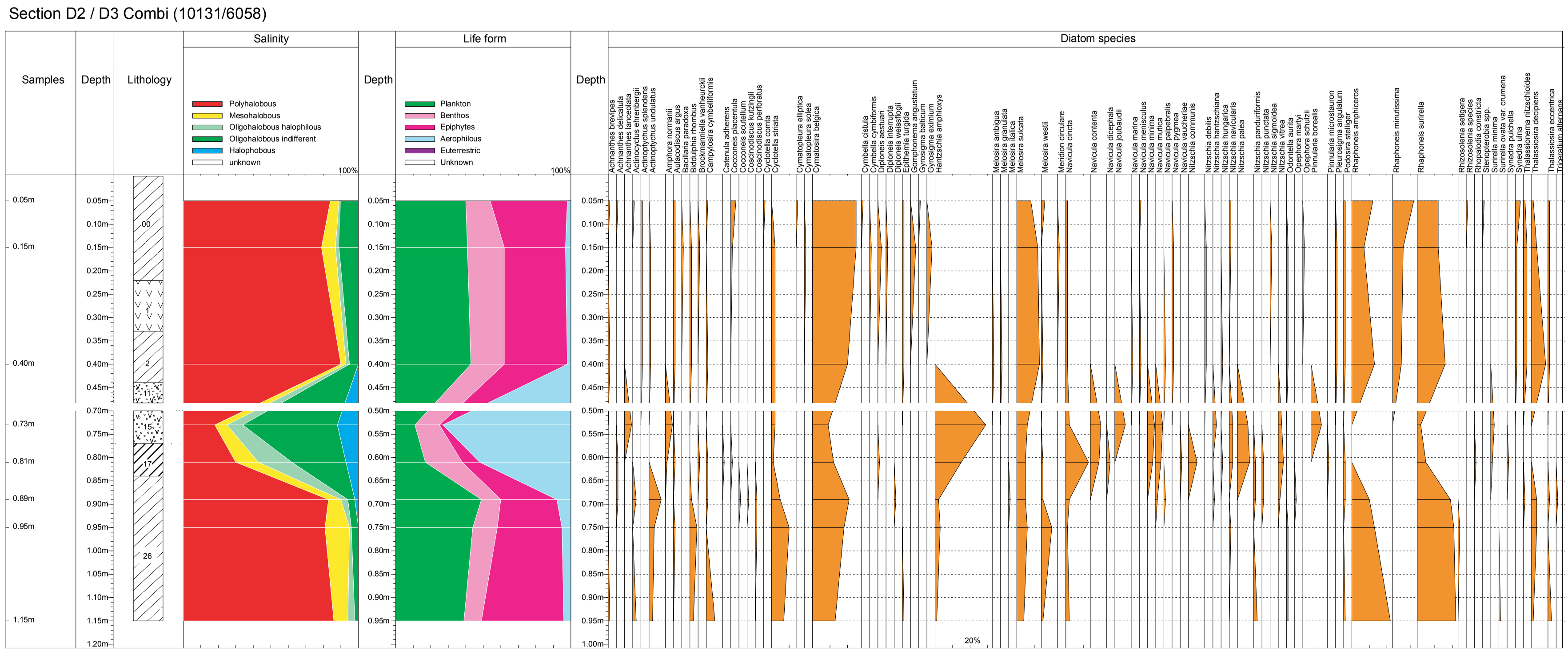

Figure 15.5 Combined diatom diagrams D2 (10,131) and D3 (6058).

Comment on the diagrams shown in figures 15.4 and 15.5.
The curves representing the individual diatom species have been arranged in alphabetical order. The main diagrams (salinity and life form) were obtained by adding up species with the same ecology. Details on the species are to be found in section 15.4. Lithology according to chapter 2.

15.4 Explanation of terms

Some of the aforementioned classes will be explained below.

15.4.1 Allochthonous coastal species

Allochthonous coastal species are diatom species deriving from the North Sea coastal area. They are marine species, often with a planktonic (including tychoplanktonic) and partly also benthonic life form. In our study they comprised the following species:

Actinocyclus ehrenbergii
Actinoptychus splendens
Actinoptychus undulatus
Aulacodiscus argus
Biddulphia rhombus
Brockmanniella vanheurckii
Campylosira cymbelliformis
Cymatosira belgica
Melosira sulcata
Melosira westii
Nitzschia panduriformis
Odontella aurita
Podosira stelliger
Rhaphoneis amphiceros
Rhaphoneis surirella
Rhaphoneis minutissima
Thalassiosira decipiens
Thalassiosira eccentrica

They are transported by the tides and by waves, but sometimes – and only in the case of a storm – in small quantities also by the wind. As most coastal diatom species are highly silicious and their skeletons resistant to corrosion, they are found in almost all coast-related sediments. They are particularly common in sediments that are transported inland by tidal currents, wave action and sometimes the wind. Being strongly silicious, they are fairly insoluble. There is usually a good chance of their entire or partial preservation in sediments. But even if they are fragmented or corroded through solution they are readily identifiable thanks to their silicious skeletons.

15.4.2 Aerophilous species

Although diatoms are aquatic organisms, aerophilous diatoms require only little water to develop and bloom. Water adhering to sediment particles, more highly evolved plants and mosses, and interstitial water of sand granules and clay particles in soils is all they need.

Live aerophilous species are found in environments in which no, or only very little sedimentation takes place. Soil formation is the prevalent process. Fossilisation of aerophilous diatoms indicates that the diatoms were incorporated in sediments shortly after death, because diatoms rarely fossilise in soils as the vegetation dissolves their silica for absorption. So soils are usually devoid of diatoms. The most important aerophilous species in our study are:

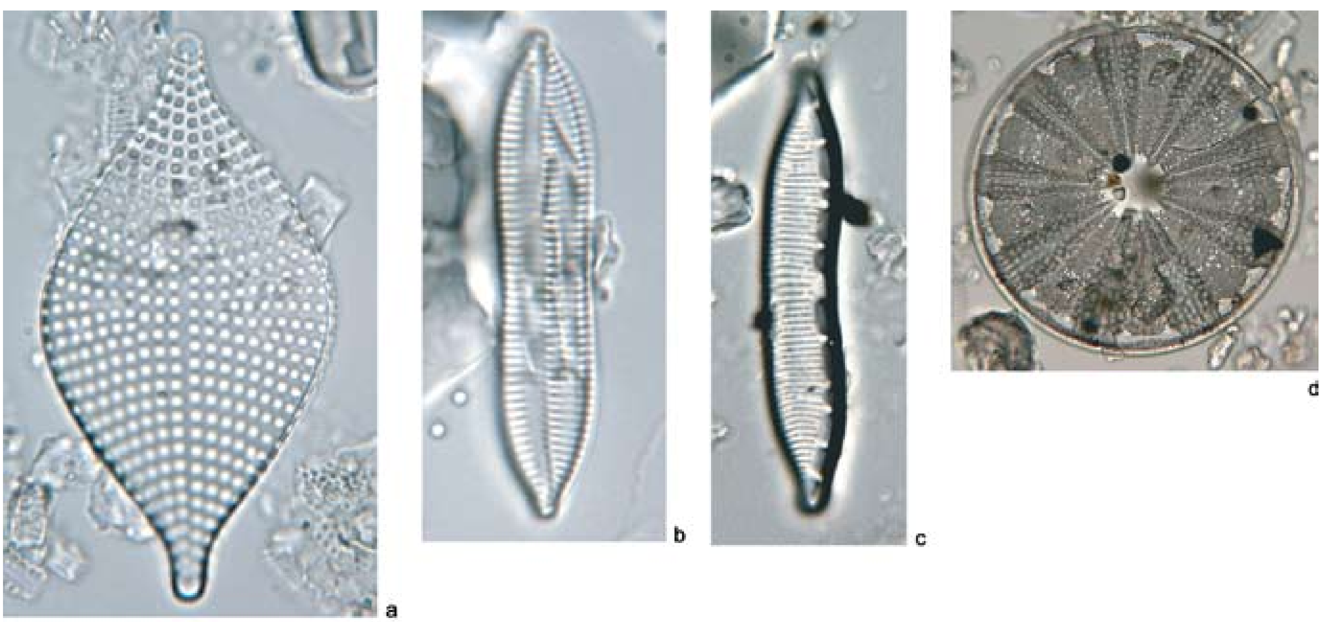

Figure 15.2 Some important diatom species, illustrating the great variety in forms. From left to right: *Rhaphoneis amphiceros*, (600×), *Nitzschia apiculata* (400×), *Hantzschia amphioxys* (400×) and *Actinoptychus splendens* (200×).

Hantzschia amphioxys
Navicula cincta
Navicula contenta
Navicula mutica
Nitzschia palea
Pinnularia borealis
Pinnularia lagerstedtii
Pinnularia subcapitata.

The aerophilous species *Hantzschia amphioxys* and *Navicula cincta* are also indicators of environments rich in nutrients, sometimes to the extent of having eutrophied, such as areas influenced by humans and cattle (Körber-Grohne 1967).

15.4.3 Brackish estuaries

The most important species in areas where fresh river water is exposed to saline seawater and the two mingle (estuaries) is *Cyclotella striata*. Only a few plankton species can live in such highly dynamic environments. Banks of estuaries, intertidal zones, and also areas of shallow water are moreover the habitats of brackish benthonic species, the most remarkable representative of which is *Nitzschia navicularis*. The two species occur combined only in brackish estuaries.

15.4.4 Brackish species

Lakes and pools in brackish environments whose waters freshen through rainfall have an unusual diatom association. They are occasionally flooded by seawater only at high (storm) tides and remain brackish through evaporation. Species characteristic of such environments are *e.g.* *Navicula pygmea, Nitzschia apiculata, Nitzschia hungarica, Rhopalodia musculus* and *Stauroneis gregori*.

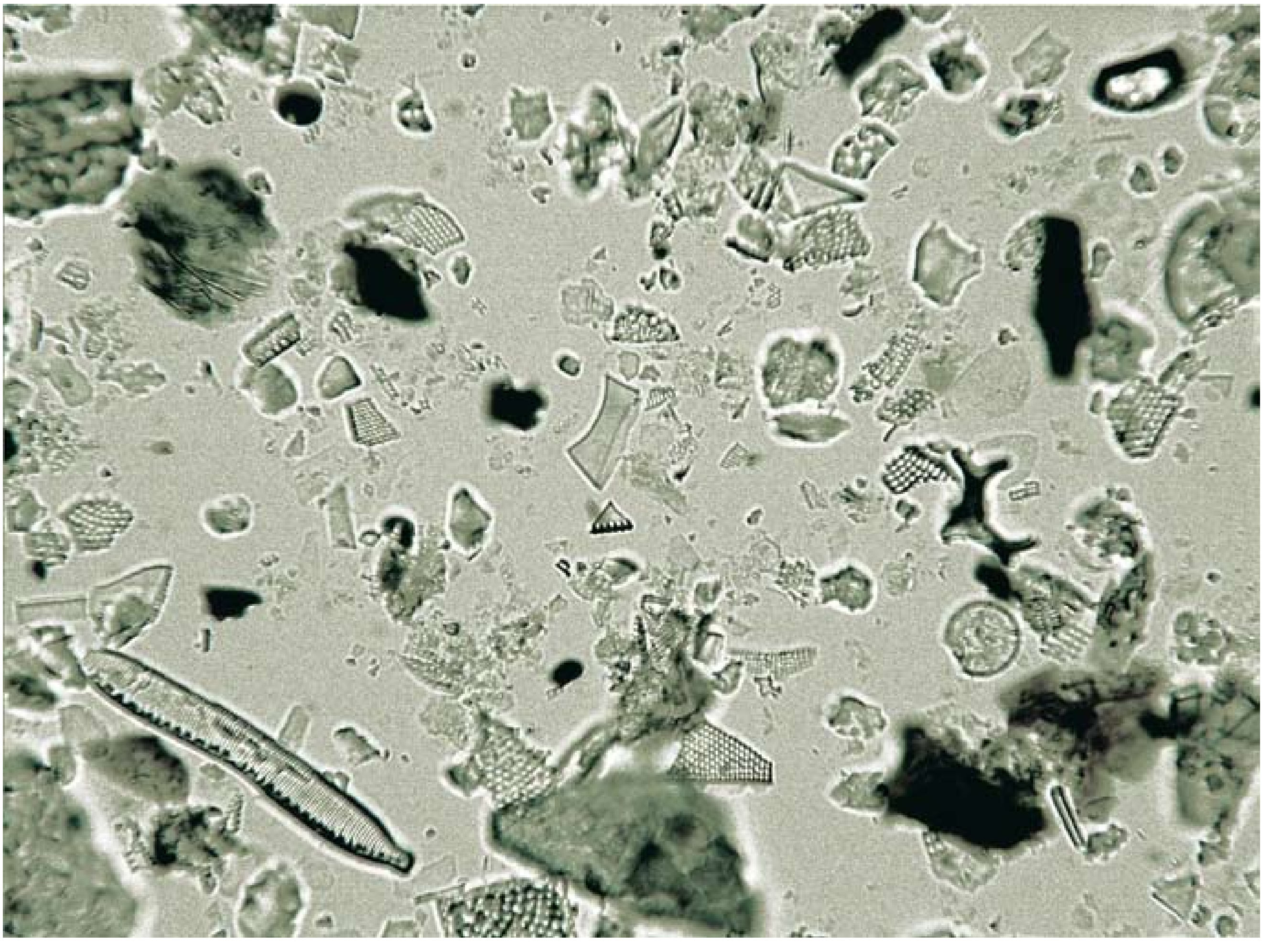

Figure 15.3 *Hantzschia amphioxys* (lower left corner) clearly stands out from the fragmented allochtonous diatoms that costitute the greater part of the assemblages. *Hantzschia amphioxys* is an indicator of a eutrophic environment affected by humans and cattle (magnification 1500×).

15.4.5 Freshwater species
Few freshwater species were encountered in the study. Most derived from river water and are species that can sometimes survive for some time under slightly more brackish conditions, such as *Cocconeis placentula*.

15.4.6 Sample composition
Diatoms are usually classified on the basis of succession and/or ecological criteria. However, not all species occurring in sediments can be classified according to such criteria. Vos set up a simpler classification system (Vos/De Wolf 1993) that provides insight into 'diatom worlds' on the basis of salinity and life form. This system works well in cases involving a succession of aquatic environments. At Schipluiden, however, aquatic conditions alternated with terrestrial ones, involving, among other processes, soil formation. Strict application of Vos' classification would have implied the loss of valuable diatom information.

Most diatoms in coastal sediments represent a thanatocoenosis and not a biocoenosis. They comprise the silicious skeletons of (deceased) algae from different biological communities, varying from freshwater to entirely marine communities. The species from the 'open sea' – *i.e.* the planktonic, tychopelagic and benthonic species – are referred to as allochthonous coastal species. These species also occur both live and dead in estuaries and mud-flat areas. The exchange of seawater enables some allochthonous coastal diatoms to bloom in such environments, but they are also deposited in sediments in such areas as empty valves (diatom skeletons) transported there by the tides.

The allochthonous coastal species' preferred habitat may be the coast, but after their death they are incorporated in sediments and are in that form often transported, for example into estuaries.

15.5 Analysis
15.5.1 Section D1 (fig. 15.4)
The stratification of the section (trench 20, north section, no. 6630)

0.00 – 0.03 m	Unit 1	peat/gyttja
0.03 – 0.13 m	Unit 2	clay, very humic, rooted and horizontally layered (disturbed)
0.13 – 0.20 m	Unit 11	sandy humic clay
0.20 – 0.29 m	Unit 18	humic clay, rooted
0.29 – 0.39 m	Unit 19	clay, slightly sandy, rooted
0.39 – 0.43 m	Unit 25	sand (aeolian?)
0.43 – 0.85 m	Unit 26	sandy humic clay (banded), rooted at the top

Diatom contents
Unit 26
The two samples (from 0.85 and 0.55 m) were found to be rich in diatoms. Allochthonous coastal species such as *Melosira sulcata, Rhaphoneis amphiceros* and *Rhaphoneis surirella* were frequently observed. Species such as *Cyclotella striata* and some freshwater species were found in lower percentages. The lowermost sample (0.85 m) included pyrite granules and faecal pellets containing freshwater diatoms.

The combination of marine allochthonous coastal species, the occurrence of *Cyclotella striata* – a plankton species characteristic of brackish estuaries – in percentages from 5 to 10, and the presence of freshwater species together points to estuarine sedimentation conditions. The freshwater species were most probably transported here by river water, because the water at the sampling point was brackish. Its salinity varied substantially, depending on the tides and the seasons. The presence of pyrite in the sample from 0.85 m moreover implies anoxic conditions at the time of sedimentation. When oxygen was introduced into the sediment in later times, the iron sulphide was converted into pyrite. The absence of pyrite in the 0.55 m sample implies that this area occasionally emerged from the water around this time already.

Units 26 and 19
The dominant species in these samples (from 0.45, 0.39 and 0.29 m) is *Nitzschia navicularis*, a benthonic species that is nowadays found in mud flats and estuaries. Other important species are *Nitzschia punctata, Nitzschia hungarica* and *Nitzschia sigma*. They are brackish species that nowadays live in coastal areas in isolated pools whose water is freshened through rainfall.

The section shows that the aquatic sedimentation in this area was for a short time interrupted by the deposition of a thin layer of aeolian sand, which extends to the foot of the dune (Unit 25). In fact there is a seamless transition between Units 26 and 19. This is confirmed by the diatom spectra. The changes evident in the samples from 0.39 and 0.29 m (Unit 19) are already observable in the sample from 0.45 m, from the top of Unit 26. The number of allochthonous coastal species in the uppermost sample is much smaller, but still points to an estuarine environment. The area emerged from the water at low tide, and water remaining in pools became fresh as a result of precipitation. The pools were flooded by seawater only at high (storm) tides. These observations all point to a succession associated with isolation from the sea.

Unit 11
The sample from 0.17 m had a low diatom content. The preparation was found to contain large quantities of fine organic matter that looked burnt. It also included very fine fragments of corroded diatoms. The most important species encountered are first of all the allochthonous coastal species

Cymatosira belgica and *Thalassiosira eccentrica* and secondly *Cyclotella striata* and *Cyclotella stylorum,* which are both brackish plankton species that are nowadays found in estuaries, although *Cyclotella stylorum* is extremely rare in our temperate climate. Two specimens of each species were found. In the third place there were also various freshwater diatoms: *Amphora ovalis, Navicula oblonga,* indet. *Pinnularia* fragments, and fragments of *Pinnularia maior*. They are benthonic species and epiphytes that live in *e.g.* ditches.

This sediment, which has the characteristics of a gyttja, was probably laid down in depressions in the landscape. Such depressions may from time to time have become quite warm, leading to an increase in salinity resulting in the formation of a favourable biotope for species such as *Cyclotella stylorum*, which is known from warmer climates. During precipitation the 'freshwater ditch flora' will then have flourished.

Unit 2

The lowermost sample (0.12 m) was rich in diatoms. It was found to contain many allochthonous coastal species, such as *Actinoptychus undulatus, Cymatosira belgica, Melosira westii, Melosira sulcata, Rhaphoneis amphiceros, Rhaphoneis surirella* and *Thalassiosira eccentrica*. *Achnanthes brevipes, Cyclotella striata, Diploneis elliptica* and *Rhopalodia musculus* moreover imply that the sediment was laid down in a shallow brackish, vegetated environment. The presence of *Hantzschia amphioxys* shows that this area periodically emerged from the water. The presence of the marine allochthonous coastal species and the fairly high percentages of *Cyclotella striata* indicate the influence of a nearby estuary – an environment in which sediment was during rare storm floods transported inland from the sea.

The uppermost sample (0.06 m) was also rich in diatoms. The dominant species are *Diploneis didyma* and *Nitzschia navicularis,* which are both characterised by a benthonic life form. They are nowadays found in mud flats and estuaries. Besides the usual allochthonous coastal species *Actinoptychus undulatus, Melosira westii, Melosira sulcata* and *Rhaphoneis amphiceros,* the sample also contained the brackish species *Diploneis elliptica* and *Nitzschia punctata*. The diatom spectrum points to a brackish estuarine environment. The area seems to have come under tidal influence again during the formation of this unit.

Unit 1

The sample from 0.01 m contained no diatoms, precluding interpretation. The diatom content was probably dissolved as result of soil formation and subsequent peat growth.

15.5.2 Sections D2 and D3 (fig. 15.5)

The stratification of section D3 (trench 10, south section, no. 10,131)

0.00 – 0.22 m	Unit 0	clay containing many sand lenses
0.22 – 0.33 m	Unit 1	reed peat
0.33 – 0.44 m	Unit 2	humic clay (irregular transition to the underlying sand)
0.44 – 0.50 m	Unit 11	humic sand, rooted

The stratification of section D2 (trench 12, south section, no. 6058)

0.70 – 0.77 m	Unit 15	peat, sandy
0.77 – 0.84 m	Unit 17	sand, very humic (soil?), minerals (jarosite, siderite) at a depth of 0.77 m
0.84 – 1.20 m	Unit 26	clay with a sandy top (0.84 – 0.91 m), rooted

Diatom contents

Unit 26

The sample from 1.15 m was rich in diatoms, that from 0.95 m had a lower diatom content. Allochthonous coastal species were dominant, such as *Campylosira cymbelliformis, Cymatosira belgica, Melosira sulcata, Rhaphoneis amphiceros* and *Rhaphoneis surirella*. The brackish species *Cyclotella striata* is present in fairly high percentages. The aerophilous species *Hantzschia amphioxys, Navicula cincta* and *Navicula mutica* were found in low percentages.

The high *Cyclotella striata* values imply that the clay (with its sandy top) was laid down in the same estuarine environment as that in which the allochthonous coastal species were deposited. The aerophilous species *Hantzschia amphioxys, Navicula cincta* and *Navicula mutica* give more specific information about the environment. They show that the area emerged from the water for varying lengths of time several times a year. The numbers, preservation and species spectrum of the diatoms indicate regular deposition of sediments in an estuarine environment. This section reflects drier conditions in the area dominated by estuarine sediments than in the same Unit in section D1.

Unit 17

The sample from 0.81 m also included a few allochthonous coastal species, but more conspicuous are the aerophilous species *Hantzschia amphioxys, Navicula mutica, Navicula contenta, Nitzschia palea* and also *Amphora normannii, Nitzschia vitrea* and *Surirella minima*. *Navicula cincta* points to polluted conditions.

This sample represents a kind of transitional situation. It reflects a substantial decrease in sedimentation relative to Unit 26 (0.84 – 1.20 m). The annual floods referred to above had by this time become less prolonged.

Unit 15
This sample (0.73 m) contained fewer diatoms than the preceding sample. Besides the species encountered in the sample from Unit 17 it also contained *Navicula joubaudii, Nitzschia hantzschiana* and fragments of *Pinnularia borealis*. The latter are typically aerophilous species that are indicative of soil formation. But apparently some sedimentation was still taking place, because the diatoms would not have been preserved if they had not become incorporated in sediments shortly after death. Flooding, accompanied by sedimentation, occurred less often than during the time when Unit 17 was laid down, probably only a few times a year.

Unit 2
The sample from 0.40 m was rich in diatoms. Dominant are the allochthonous coastal species *Cymatosira belgica, Melosira sulcata, Rhaphoneis amphiceros, Rhaphoneis minutissima, Rhaphoneis surirella* and *Thalassiosira decipiens*. Other species encountered in the sample are the brackish *Cyclotella striata* and the freshwater *Melosira ambigua, Melosira granulata* and *Synedra ulna*. Entire valves of *Synedra ulna* were observed. The sample also contained many pyrite granules.

The combination of marine allochthonous coastal species, the occurrence of *Cyclotella striata* and the presence of freshwater species that were not transported, or transported only very little (entire *Synedra ulna* valves), implies that the sediment was laid down in the fresh part of an estuary. The pyrite in the sample was probably deposited under anoxic conditions, later followed by the introduction of oxygen.

Unit 0
The lowermost sample (0.15 m) was rich in diatoms. Dominant are allochthonous coastal species such as *Cymatosira belgica, Melosira sulcata, Rhaphoneis amphiceros, Rhaphoneis minutissima, Rhaphoneis surirella* and *Thalassiosira decipiens,* and also the freshwater species *Gomphonema angustatum* and *Gyrosigma eximium*. Other conspicuous species in the sample are *Cyclotella striata* (brackish) and *Meridion circulare* (freshwater).

The combination of marine allochthonous coastal species, the occurrence of *Cyclotella striata* and the presence of freshwater species such as *Gomphonema angustatum, Gyrosigma eximium* and *Meridion circulare* implies that the sediment was laid down in the fresher part of an estuary. The area emerged from the water at low tide and had by this time become less susceptible to marine ingression.

The uppermost sample (0.05 m) was also rich in diatoms. The sample contained many fragments. Dominant species are the allochthonous coastal species *Cymatosira belgica, Melosira sulcata, Rhaphoneis amphiceros, Rhaphoneis minutissima* and *Rhaphoneis surirella*. A few freshwater species were found, including *Cocconeis placentula* and *Synedra ulna*.

The combination of marine allochthonous coastal species and freshwater species implies that this sediment was formed within reach of the freshwater in the estuary. Sediments were supplied only during storm floods (as shown by the many fragments).

All three samples of section D3 contained *Actinoptychus splendens*. This is an allochthonous coastal species that has occurred in the North Sea basin only after the closing of the coast of the western Netherlands, following the development of an uninterrupted series of beach barriers and dunes (De Wolf /Denys 1993). The occurrence of this species in Unit 2 at Schipluiden is remarkable on account of the early date, around 4500 BP,

15.5.3 Samples from the fill of well 12-314 (nos. 6055 (bottom) and 6056 (top))

Two samples from the fill of one deep unlined well at the centre of the settlement site were analysed to obtain an impression of the local hydrological conditions. The preparations of these samples were not subjected to full analysis. A quick scan sufficed to provide a good impression of the composition of the diatom flora.

The dominant species in the lowermost sample, from the base of the pit fill (no. 6055), was the eutrophic, aerophilous species *Hantzschia amphioxys,* of which 8 complete (double) and 7 broken valves were found. A second important species was the likewise aerophilous *Navicula mutica*, which was represented by 4 complete (double) valves. The sample also contained a few fragments of marine (allochthonous) diatoms plus one valve each of *Cyclotella striata* (brackish) and *Pinnularia borealis* (aerobic).

Dominant in the uppermost sample, from halfway up the fill (no. 6056), was *Navicula mutica*, represented by 8 complete valves and 1 fragment. Other species encountered (all of which are aerophilous) are *Hantzschia amphioxys* (3 complete valves and 13 fragments), *Navicula cincta var. heufleri,* and also *Nitzschia hantzschiana, Navicula atomus, Stauroneis muriella* and *Pinnularia borealis*. The latter species were only sporadically observed. The sample also contained fragments of marine diatoms.

The dominance of *Hantzschia amphioxys* in the lowermost sample points to an environment richer in nutrients (eutrophied) than that reflected by the uppermost sample, in which the dominant species *Navicula mutica* implies a shortage of phosphate and nitrate. Evidently an environment less rich in nutrients formed in the pit. The majority of the species point to alkaline conditions. Their dominance implies that the pit was often dry. As the pit was evidently no longer used, it filled up relatively quickly, ensuring the burial and preservation of the diatom flora contained in it. The differences in the composition of the diatom flora show that the pit did not become filled in one go. This is also evident from the (micro)stratification of the fill.

15.5.4 Pottery sherds

The diatom contents of the sherd samples were found to vary substantially, from less than six identifiable fragments (8×) to very high diatom contents (3×) of more than 100 identifications. The sample of one sherd (no. 3664) also contained phytolites from grasses. Together with the aero-philous diatoms, they show that the clay used for the pot concerned was obtained at the former ground surface. The phytolites may derive from grasses either directly or indirectly, for example via (cattle) manure.

The sherds could be grouped on the basis of the concentrations and the species spectra.

The first group consists of sherds that contained no diatoms, or at least too few to allow determination of the clay's sedimentary environment. This could be attributable to dissolution (soil formation) and/or specific sedimentation conditions – most probably a combination of the two factors, considering the development of the landscape as outlined above. This group 1 comprises eight sherds, which were tempered with crushed quartz (4×), shell (3×) or vegetable matter (1×). The majority of the sherds remarkably date from phase 3, but there are also some from phase 2a (table 15.1). One of the sherds of this group with low diatom contents (no. 256) did contain two fragments of freshwater diatoms – Pinnularia, one of which was Pinnularia maior. The pot concerned may have been produced non-locally.

The sherds of the second group are characterised by the presence of large quantities of aerophilous diatoms alongside brackish and allochthonous coastal species. This group comprises ten sherds, tempered with crushed quartz (5×, in one case combined with vegetable matter), stone (2×) and shell (3×). They date from all the occupation phases. Four sherds, finally, were attributed to a third group. They did contain (fairly) large quantities of diatoms, but no aerophilous species. The majority of the represented species are allochthonous coastal and brackish estuarine species: *Cyclotella striata* (planktonic), *Nitzschia navicularis* (benthotic) and *Navicula pygmea*. The succession that can be inferred from the three sample sections from the sections of the excavation trenches leads to the conclusion that these sherds are made of clay obtained from the deepest part of Unit 26. They date from phases 1 (2×), 2a and 3. Did the potters deliberately select this particular clay or was it coincidence that the same clay happened to be used each time?

15.6 CONCLUSIONS

15.6.1 Environmental changes

The changes in the diatom compositions of the analysed sediments clearly reflect the changes that took place in the sedimentary environment and the hydrological conditions throughout the period of occupation. The general trend was a decrease in flooding frequency, with regular high and low tides gradually giving way to more irregular floods during spring tides and storms. In the end, sediments were deposited over short periods of time only during severe storms. This development was accompanied by a gradual change towards freshwater conditions and the emergence of the clastic deposits from the water.

Prior to the period of occupation (Unit 40) the site was characterised by dynamic estuarine conditions with a strongly varying salinity. Pyrite indicates that sediments were laid down in an anoxic environment and that they later emerged from the water and became exposed to oxygen.

The diatom composition of the sediments of Unit 26 is likewise in accordance with an estuarine environment. In some sediments allochthonous coastal species are dominant, whereas in others freshwater species are well represented. The sediments also contain valves of marine and brackish diatoms. During high (spring and storm) tides the area was regularly raised by sedimentation. The surface was negotiable in calm periods. Water remaining in depressions (pools) became fresh as a result of precipitation and a brackish flora developed during phases 1 and 2a (Units 19 and 18). High tides were accompanied by the ingression of salt water, each time followed by a gradual return to freshwater conditions. Conditions varied from one area to another due to differences in altitude, susceptibility to marine ingression and evaporation of the seawater. In addition to this brackish diatom flora, Unit 17 – the peaty (chronological) equivalent of Unit 18 – contains an aerophilous component. Occasionally sedimentation occurred, but the surface also remained dry for long periods of time. This implies a landscape that was suitable for long-term occupation.

The concentration of allochthonous coastal, marine and brackish diatoms in the peat sediment of Unit 11 (phase 3) is even lower, with the main autochthonous diatoms being aerophilous species. Large amounts of black organic matter were also found in the preparations. Sedimentation had evidently decreased further since the formation of Units 17 and 18.

15.6.2 The new allochthonous coastal species Actinoptychus splendens

The general transformation of the diatom flora of Schipluiden illustrates the environmental changes that took place in this area in the centuries after around 5000 BP (3650 cal BC, see chapter 2) – the period in which the coastline began to expand. The area of Rijswijk, Schipluiden and Ypenburg gradually came to be closed off from the sea due to the formation of beach barriers and dunes, and this development was accompanied by a switch to freshwater conditions

ecogroup	phase	3	2a	2a	3	3	3	x	3	1	1	2a	2a	2a	2a	2a	2b	3	3	1	1	2a	3
	diatom group	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3
	find number	256	339	2022	2107	3407	7937	8479	7353	4738	4589	4493	6484	2127	987	2897	4431	3454	3664	4741	4589a	4489	5647
	Unit	10	18	17	11	11	10	20	11	19	19	18	18	18	18	17	16	10	11	19	19	18	10
	temper	qua	pl	shell	qua	qua	qua	shell	shell	pl, qua	shell	shell	sto	shell	qua	shell	qua	qua	sto	qua	qua	shell	grog
ecogroup		very poor	barren	barren	many small fragments indet	some probably marine fragments	poor	poor	barren					many small fragments indet.		some probably marine fragments						many small marine fragments	
1	Actinocyclus ehrenbergii									f	f		f-1	f					2f			2f	6f
1	Actinoptychus undulatus									2f-1			2f-1	2f-1	f	1	1			1		4f	f
1	Aulacodiscus argus									f	f		f	f								f	f
1	Campylosira cymbelliformis														1				1				
1	Coscinodiscus perforatus																		2f				3f
1	Cymatosira belgica									4f-8	1	f-2	3f-4	5f-13	5	3				f-1	3	1	f
1	Melosira sulcata				1					7	f	5	f	2f-13	2f-1		1		f-1	f-2	4	12	5f-5
1	Melosira westi									f-1	1	1	f-1	2f-6					1			3	f-2
1	Nitzschia panduriformis														1				1			f	
1	Podosira stelliger									f		f	2f	f	2f							4f	4f
1	Rhaphoneis amphiceros									2f			5f-2	f-1						2f-1		f	2f
1	Rhaphoneis surirella									2f	1		3f-1	2f-6	2f-2	2f	1						3f-1
1	Thalassiosira decipiens							1					2f		f-1			1	f			f	2f-3
1	Thalassiosira eccentrica									1										f-1			
4	Cyclotella striata				f					2	f	f-1	3f-1	2f-8	1					2	2	f-1	4f-2
4	Nitzschia navicularis				f					10f-6	2f-4	5f-8	21f-7	1	3f-1	f-2	f			5	6f-9	4f-1	25f-2
5	Navicula pygmea									1	f	f-7	1							3f-32	3f-6		
5	Nitzschia apiculata									f-1	1	2								5	2		
5	Nitzschia hungarica									5f-1	f	6f-12	3f							2f-8	3f-3		
5	Rhopalodia musculus											1				2							
5	Stauroneis gregori																			9			
2	Navicula contenta											2											
2	Navicula mutica									2						1		f-2					
2	Nitzschia palea												f		2f		9						
2	Pinnularia borealis																	f	f				
2	Pinnularia lagerstedtii																	1					
2	Pinnularia subcapitata															2							
3	Hantzschia amphioxys						1			4f-3		1	3f	2f		f-3	10f-3	5f-4	5f-2	2			
3	Navicula cincta									6f-4		2f-7	2f-8	3f-5	5f-7	2f-9	5f-9	f-3	1	2f-11			

Legend

1	allochtonous coastal species
4	estuarine brackish species
5	brackish species
2	aerophilous species
3	aerophilous species/ cattle

Table 15.1 Survey of the diatom identifications of pottery sherds. Only indicators for specific ecological condition are selected. They are classified in five main classes. The values refer to the number of complete (unbroken) diatom skeletons. Fragments are indicated with 'f'.

(chapter 14; Cleveringa 2000). Particularly reliable evidence of this change in coastal development is provided by the dates of shells that were found in an exposure near Rijswijk (Van der Valk *et al*. 1985, appendix).

The results of our diatom study confirm this development. An environment had developed in which the newly formed beach barriers were here and there raised further during severe storms. In drier periods the wind would blow up the sand, leading to the formation of low dunes. This ultimately resulted in an uninterrupted coastline. The further development of freshwater conditions and soil formation created an environment favourable for peat growth (Cleveringa *et al*. 1985). The onset of peat formation has been dated to around 4700 BP (3600 cal. BC, Van der Valk 1985).

Interesting in this context is the earliest occurrence of valves of the allochthonous coastal diatom *Actinoptychus splendens* (Unit 2, section D3, sample 0.40 m). This species was not found in the older samples, but neither was it observed in the samples from the same Unit 2 in section D1. From research elsewhere in the coastal area of the Netherlands and Flanders it is known that the occurrence of this diatom species in sediments implies an age of about 4500 BP. It would seem that the appearance of this species is associated with the closing of the coastline and the development of a new, favourable biotope in the North Sea. The flat, shallow coast with its distinct shoreface gradually became steeper. Via the estuaries of the main rivers the valves of this species were transported inland along with water from the North Sea. So sediments laid down around 4500 BP can be dated more precisely via *Actinoptychus splendens*. It would seem that this new species became increasingly important as the coast grew steeper.

15.6.3 The function of the 'well'

The diatoms encountered in the one sampled well are predominantly aerophilous. The pit was humid, but it was not permanently filled with water, because otherwise aerophilous diatoms would not have been able to develop there. The pit became filled with sediments blown in from its immediate surroundings. As our analysis was restricted to only one pit, little can be said about the general use of the pits concerned. Having been dug through the body of the dune down into the underlying sediments, the pits may also have served to obtain clay for the production of pottery.

15.6.4 Conclusions with respect to the manufacture of the pottery

Fourteen of the 22 examined sherds contained (more than) enough diatoms to allow a reliable characterisation of the employed clay. In terms of composition they correspond completely to the analysed samples of the clays bordering the dune, containing combinations of allochthonous coastal, brackish and aerophilous species that were also found in the clays. This leads to the conclusion that the pottery of this group was locally produced, using clay occurring at the surface. Aerophilous diatoms were significantly absent from some of the sherds (N=4). In those cases the pottery was probably produced from clay from an older layer or from a fresh sediment, untouched by humans or cattle.

The other examined sherds (N=8) contained very few or no diatoms. As the clay of three of these sherds was tempered with crushed shell, implying that the pottery was made in the coastal area, we assume that the absence of diatoms is attributable to dissolution due to soil formation or specific conditions in the deposition environment. Intriguing is one (quartz-tempered) sherd that was found to contain exclusively two freshwater diatom species. The pot in question may have been produced elsewhere.

There is no clear correlation between these groups and the employed temper. All three types of clay were tempered with crushed shell, even that of group 1 with a low diatom content. This is an extra argument for assuming that the latter pottery was also produced locally.

There is on the contrary a clear correlation between the distinguished types of clay and the occupation phases. The clay with a low diatom content (group 1) was used predominantly in phase 3 and that containing marine diatoms in phase 2a. Three of the four sherds from phase 1 contain no or only very few aerophilous diatoms, making it highly likely that the pots concerned were made from clay available at the surface. In phase 1 fresh, estuarine clay was used for the manufacture of pottery, in phase 2a clay formed under aerophilous conditions and in phase 3'old' clay, from which the diatoms had largely disappeared due to dissolution.

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16 Molluscs

Wim Kuijper

Shell samples were collected from several clastic deposits in the sections and borings. They inform us about the salinity and dynamics of the environment before and shortly after the period of occupation, and in the Gantel system. Shell pottery temper was identified as mainly crushed cockle.

16.1 Introduction

In the archaeological investigation special attention was paid to the occurrence of molluscs as they could have provided information on the local environment before, during and after the period of occupation and on the part played by molluscs in the occupants' diet. In actual fact, however, molluscs were encountered in only small quantities.

Shell fragments were only sporadically encountered in the settlement area, but part of the pottery was tempered with ground shells. A very small number of tiny shell fragments were found in the zoological analysis of sieve residues.

Shells were found in several deposits in the borings. The overlying Dunkirk I deposits in particular were found to contain dense concentrations of shells. The sediments of the boring samples were rinsed with water through a sieve with a mesh width of 0.25 mm. The residues were then microscopically examined.

See chapters 2 and 14 for information on the stratigraphy and the physical geography of the excavated settlement and its surroundings.

16.2 Results

16.2.1 The settlement

Virtually no molluscs were found in the actual settlement area or in the surrounding deposits. As far as the dune itself is concerned, this could be attributable to dissolution in the decalcified dune sand, in which bone had indeed also survived in only very small quantities and in a poor state of preservation. This does however not hold for the peripheral zone. The conclusion must hence be that species such as edible mussel and edible cockle, which are commonly – and often in large quantities – encountered in coastal settlements, did not feature on the occupants' menu.

At Schipluiden only 16 tiny fragments of marine mollusc species were encountered in 11 find assemblages. Grouped according to phase they are as follows:

phase 1	mussel (*Mytilus edulis*)
phase 1-2a	mussel, peppery furrow shell (*Scrobicularia plana*)
phase 2a	peppery furrow shell, lagoon cockle (*Cerastoderma glaucum*)
phase 3	peppery furrow shell.
phases 1-3	mussel, edible cockle (*Cerastoderma edule*), peppery furrow shell

These four species and the small numbers in which they were found do not yield any information suggesting changes in the local environment in the course of the investigated period. They do probably not represent the remains of consumed molluscs. The fragments have thin walls and appear to derive from small specimens. They may have been brought to the site by humans (whether or not deliberately) or deposited there during high tides. The encountered species may well have lived in a marine environment with a reduced saline content (brackish).

One of the samples (phases 1-2a) contained a few fragments of the shells of land snails: an amber snail and the shell of the beautiful snail. Both species may have occurred naturally at the site; they are common species characteristic of a wide range of open terrestrial environments, including high-lying salt marshes and damp dunes.

There will undoubtedly have been other snail and mussel species both on land and in the water, though the mollusc fauna may have been poor due to extreme conditions, for example extreme temperatures or saline contents.

16.2.2 Borings in the surrounding area

In the boring research that was conducted in the site's surroundings with the aim of reconstructing the former landscape (see chapter 14) a few small shell-containing samples were collected of several successive deposits (table 16.1). The majority had a volume of only 10 cm^3.

The plant and animal remains contained in these very small samples (table 16.1) yielded the following environmental evidence.

The Early Holocene clay was deposited in a coastal area under saline and brackish conditions. The area was shielded from the open sea and was a kind of tidal-flat area or a lagoon.

boring	68	68	73	173	174	68	181	151	181
depth in cm below surface	645	460	370 - 377	460 - 470	470	317 - 320	370 - 375	413 - 424	260 - 270
sediment	sandy cl.	sandy cl.	wd/sand	cl. sand	cl. sand	sandy cl.	cl. sand	clay	clay
Unit	Earl. Holo.	R-Z	R-Z	R-Z	R-Z	40/19	40/20	2	2
volume in cm^3	10	10	5	10	10	10	10	100	50
molluscs									
Barnea candida	–	–	1	–	–	–	–	–	–
Cerastoderma edule	–	1	1	x	–	–	–	x	–
Mytilus edulis	x	x	x	x	x	1	1	–	x
Littorina saxatilis	x	–	–	–	–	–	–	–	–
Macoma balthica	–	–	1 doublet	–	–	–	–	x	x
Scrobicularia plana	–	1 doublet	–	x, 1 doublet	1 doublet	1 doublet	–	–	1
Spisula subtruncata	–	1	–	–	–	–	–	–	–
Hydrobia ulvae	xx	1	x	x	x	x	–	x	x
Hydrobia ventrosa	xx	–	–	–	–	–	–	xx	–
other animal remains									
foraminifers	–	–	x	x	x	–	–	xxx	xx
ostracods	–	–	x	xx	x	x	–	xxx	xx
Nereis sp. (a ragworm) jaws	x	–	–	1	–	1	–	x	–
Echinocardium cordatum spines	–	x	x	x	x	x	–	–	x
sea-mats	–	–	1	–	–	–	–	–	–
sponges spicula	–	–	–	–	–	–	–	x	–
plant remains (seeds)									
Agrostis sp.	–	–	–	–	–	–	–	–	1
Aster tripolium	–	–	–	–	–	–	–	–	1
Atriplex sp.	–	–	–	–	–	–	–	–	1
Bolboschoenus maritimus	–	–	–	–	–	–	1	–	–
Carex sp.	–	–	–	–	–	–	–	x	1
Chenopodium glaucum/rubrum	–	–	–	–	–	–	–	–	2
Mentha sp.	–	–	–	–	–	–	–	4	–
Suaeda maritima	–	1	–	–	–	–	16	–	–
Scirpus sp.	–	1	–	–	–	–	–	–	–
charcoal	–	x	–	–	–	–	–	–	–

x = 2 - 20　　cl = clay, clayey
xx = 20 - 50　　wd = wood
xxx = hundreds　　R-Z = Rijswijk-Zoetermeer sands

Table 16.1 Identifications of molluscs from bore hole samples.

The Rijswijk-Zoetermeer sands originated in a saline (marine) environment (tidal-flat area) that was connected to the open sea. One sample (boring 73) contained a piece of wood with drill holes and a white paddick shell.

Unit 40/Unit 19 originated in a saline tidal-flat area.

Unit 2 was deposited in a brackish (or saline) coastal area: a calm tidal-flat area or a lagoon.

Unit 0 (Dunkirk) was formed in the Gantel system (see section 2.2.3). Molluscs characteristic of marine, brackish, freshwater and terrestrial environments were all represented. The total picture is indicative of sedimentation in an estuary: a transitional area between land and sea where freshwater flowed into the sea; see also section 16.2.4.

16.2.3 Pottery temper

Some of the prehistoric pottery was tempered with shells fragments (chapter 6). Six sherds from phase 2a were microscopically examined to see whether any of the employed species could be identified. The shell remains were burned and visible in the clay matrix as a fragment or an impression. The small dimensions (at most a few mm^2) and damage made it very difficult to determine the species, but some information was nevertheless obtained. The shells were found to derive from cockle (edible or lagoon cockle), a mudsnail (*Hydrobia ulvae*/*Hydrobia ventrosa*) and an unknown bivalve.

In addition, some foraminifers, large diatoms, fine sand grains and fine plant matter (carbonised) were recorded. One of the sherds contained a carbonised rough club-rush seed.

Both the shells and the clay indicate that the pottery was made from material deposited in a saline or brackish environment. The latter option is the most likely. And both the shells and the clay were probably easily accessible in the site's surroundings. The clay will have been formed in the period preceding the occupation phase concerned (2a). The most likely source of the clay is Unit 19.

16.2.4 Unit 0 (Dunkirk I deposits)

A large sample was taken from the base of the Dunkirk I deposit, which was laid down in the (estuarine) area of the tidal inlet/river Gantel and covered the dune. It dates from approximately 500 to 0 cal BC. Long grooves were observed at the base of this deposit (see section 2.2.3). A sample of one litre of sand mixed with layers of clay was taken from the fill of one of those grooves. This sample was studied for the presence of molluscs. In addition, another 5 litres of sand was studied to see whether it would yield comparable evidence. That was indeed found to be the case.

The molluscs encountered in the sample (table 16.2) proved to derive from different environments. Seven of the represented species favour a marine environment and three prefer brackish conditions. Some marine species, such as the mussel, Baltic tellin, peppery furrow shell, mudsnail and periwinkle, can tolerate reduced saline contents and are hence encountered in brackish environments, too. The represented range of species is indicative not of open saline water (the North Sea) but of a calm saline, tidal-flat kind of coastal area. The assemblage includes both poorly preserved and well-preserved shells.

Species characteristic of a marine environment (poorly to well-preserved)	
Cerastoderma edule	some valves and fragments
Cerastoderma glaucum	some valves and fragments
Mytilus edulis	several dozen doublets and valves and some fragments
Spisula subtruncata	some valves and fragments
Macoma balthica	some doublets, valves and fragments
Scrobicularia plana	1 valve and some fragments
Hydrobia ventrosa	several dozen
Hydrobia cf acuta	a few
Hydrobia ulvae	a few
Littorina sp.	1
Species characteristic of a freshwater environment (well-preserved)	
Mercuria confusa	11
Valvata piscinalis	1
Stagnicola palustris	25
Galba truncatula	5
Radix ovata	2
Anisus leucostoma	1
Species characteristic of a terrestrial environment (well-preserved)	
Oxyloma sp.	5
Vallonia pulchella	1
barnacle, plates	some
Echinocardium cordatum	some fragments, dozens of spines
ostracods, shells	dozens
foraminifers	
plant remains	small quantities

Table 16.2 Molluscs from the lower part of Unit 0. The sample, consisting of one litre of sand mixed with thin layers of clay, was sieved through a 0.25-mm mesh width.

The freshwater shells were all well preserved. They represent a fairly narrow faunal range, which nevertheless includes some remarkable species, in particular the swollen spire snail – a mollusc favouring freshwater tidal areas that tolerates slightly elevated saline contents. The dwarf pond snail and the ram's-horn tolerate desiccation of their biotope. They occur in shallow ponds surrounded by vegetation and at the edges of larger areas of water. The marsh snail can also survive in such environments. Finally, two terrestrial species were also encountered. Both species are encountered on damp banks.

As far as the reconstruction of the former environment is concerned there are two possibilities. The deposit may have been formed in a coastal area where freshwater flowed into the sea. In such an area, a mixture of saline and freshwater will have led to the formation of a brackish environment in which all of the encountered molluscs could have lived. The shells will then have been washed some distance away from their original positions by currents. The second possibility is an area with alternating periods of strong and less strong marine influence. In that case the freshwater species will have lived here in periods with strong discharge of freshwater and the marine species will have colonised the area in periods of pronounced marine influence. The brackish sediments will have been laid down in the transitional periods.

The majority of the other represented animal species favour a saline environment. The seeds contained in the same sample derive from plants that grow on the banks of areas of freshwater (some also in brackish water) and in swamps. The few aquatic plants encountered are characteristic of freshwater and brackish water. These results agree well with those of the mollusc analysis.

16.3 Conclusion

All the investigated deposits were laid down in a marine coastal area shielded from the open sea. In some periods the environment was saline due to a good connection with the open sea (Rijswijk-Zoetermeer sands), in others it was characterised by a reduced saline content (brackish), represented by the Early Holocene clay and Unit 2. During the deposition of the Dunkirk I sediment by the Gantel the area was an estuary. The environments in this coastal area ranged from tidal gullies in open connection with the sea to calm tidal flats and salt marshes.

Deposits from the period of the excavated settlement on the dune contained few mollusc remains. The small quantities encountered point to a calm saline or brackish environment.

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scientific	English	Dutch
Mollusca	molluscs/shells	mollusken, weekdieren, schelpen
Anisus leucostoma	button ram's-horn	geronde schijfhoren
Barnea candida	white piddock	witte boormossel
Cerastoderma edule	edible cockle	gewone kokkel
Cerastoderma glaucum	lagoon cockle	brakwaterkokkel
Galba truncatula	dwarf pond snail	leverbotslak
Hydrobia cf acuta	mudsnail	vergeten brakwaterhoren
Hydrobia ventrosa	spire mudsnail	opgezwollen brakwaterhoren
Hydrobia ulvae	mudsnail	wadslakje
Littorina sp.	periwinkle	alikruik
Macoma balthica	Baltic tellin	nonnetje
Mercuria confusa	swollen spire snail	getijdenslak
Mytilus edulis	edible mussel	gewone mossel
Oxyloma sp.	amber snail	barnsteenslak
Radix ovata	common pond snail	ovale poelslak
Scrobicularia plana	peppery furrow shell	platte slijkgaper
Spisula subtruncata	cut trough shell	halfgeknotte strandschelp
Stagnicola palustris	marsh pond snail	moeraspoelslak
Vallonia pulchella	smooth grass snail	fraaie jachthorenslak
Valvata piscinalis	common valve snail	vijverpluimdrager

Table 16.3 Glossary of the scientific, English and Dutch names of the species mentioned in the text.

17 Coprolites, macroscopic analysis

Mark van Waijjen
Caroline Vermeeren

Coprolites were collected from deposits from all the occupation phases. They were classified according to their shape, dimensions and inclusions. Two main categories (each including subtypes) were distinguished: a flat, round type, attributed to herbivores, probably cattle, and a cylindrical type, attributed to carnivores or omnivores, possibly dogs. The site's inhabitants may themselves have been responsible for the largest subtype of the latter category.

17.1 Introduction

Coprolites are fossilised droppings. They are usually preserved if they undergo desiccation before becoming incorporated in a deposit. During the excavation, 187 coprolites or coprolite-like remains were collected. From previous research it was known that pollen analysis can allow statements to be made about a site's former natural vegetation, the crops that were grown and the food that was consumed by the occupants (Vermeeren/Kuijper 1996). Herbivore coprolites provide information primarily on the (natural) vegetation in a site's surroundings while carnivore/omnivore coprolites can tell us more about consumption patterns and cultivated crops. For this reason the coprolites were macroscopically classified and a number of coprolites were selected for pollen analysis.

17.2 Methods

The macroscopic coprolite analysis comprised two parts. The first aimed to identify the 'producer' – herbivore, carnivore or omnivore – and where possible specify it more closely – cattle, dog, fox, man, *etc*. This is of vital importance with respect to the interpretation of the coprolites' pollen contents.

All the finds recorded as coprolites (N=194) were assessed. Seven finds were rejected. The remaining 187 specimens were coded by BIAX *Consult* on the basis of the following variables: fragmentation, dimensions, shape, large inclusions. The coprolites were not weighed, as the weight of such finds is greatly dependent on the state of preservation, and hence not very suitable as a criterion for identification

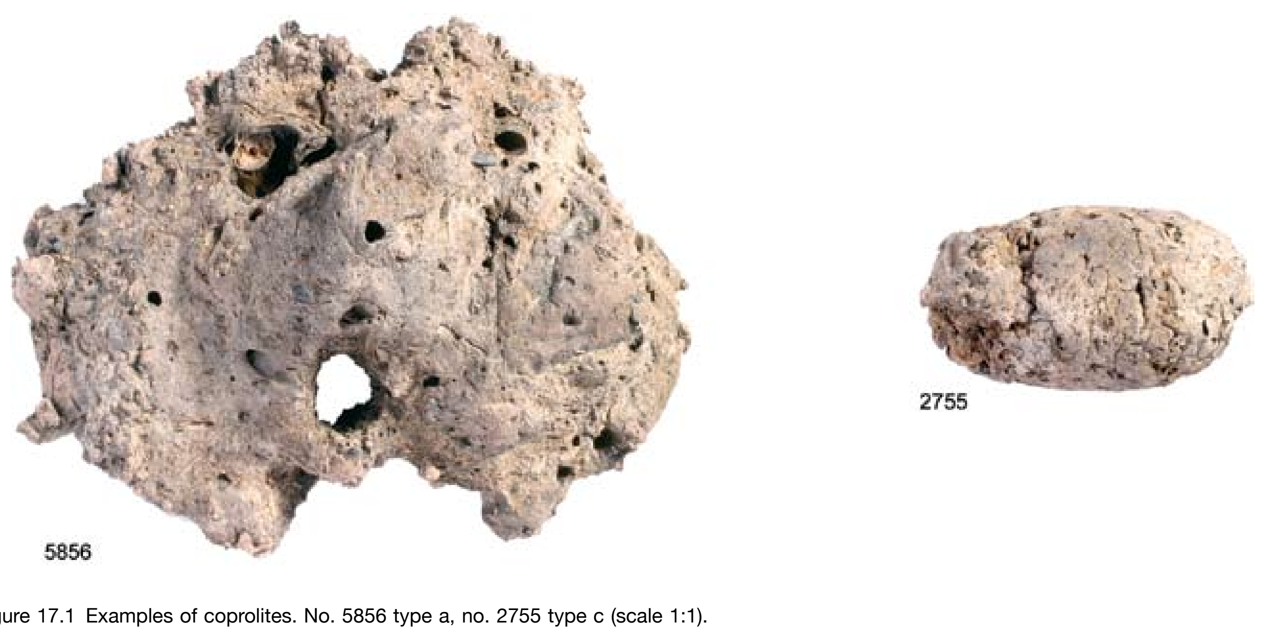

Figure 17.1 Examples of coprolites. No. 5856 type a, no. 2755 type c (scale 1:1).

(Van Waijjen/Vermeeren 2004). Although the coprolites were treated with special care, many disintegrated in the field or later during storage. Even so, the majority (N=167) could be attributed to one of the distinguished categories.

The second aim of the analysis was to select 16 suitable coprolites (plus 5 spare specimens) for pollen analysis. The coprolites in question were selected on the basis of quality, diversity of producers and spread across the distinguished occupation phases, to ensure optimum results. Two groups of eight coprolites each were thus selected. The results of the first group are reported in chapter 18.

17.3 Materials

The majority of the 187 collected coprolites came from the aquatic deposits on the dune slopes (89%). A much smaller number were recovered from the occupation layer on the dune itself and from pit fills. This difference is indisputably attributable to differences in preservation conditions. The largest number of coprolites was found on the long southeastern side (69%), in accordance with the general find distribution pattern. Coprolites were likewise found in find ratios comparable with those of the other finds at the northern end (13%) and on the northwestern flank (11%). In total, 167 coprolites could be dated to one of the occupation phases. More than half date from phase 2a. The find numbers decrease progressively via phase 2b to phase 3 (table 17.1). No coprolites had survived from phase 1. These proportions will be partly attributable to the employed collection method (phase 1) and partly to the preservation conditions. We again observe a correlation with the general find distribution. There is no particular area or period in which coprolites are disproportionately represented. They are a structural element of the find assemblage.

17.4 Classification and Producers

Three main types of coprolites were distinguished:
– type a is rounded and flat,
– type b has a comparable shape, but is less rounded and thinner.

phase / type	1-2a	2a	2b	3	1-3	totals
a	1	7	3	7	1	19
a/b	–	1	1	–	–	2
b	1	5	2	–	–	8
b/c	–	2	1	–	–	3
c	6	58	29	5	14	112
c large	–	11	4	2	2	19
?	–	7	10	4	3	24
Totals	*8*	*91*	*50*	*18*	*20*	*187*

Table 17.1 Coprolites, type versus phase.

These two types are both of the 'cow pat' variety and are assumed to derive from herbivores.
– type c is cylindrical; a number of subtypes were distinguished on the basis of diameter and inclusions. The coprolites of this type are assumed to derive from carnivores (dogs) and omnivores (humans). Below is a detailed description of the distinguished (sub)types.

Type a is characterised by dark brown, almost peaty matter and has a rounded, flat shape. It looks like an originally mushy substance that has hardened. The coprolites of this type include many – often fairly large – botanical remains. Remarkable are the many straight tunnels with a round cross-section lined with epidermis that were formed by plants growing vertically through the droppings. Evidently, (cyper)-grass, sedge and/or reed stems grew through the droppings while they were still soft. Some of the holes may however have been formed by roots penetrating the matter from overlying peat, as suggested by the presence in some of the coprolites of type a of (large) reed rhizomes, which certainly did not pass through the gastrointestinal tract. Coprolites of this type are most likely of herbivore origin. The flat shape and the (coarse) botanical component suggest they are (parts of) cow pats.

Subtype a2 is largely similar to type a, but less brown and less humic, and (virtually) not vertically penetrated by plant growth.

Type b has many features in common with type a, in particular the botanical component, but is less rounded and flatter (approx. 0.5 centimetre), contains a lot of inorganic matter (clay/sand), consists of harder and heavier matter and is less clearly vertically penetrated by plant growth than type a. It is quite possible that the only cause of the differences between types a and b is the substrate onto which the faeces were dropped. Type a will have been dropped onto a peaty or humic soil and type b onto a clayey or sandy substrate. So the coprolites of type b are most probably likewise of herbivore origin.

Subtype b2 is largely the same as type b, but (virtually) not vertically penetrated by plant growth. Only one coprolite of this type was distinguished.

Type c is characterised by a cylindrical shape and a clearly visible outside. The diameter of the cylinder is generally around 1.75 centimetres. In the case of unfragmented specimens the cylinder often has a pointed end, indicating a carnivore or omnivore origin.[1] The coprolites of type c are pale yellow; the matter is truly mineralised and contains gas cavities. In addition, sand, fine organic matter and often also small bone fragments were almost always observed in the macroscopic analysis. Their small size suggests they derive from foxes or dogs and makes it unlikely that they were produced by humans.

Subtype c* resembles type c, but is a little larger (ø = 2 cm) and clearly more porous. Only three coprolites of

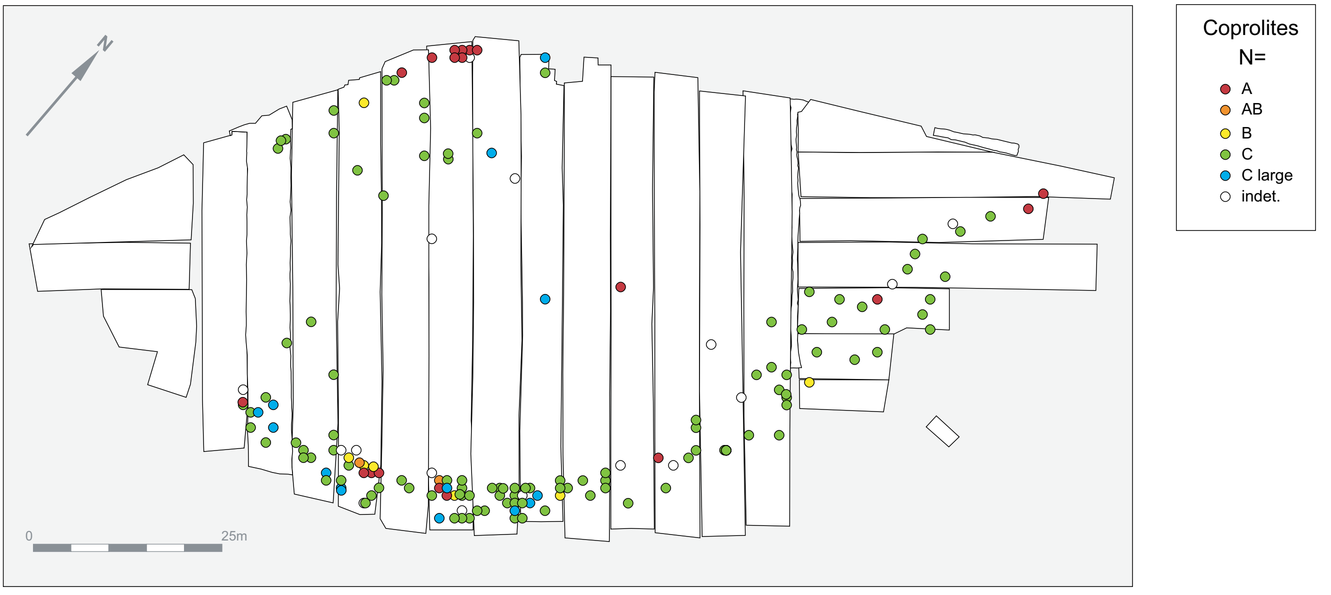

Figure 17.2 Distribution patterns of coprolites per square metre.

this type were distinguished. They probably also derive from carnivores or omnivores.

Subtype c-large likewise resembles type c, but is distinctly larger (ø = 2/2.5 cm). It is often not round, but oval or flattened in cross-section. These coprolites were produced by possibly carnivores, most probably omnivores such as large dogs or humans.

Subtype c2 is similar to subtype c-large, but clearly contains more botanical matter than type c, and little bone or sand. The matter is light and porous and contains more and larger gas cavities. These coprolites most likely derive from omnivores such as large dogs or humans.

Subtype c3 clearly contains more bone than type c, including fairly large fragments. The food was evidently less vigorously chewed. The coprolites of this type also contain larger quantities of coarse sand and sometimes also charcoal, implying feeding from the ground. They vary in size, but are on the whole larger than the coprolites of type c (approx. (ø = 2/2.5 cm). This type is probably attributable to a carnivore such as a large dog or possibly a wolf.

Table 17.2 shows the scores per type, table 17.1 the distribution of the (main) types according to the distinguished phases. The proportions of phases 2a and 2b are more or less the same. We note a relatively large number of coprolites of type a from phase 3, but this may very well be due to better preservation in the peat.

17.5 Conclusion

The great majority of the classified coprolites belong to type c and its subtypes (81%). Of these coprolites, 69% most probably derive from dogs and 20% (subtypes c-large and c2) possibly from humans, with dogs as alternatives. The other 11% could not be attributed to a specific producer. So most, if not all, of the cylindrical coprolites seem to have been produced by dogs, which evidently roamed freely around the settlement. Wolves and foxes are less likely producers, considering the context.

Some of the coprolites (18%) look like (parts of) cow pats. We assume that the proportions of the surviving coprolites do not correspond to the proportions of the original droppings. The difference will be largely attributable to the much smaller chances of fossilisation of the latter group of droppings. In the absence of alternatives, and considering their relative great importance for the community (chapter 22), cattle are the most likely producers of those droppings.

The coprolites comprise no droppings typical of pigs, sheep or goats. In the case of goats and sheep this is in accordance with the absence of remains of those animals in the bone assemblage. As for pigs, it could mean that pigs did not roam freely in the farmyards, that is, not in the peripheral zones to which the coprolite study relates.

type		N=	totals
a		10	
a?		1	
a2		8	
	subtotal		19
a/b		2	
b		7	
b2		1	
	subtotal		10
b/c		3	
c		78	
c large		19	
c*		3	
c/c2		4	
c/c3		8	
c?		2	
c2		8	
c3		9	
	subtotal		134
?		10	
–		14	
	subtotal		24
Totals			*187*

Table 17.2 Coprolites, numbers per type.

note

1 In – more or less – natural environments, the menu of carnivores such as dogs and foxes also includes a plant component, making it more difficult and less meaningful to distinguish between carnivores and omnivores.

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18 Pollen analysis and the reconstruction of the former vegetation

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Three pollen diagrams supplemented by four pollen spectra obtained for samples from wells and eight pollen spectra obtained for coprolites were used to reconstruct the vegetation at the time of the occupation of the dune. The diagrams and spectra show a treeless dune that was initially surrounded by a salt marsh and later by a freshwater reed and sedge marsh. There may have been patches of alder carr at some distance from the dune.

18.1 Introduction

Several pollen analyses were conducted with the aim of reconstructing the former vegetation on and around the dune and the changes that took place in the environment during its occupation. Samples were taken with a view to obtaining pollen diagrams for waterlogged sediments in the lowest parts of the dune's slopes and pollen spectra for the fills of waterlogged features on top of the dune. Off-site pollen diagrams were not included in the research programme. During the excavation two more promising sources of pollen were discovered: a soil profile on top of the dune and a series of coprolites. They were both added to the list of sediments and objects to be analysed.

18.2 Materials and methods

The slopes of the dune and the soil profile were sampled by driving 10 × 15 × 50 cm boxes into the sections made during the excavation. One series of samples was obtained from the northern end of trench 16 and a second one from the southern part (fig. 18.1, 16N and 16S). Samples of sediments were hence taken as far away as possible from the areas of human activity. Schipluiden 16N comprised sediment from Units 20, 10 and 02 (chapter 2) and Schipluiden 16S sediment from Units 19 and 10. By the time the latter units were sampled, the younger units had already been removed. As some parts of these units moreover appeared slightly trampled, an additional, very small trench – trench 40 – was dug especially for the purpose of obtaining a sample for pollen analysis. The trench was dug as far away from the dune as technically feasible, but even there the sediments were found to contain some discarded bones. The box taken

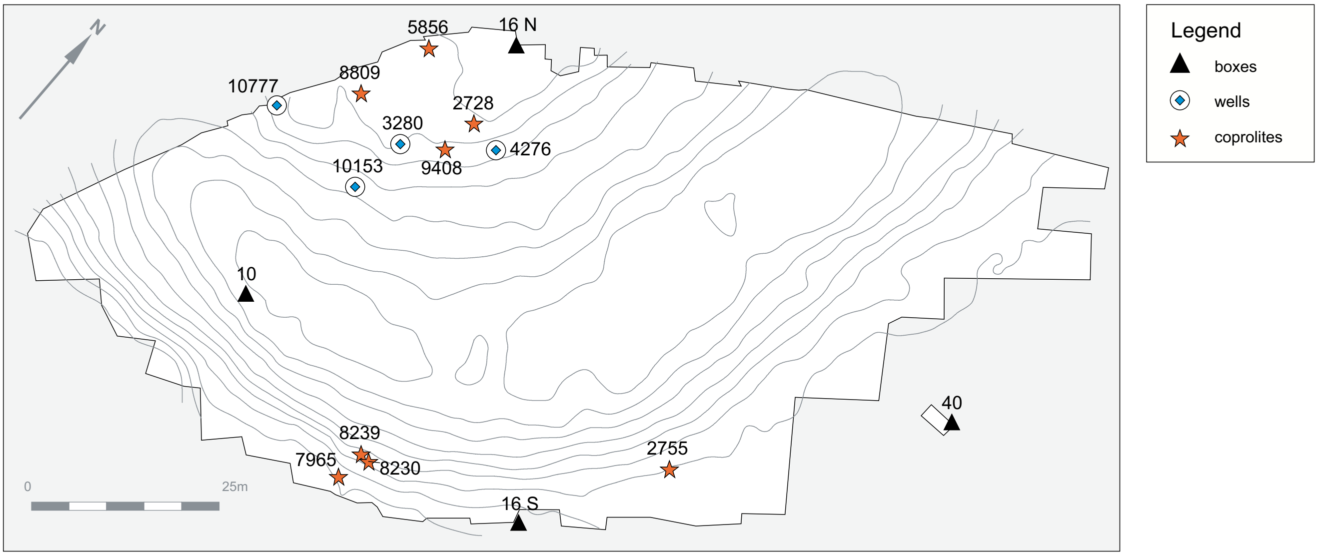

Figure 18.1 Points at which the box and well samples were taken and findspots of the coprolites.

from this trench – sample 40 – comprised sediments from Units 19, 10, 02, 01 and 00. Only the sediments of the lowest three units of this sample were analysed. The soil profile was sampled in trench 10.

The (formerly) waterlogged features on the dune were tested for the presence of pollen. Most were found to contain poorly preserved pollen or no pollen at all. Four of the pollen-containing features were selected for full analysis – *i.e*. single spectra were counted from the bases of their fills.

The coprolites were described and classified by BIAX-*Consult*, which divided them into three categories on the basis of their morphology (chapter 17). Some are mere fragments. Eight of the less damaged specimens were analysed.

Pollen was extracted in the usual way, by subjecting the sediments to KOH and HCl treatment, heavy liquid separation and acetolysis with the addition of a Lycopodium tablet. Before treatment, the clastic sediments in the boxes were cut into 1-cm-thick slices and the more compressed peat sediments into 0.5-cm-thick slices. Matter from the interior of the coprolites was subjected to treatment with 85% phosphoric acid, heavy liquid separation and acetolysis (Vermeeren/Kuijper 1993). The laboratory work was carried out by W.J. Kuijper. The pollen grains from the sediments were identified and counted by K. Verhoeven and those from the coprolites by the author. The grains were identified with the aid of the keys of Faegri *et al*. (1989), Moore *et al*. (1991), Punt *et al*. (1976-1995) supplemented by Reille (1992/1995/1998), several type lists set up by Van Geel and the reference collection of the Faculty of Archaeology of Leiden University.

The soil profile proved to be sterile. The pollen from the sediments and that from the coprolites will be discussed separately below.

18.3 Pollen from the slopes and the top of the dune

The research programme allowed for only a limited number of spectra. Nevertheless, three pollen diagrams were drawn and four spectra were obtained for the bases of the primary fills of the sampled well features. The pollen sum is a Total Pollen sum. Most of the tree pollen must have come from far away, transported by water and long distance air currents. In the period of occupation, trees such as *Picea* and *Abies* were not to be found in the Netherlands and *Pinus* was extremely rare. It is assumed that *Tilia* and *Ulmus* will not have done well in an environment close to the sea. It is likewise doubtful that *Quercus* and *Corylus* grew in such an environment, and this is indeed confirmed by the results of the wood analyses (chapter 21). An Arboreal Pollen sum was feasible, but would not have clearly shown to what extent the dune was covered with trees or shrubs. An Upland Pollen sum posed the problem of which herbs to exclude. Therefore all pollen and spore taxa were included in the sum. The most significant parts of the diagrams are shown in figures 18.2-4. The data that are not shown confirm the illustrated parts of the diagrams (table 18.1).

18.3.1 Diagram Schipluiden 40

The Schipluiden 40 diagram, which was obtained for a sample taken around 20 m to the east of the dune, includes comparatively little tree and shrub pollen. This diagram relates to Unit 19 (clay), which was formed in occupation phase 1, and Unit 10 (peat), formed in occupation phase 3. The main components are *Pinus, Alnus*, *Quercus* and *Corylus*. The *Pinus* values obtained for Unit 19 are slightly higher than those obtained for the phase of the growth of the peat of Unit 10. The reverse holds for the other three species. The *Pinus* pollen is assumed to have been transported from a source much further away than the pollen of the other species. Even so, the values of all the trees and shrubs are too low to allow a reconstruction of a vegetation comprising trees and shrubs on or in the immediate vicinity of the dune. There may have been some insect-pollinated shrubs, shedding very little pollen, but the main vegetation consisted of herbs. The herb pollen dating from the phase when clay was laid down in the tidal marsh is dominated by Chenopodiaceae and Asteraceae tubuliflorae. Pollen of this type is released by for example *Salicornia* species, *Suaeda maritima* and *Aster tripolium*. These plants are the main members of halophytic vegetations thriving in the lower parts of salt marshes. *Plantago maritima* also grows in such areas. Such a halophytic vegetation was clearly to be found on the southern side of the dune in occupation phase 1. Asteraceae liguliflorae, Apiaceae and Brassicaceae have been included under the heading of ‘salt marsh’, but which species they represent is not clear.

Peat formation started some time after the deposition of the clay of Unit 19. A vegetation releasing Poaceae and *Solanum dulcamara* pollen took over. It may have been a slightly brackish marsh vegetation comprising *Phragmites australis* and liana *Solanum dulcamara*, which is also tolerant of salt. Peat growth continued under a vegetation dominated by Cyperaceae (sedges), which also included plants such as *Sparganium* species, *Typha latifolia* and *Iris pseudacorus*. They are indicative of a freshwater environment. Indicators of open water proper are absent. During occupation phase 3, the low-lying areas bordering the southern slope of the dune were marshy without significant pools of open water.

The picture that emerges for the vegetation on the dune is less clear. It may have been pasture-like. Some of the Poaceae and Cyperaceae may have grown on the dune. Pollen percentages of upland herbs are very low. Some *Plantago lanceolata* and *Artemisia* may have been part of the local vegetation.

section or feature Unit	40 19S	40 10	40 2	16 S 19S	16 S 10	16 N 30	16 N 10	16 N 2	3280	4276	10153	10777
Alisma	–	–	–	–	–	•	–	–	–	–	–	–
Caryophyllaceae	•	–	–	•	•	–	–	–	–	–	–	–
Cuscuta	–	–	–	–	–	•	–	–	–	–	–	–
cf Epilobium	–	–	–	–	–	–	•	–	–	–	–	–
Ericales	–	–	–	•	–	•	–	–	•	–	–	–
Fabaceae	–	–	–	–	–	•	–	–	•	–	–	–
Lotus corniculatus	•	–	–	–	–	–	–	–	–	–	–	–
Lotus pedunculatus	•	–	•	•	–	–	•	–	–	–	–	•
Lythrum	•	•	–	•	–	•	–	•	–	–	•	•
Mentha type	–	•	–	–	–	–	–	–	–	•	•	–
Polygonum aviculare	–	–	–	–	–	•	•	–	–	–	–	–
Pulmonaria type	–	•	–	–	–	–	–	–	–	–	–	–
Ranunculus	•	–	–	•	–	•	–	•	–	•	–	–
Ranunculaceae	–	–	–	•	–	–	–	–	–	–	–	–
Rumex acetosa type	•	–	-	•	–	–	–	–	–	–	–	–
Sanguisorba officinalis	–	–	–	–	–	•	–	–	–	–	–	–
Thalictrum	•	–	–	•	–	–	–	•	–	–	–	–
Vicia type	•	•	–	–	–	–	•	–	•	–	–	–
Polypodium	•	–	–	•	•	•	•	•	–	–	•	•
Pteridium	•	•	–	•	•	•	•	•	–	–	–	–
Sphagnum	•	–	•	•	•	•	•	•	–	•	–	–
Triletae psilatae	•	•	•	•	•	•	•	•	•	–	–	•
Acritarchs	–	•	•	•	•	•	–	•	–	•	•	•
Diatoms	–	–	–	•	–	•	–	–	•	–	–	•
Foraminiferae	•	•	•	•	•	•	•	•	•	–	–	•
Neurospora ascospore	–	–	–	–	•	–	–	–	–	–	–	–
Tetraploa aristata	–	–	–	–	–	–	–	–	–	•	•	–
Tilletia	•	–	•	•	–	–	–	–	•	–	–	–
Ustulina ascospore	–	–	–	–	–	–	–	•	–	–	-	–
Units only												
Veronica	•	–	–	•	–	•	•	•	.	.	.	.
Dinoflagellatae	–	–	–	–	–	•	–	–	.	.	.	.
wells only												
Calystegia	.	.	.	.	.	.	.	.	–	–	–	•
Filipendula	.	.	.	.	.	.	.	.	•	•	•	•
Humulus	.	.	.	.	.	.	.	.	–	–	•	–
Polygonum persicaria type	.	.	.	.	.	.	.	.	–	–	–	•
Pediastrum	.	.	.	.	.	.	.	.	–	–	–	•
Gelasinospora ascospore	.	.	.	.	.	.	.	.	–	–	–	•

Table 18.1 Pollen types not included in the diagrams.

18.3.2 Diagram Schipluiden 16 South

Schipluiden 16 South, which relates to Units 19 (clay) and 10 (peat), is quite similar to the above diagram. The stage in which the area was covered with sedges is not represented, presumably because the part of the peat concerned had already been removed by the time the samples were taken. The only element not encountered in the Schipluiden 40 diagram is Cerealia pollen. The characteristics of such pollen are a size of >36 μ, a large pore, an annulus with a thickness equal to the diameter of the pore and a distinct boundary between the annulus and the body of the grain. A few other Poaceae pollen grains had a similar size but lacked the other features. Some Cerealia are represented in the salt marsh deposit. A modest peak in the part of the diagram represent-ing the phase of peat growth must be associated with occupation phase 3. This implies that cereals were processed on the dune. Whether they were only threshed there or were actually grown there remains unclear. The kinds of cereals known at this time are poor pollen releasers. Most of the pollen of those cereals is released during rough handling of the crop.

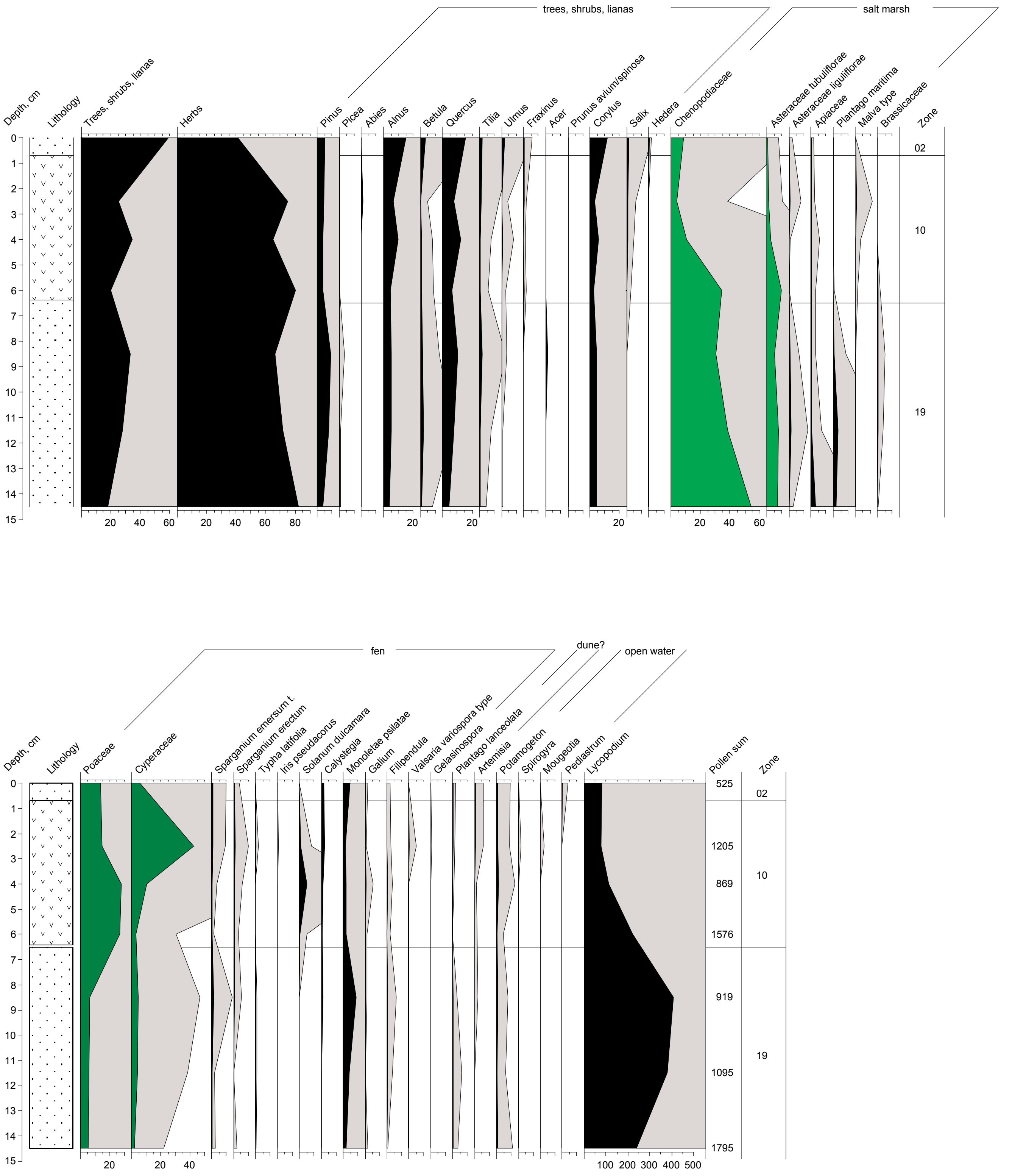

Figure 18.2 Pollen diagram Schipluiden 40. Percentages (black) and percentages 10× (grey). Dominant local pollen taxa indicated in colour.

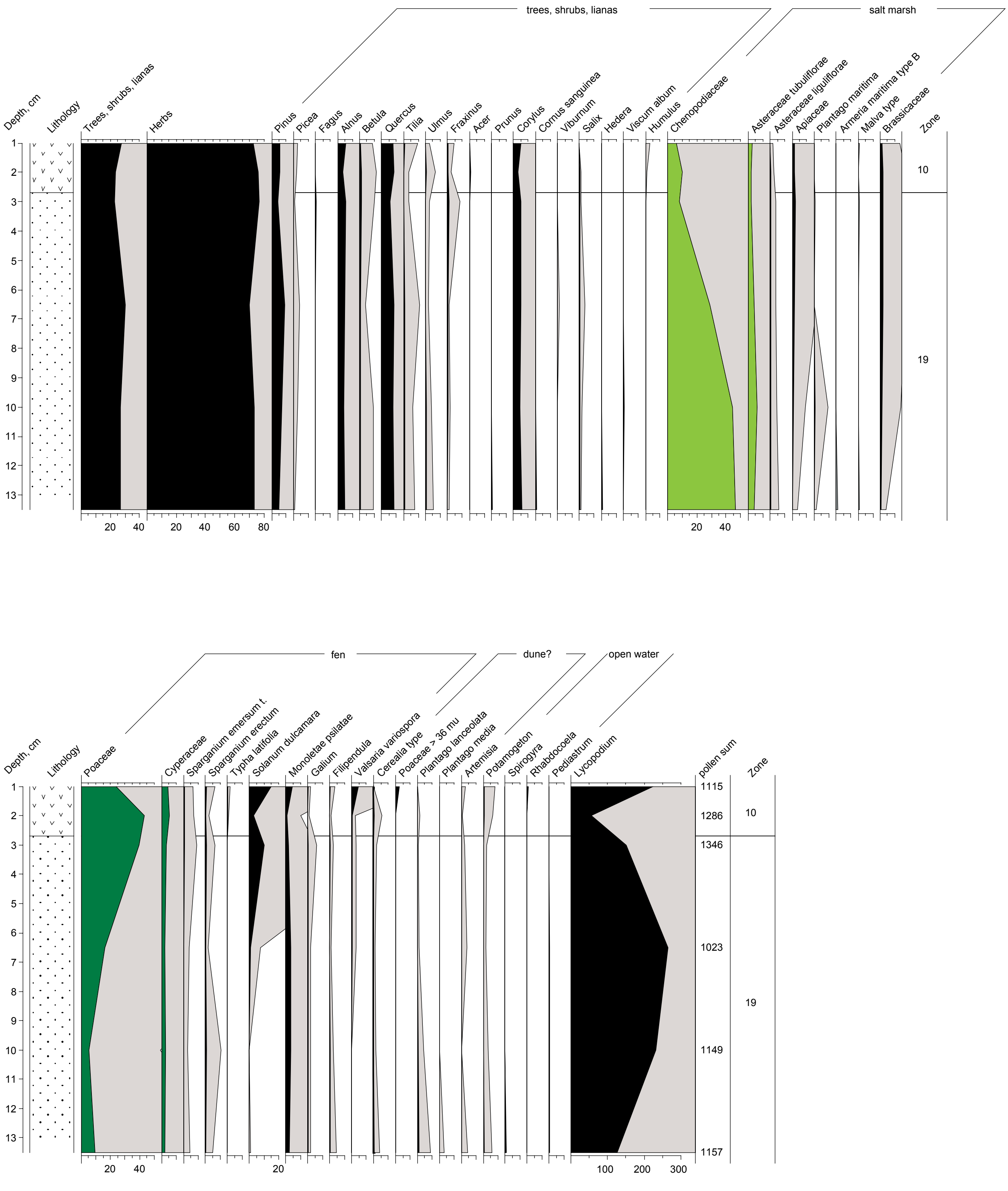

Figure 18.3 Pollen diagram Schipluiden 16 South. Percentages (black) and percentages 10× (grey). Dominant local pollen taxa indicated in colour.

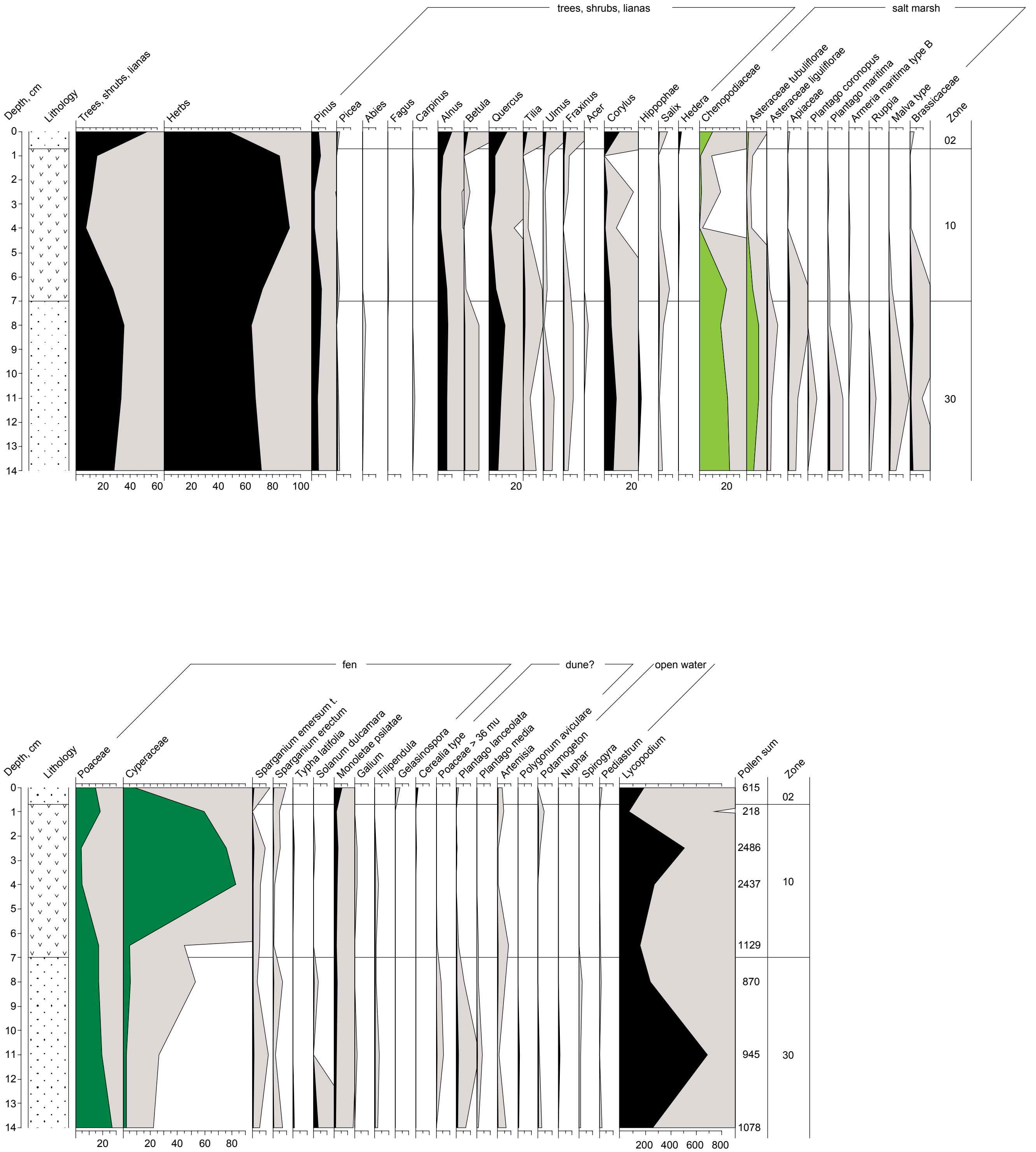

Figure 18.4 Pollen diagram Schipluiden 16 North. Percentages (black) and percentages 10× (grey). Dominant local pollen taxa indicated in colour.

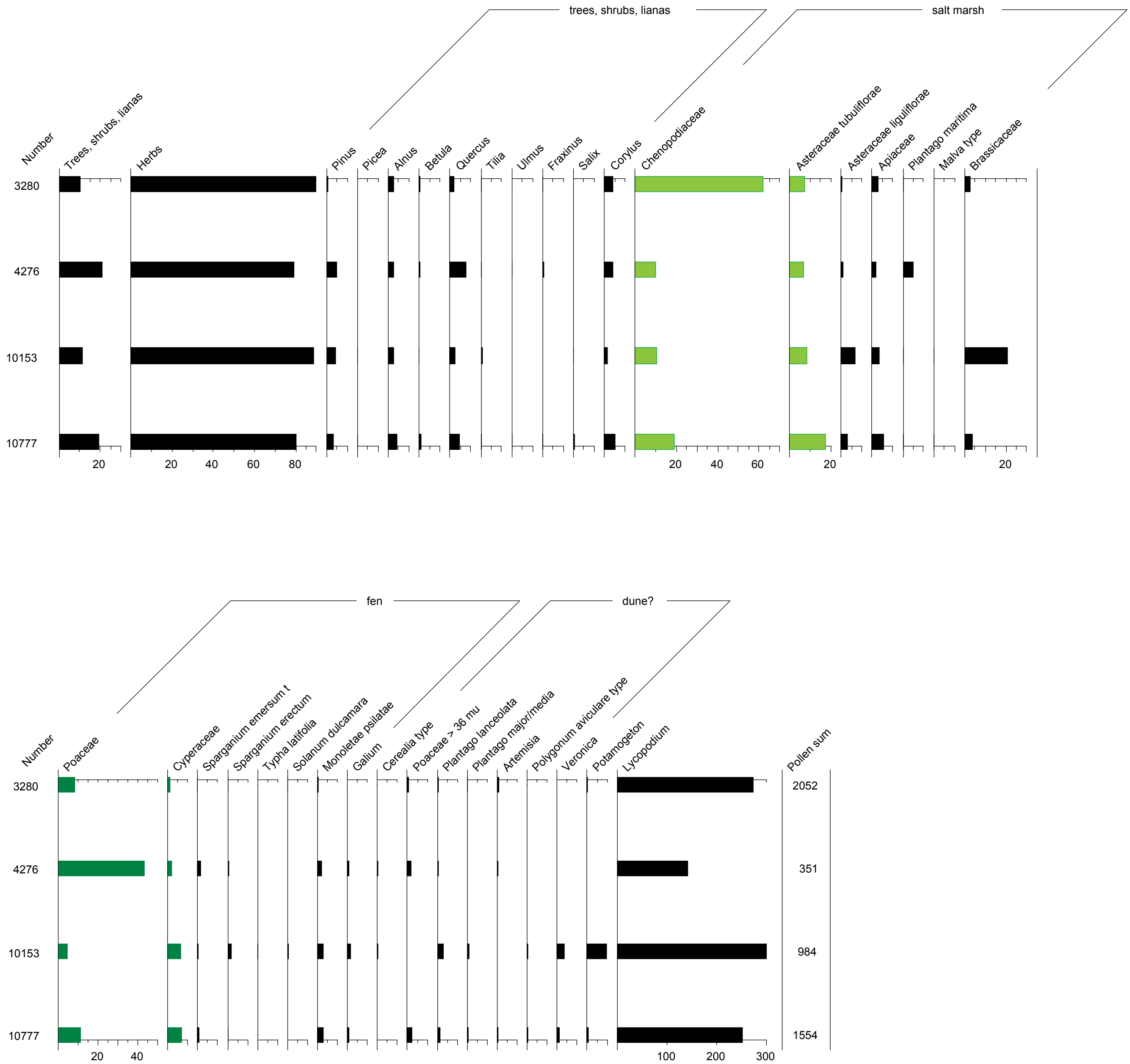

Figure 18.5 Pollen spectra obtained for the fills of the wells. Dominant local pollen taxa indicated in colour.

18.3.3 Diagram Schipluiden 16 North

The other side of the dune is represented by diagram Schipluiden 16 North, relating to Units 30 (clay) from occupation phases 1-2a, 10 (peat) from phase 3, and 2 (clay). The diagram shows the same kind of vegetation as revealed by the diagrams obtained for the southern side. *Ruppia* points to salt or brackish open water in depressions on the salt marsh or in nearby environments, from which it may have been transported by occasional floods. The *Malva*-type pollen in this diagram is at least partly released by *Althaea officinalis*. This tall herb and the shrub *Hippophae* are characteristic of the lower parts of dunes which are only flooded by salt water during extremely high tides. In the other diagrams *Malva*-type pollen is not associated with the salt marsh, but – in

Schipluiden 40 at least – with the peat, and the pollen grains were not clearly *Althaea*-like. The vegetation may be characteristic of the foot of the northern slope. There seems to have been no brackish peat-forming vegetation comprising *Phragmites*. This impression may however be attributable to the counting of an insufficient number of spectra. The peat was very compressed; the pollen zone containing Poaceae may have been overlooked.

18.3.4 Unlined wells

It was hoped that the missing information concerning the vegetation on the dune itself would be provided by the samples from the bases of the fills of the (unlined) wells. Four of those samples were analysed, all from the northwestern group and all dating from phases 1-2a. The results are shown in figure 18.5 and table 18.1. It should be borne in mind that the pollen retrieved from such features will not all have been released by the surrounding vegetation. Many pollen grains will have made their way into the wells along with plant matter thrown into the wells by the occupants or with the dung of their cattle. The samples nevertheless show an almost complete absence of trees and shrubs. There is no evidence suggesting that any insect-pollinated trees or shrubs, or trees or shrubs producing little pollen grew close to the wells. If such trees and shrubs were present, some of their pollen would have been found. One well sample (no. 3280) was dominated by Chenopodiaceae. This well was also sampled for the presence of macro-remains. It was found to contain many remains of a rich brackish, ruderal flora comprising Chenopodiaceae (see also chapter 19, sample 12). These remains are in accordance with the pollen. Poaceae pollen dominated a sample from another well (no. 4276). The same sample contained pollen of *Plantago maritima*, but also that of *Sparganium erectum*. These plants do not grow together. A third well sample (no. 10,153) contained mainly Brassicaceae pollen (see chapter 19, sample 21, for the fairly undifferentiated macro-remains recovered from this well), while a fourth (no. 10,777) yielded pollen of Poaceae, Asteraceae tubuliflorae and Chenopodiaceae. When the latter sample was being prepared for pollen analysis it was found to contain macro-remains of *Salicornia*. Except for the alga *Spirogyra* in the second sample and *Potamogeton* and some diatoms in the third one, plants that may have grown in the water in the well are absent, indicating that the wells were indeed short-lived, as suggested in chapter 3, section 3.4.2.

18.3.5 Conclusion based on the pollen from waterlogged sediments

The conclusion that can be drawn from the pollen contained in the waterlogged sediments is that the dune was in the first occupation phase on both sides surrounded by a low-lying salt marsh. After a period without deposition the salt marsh vegetation gave way to actively growing peat – first of all (in occupation phase 3) reed peat, at least on the south side, and later sedge peat. As far as can be concluded from the pollen diagrams, there were no significant bodies of open fresh water on or nearby the dune. The dune itself was treeless. The wells that were dug on the dune were not sufficiently long-lived to allow the development of an established vegetation of water plants. The resolution of the diagrams is too low to allow any statements to be made about human influence on the local vegetation.

18.4 The coprolites

Pollen in coprolites to some extent reflects the environment in which the producer spent its day, or the days before (Vermeeren/Kuijper 1993). Ingested with food, drunk with water or inhaled, pollen passes the intestines fairly undamaged. Cattle dung contains pollen from feed, from drinking water and from the air. It is possible for pollen to stay in the gut for several days or more, and individual coprolites are not assumed to represent a single meal or a single day. As cattle roamed freely in the near and far surroundings of the dune, their dung may contain more extra-local pollen than the sediment formed on the sides of the dune. The same is true of the droppings of omnivores such as dogs and humans. The analysis of coprolites may therefore yield additional information on the environment.

The Schipluiden coprolites were grouped into three categories – a flat type a, a smaller flat type b and a cylindrical type c – with subdivisions, which were attributed to cattle, possibly cattle and dog/human, respectively (fig. 17.1). Within category c, a subtype, c-large, was distinguished: a cylindrically shaped coprolite with a large diameter possibly deriving from a human (see chapter 17). Two coprolites of type a, two of type b, two of the smaller type c and two c-large coprolites were selected for pollen analysis. Three date from phases 1-2a, three from phase 2b and two from phase 3. Their findspots are shown in fig. 18.1. Table 18.2 presents the results of the analysis. The counting was time-consuming due to the presence of tiny charcoal particles. This explains why fairly little pollen was counted. Nevertheless, the results are assumed to represent the contents well, although some rarer pollen types may have been missed. Special attention was paid to the detection of remains of coprophilous fungi such as *Cercophora*, *Sordaria*, *Podospora*, *Bombardioidea* and *Sporormiella*, but none were observed.

To be noted is the low concentration of pollen encountered in numbers 8809 and 2728. The first is a coprolite of type b and the second is one of type c/c3. These low concentrations are clearly not associated with the kind of producer. What distinguishes these two coprolites

Unit	17	17	10	16	15	15	10	23
phase	2a	2a	3	2b	2b	2b	3	1?
find number	8809	2728	5856	2755	8239	8230	7965	9408
type	b	c/c3	a	c-large	b	a	c-large	c2
no. in graphs	1	2	3	4	5	6	7	8
Pinus	7.4	2.3	`9.1	2.9	–	3.0	–	0.7
cf Juniperus	2.1	2.3	1.1	0.7	–	–	–	1.1
Quercus	5.3	7.0	6.9	2.2	1.9	–	–	3.6
Tilia	1.0	–	–	–	–	–	–	–
Ulmus	–	–	–	0.7	–	–	–	0.7
Fraxinus	–	–	0.6	–	–	–	0.8	–
Prunus	4.2	–	0.6	2.9	–	–	–	0.4
Betula	–	–	–	1.4	–	1.5	0.8	0.7
Hippophae	–	–	–	0.7	–	–	4.2	–
Sambucus	–	–	–	–	–	–	1.7	–
Rhamnus	–	–	–	0.7	–	–	–	–
Populus	–	–	–	–	–	1.5	0.8	–
Corylus	2.1		8.6	6.5	11.1	3.0	7.6	14.3
Alnus	7.4	41.9	6.9	15.8	3.7	11.9	16.1	25.1
Salix	1.0	–	–	–	–	–	–	0.7
Humulus	–	–	–	–	–	–	–	0.4
Poaceae	20.0	16.3	31.4	32.4	13.0	10.4	13.6	36.2
Poaceae >36μ	–	–	–	2.9	–	–	–	–
Hordeum t.	–	2.3	–	–	–	–	–	–
Cerealia	–	–	–	–	–	10.4	–	1.4
Cyperaceae	13.7	2.3	9.1	2.2	7.4	1.5	2.5	0.7
Apiaceae	1.0	–	–	1.4	1.9	–	–	–
Artemisia	–	–	1.7	3.6	–	3.0	–	–
Asteraceae tubuliflorae	5.3	7.0	1.1	10.1	3.7	1.5	0.8	1.1
Asteraceae liguliflorae	–	–	1.1	0.7	–	1.5	0.8	–
Brassicaceae	–	2.3	3.4	1.4	16.7	28.4	5.1	–
Caryophyllaceae	–	–	–	–	–	1.5	–	–
Chenopodiaceae	6.3	2.3	8.0	2.9	9.3	10.4	2.5	9.7
Euphorbia	–	–	–	0.7	–	–	–	1.4
Euphrasia	5.3	–	–	–	–	–	–	–
Filipendula	–	2.3	–	0.7	–	–	34.7	–
Galium t.	1.0	–	–	–	1.9	–	–	–
Plantago coronopus	–	–	–	–	1.9	–	–	0.4
Plantago lanceolata	–	–	–	–	13.0	3.0	–	–
Plantago maritima	1.0	–	0.6	–	–	1.5	–	–
Polygonum aviculare	1.0	–	–	–	–	–	–	–
Potamogeton	–	2.3	1.1	–	9.3	1.5	1.7	0.7
Ranunculus aquatilis t.	3.2	2.3	–	–	–	3.0	–	–
Rumex acetosella	2.1	–	–	–	–	–	–	–
Rumex aquaticus t.	–	–	–	1.4	–	–	–	–
Solanum dulcamara	–	–	–	0.7	–	–	3.4	–
Sparganium emersum t.	–	2.3	–	–	3.7	–	0.8	–
Spergularia	1.0	–	1.1	0.7	–	–	–	–
Trifolium	–	–	0.6	–	–	–	0.8	0.7
Typha latifolia	2.1	–	–	–	–	–	–	–
Urtica	–	–	–	–	–	–	0.8	–
Monoletae psilatae	6.3	4.7	4.6	3.6	1.9	–	–	–
Polypodium	–	–	0.6	–	–	–	–	1.1
Triletae reticulatae	–	–	–	–	–	1.5	–	–
Equisetum	–	–	–	–	–	–	–	0.4
Sphagnum	–	–	1.7	–	–	–	–	–
Pollen sum	95	43	175	139	54	67	118	279
Concentration/cc	2804	1257	11764	6728	17195	11922	3449	20095
Diatoms	1	–	1	–	2	19	–	4
Spirogyra	1	–	–	–	–	1	–	–
Hystricosphaeridae	2	–	–	–	–	–	–	2
Assulina	–	–	–	–	–	–	–	1

Table 18.2 Coprolites: pollen spectra based on a Total Pollen sum. Diatoms, *Spirogyra*, Hystricosphaeridae and *Assulina* are not included in the sum and are presented by the actual numbers counted.

from the others is the sediment in which they were found: the top of the salt marsh deposits. Five of the other coprolites came from the peat deposits and one from the fill of a well. This observation raised the question whether the pollen in the coprolites corresponds to that contained in the original droppings. When droppings are still soft, beetles often dig holes in them. Vegetation can penetrate the matter and leave pollen and, after the plants' decay, holes, too. Such holes were indeed observed in the coprolites, especially in those of types a and b. They were avoided during the sampling. But although the samples were taken from the most compact parts of the coprolites and were thoroughly cleaned, there was still a possibility of the pollen contained in them being secondary and not primary. To test this, the pollen contents of the coprolites were compared with the pollen spectra obtained for the sediments in which they were found. This was done by means of Principal Components Analysis (PCA) and Correspondence Analysis (CA) using CANOCO 4 (Ter Braak/Smilauer 1998). The latter analysis was executed because the data displayed a barely normal distribution, which is a drawback for PCA. In both cases the pollen in the coprolites was found to differ from that in the matrices in which the coprolites were embedded.

The second question was whether the distinguished types of coprolite also differed from one another in their pollen contents – whether, say, type a, assumed to derive from cattle, differed from type c-large, assumed to derive from a large dog or even a human being, to give the two extremes. No such differences are immediately observable in the table. Differences between the types are observable only along the second PCA axis (fig. 18.6a). Differences are even less clearly observable in the CA results (fig. 18.6b).

The position of one type c-large in the plot differed from the other positions. The separation is based on *Filipendula*, *Hippophae*, *Solanum dulcamara* and *Sambucus*. The last three all have edible berries (the *Solanum dulcamara* berries are not poisonous when ripe). The berries of the different species ripen in the same season. Although Vermeeren and Kuijper (1993) showed that the season of consumption cannot usually be inferred from pollen in coprolites, this case may be one of the exceptions. Did the producer eat berries in the late summer?

The two a and b types on the lower right in the PCA plot and in the upper right in the CA plot are characterised by pollen of *Plantago lanceolata,* Cerealia, Chenopodiaceae and *Potamogeton*. The animals may have fed on the stubble of a cereal field and drank fresh pond water. *Plantago lanceolata* and Chenopodiaceae are in this case assumed to have formed part of the weed flora. The other coprolites yielded no such information.

18.4.1 Conclusion

The first axis in the PCA plot is tentatively assumed to represent the former environment. What is clear from this axis is that the tree and shrub species characteristic of dune vegetations were actually scarce in the surroundings of the

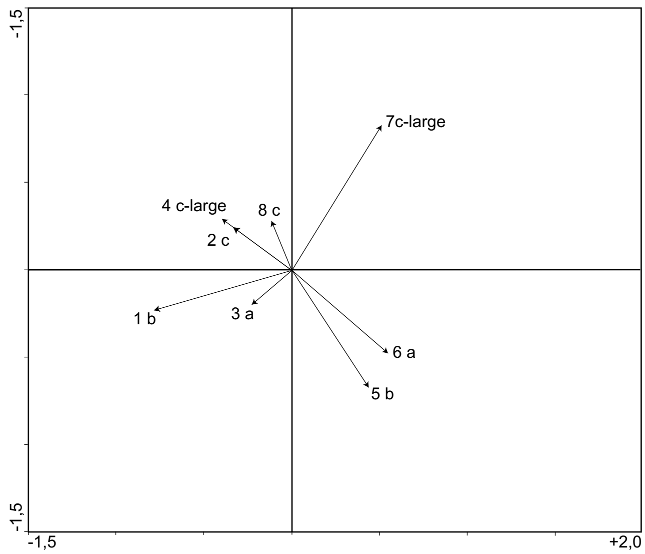

Figure 18.6a PCA analysis of coprolites, log transform.

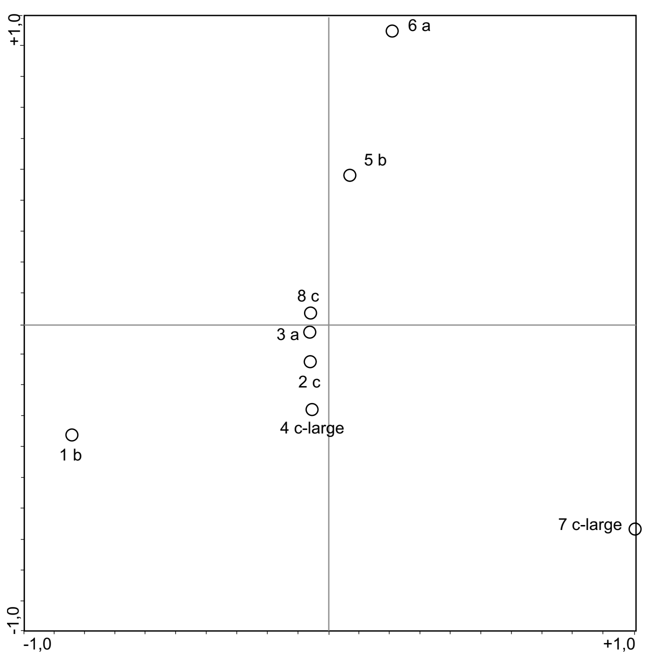

Figure 18.6b CA analysis of coprolites, log transform.

Schipluiden site. Even if we assume that tree pollen is underrepresented in dung because dung producers will not have eaten any parts of flowering trees, if there were any trees in the area visited by the dung producers, a small quantity of tree pollen would nevertheless have made its way into the dung via tree pollen adhering to consumed herbs and suspended in drinking water (see for instance Carrion *et al*. 2000). The coprolites therefore confirm the conclusion based on the pollen diagrams and spectra obtained for the well fills, which is that there were no trees at the site, and that trees were possibly also scarce in its immediate surroundings. Some of the coprolite producers seem to have visited areas where *Alnus* grew. There may have been stands of alder trees at some distance from the site. If the information based on two coprolites is to be trusted, it suggests that crops were grown somewhere near the site.

A sample of only eight coprolites is fairly small, so our interpretations may be somewhat premature. More coprolites need to be investigated. The first axis may moreover represent the matrices containing the coprolites rather than the original dung. The low pollen contents of the two coprolites from the salt marsh still need to be explained. The investigations are being continued.

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19 Botanical remains and plant food subsistence

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Analysis of plant macro-remains, including charred cereals, seeds and fruits and vegetative remains revealed a complex pattern of plant resources and plant exploitation in the Dutch coastal dune zone. Diversity in the landscape was demonstrated throughout the occupation phases. The high salt marsh and possibly low dunes in the surroundings offered possibilities for small-scale agriculture. Emmer and naked barley were the two cultivated crops. Besides these cereals, the diet comprised a broad spectrum of gathered wild plants, including fruits and berries, and roots and tubers. All the evidence combined shows a fairly broad spectrum of dietary diversity – a result of the exploitation of different resources and vegetation zones.

19.1 Introduction

One of the objectives of the Schipluiden project was the recovery of plant remains in order to reconstruct the environment during the Neolithic occupation of the site and specify the botanical part of the occupants' subsistence system.

This objective was of particular interest because it fell within the potential of the site, which lies in the Dutch coastal dune zone. Our knowledge of the settlement pattern and economy of this area during the Neolithic is rather limited due to the fact that only very few sites have been investigated (Van Zeist 1970, Raemaekers *et al*. 1997). Schipluiden has yielded a great deal of evidence relating to a local community that combined agrarian activities with the exploitation of both aquatic and terrestrial resources. The question whether the coastal zone may have been used for crop cultivation during the Neolithic can now be answered.

19.2 Methods

19.2.1 Recovery and selection of plant remains

The recovery of botanical samples was incorporated in the excavation strategy. In order to obtain assemblages of plant macro-remains representative of the site as a whole, the following strategy was followed:

1) 5-litre samples were taken from most of the features with potential for the preservation of plant remains, including wells, pits, hearths and post-holes;
2) 5-litre samples were every six metres systematically taken from the units in exposed sections. This led to the creation of a sampling grid (6 × 12 metres) covering the entire excavated area;
3) material collected on 4-mm sieves and hand-picked botanical remains were examined to assess their potential for the preservation of plant remains, including remains of processed food and roots and tubers. More than 500 samples were examined in this group.

This planned sampling strategy however resulted in more samples than could be analysed. Therefore a selection of 274 samples (of groups 1 and 2) was assessed in order to estimate the samples' botanical value, including preservation conditions, diversity of plant species and numbers of seeds and fruits. All samples were washed using a series of sieves with mesh sizes of 2.0, 1.0 and 0.5 mm, respectively. Sub-samples of 0.5 litres were taken from each sample and they were washed through a 0.25-mm sieve.

In total, 60 samples were selected for analysis using combined information on botanical value, type and date of context and position within the settlement area. The samples were selected from similar ranges of context types from each occupation phase in order to determine the environmental pattern and diachronic changes in subsistence throughout the site's occupation. The majority of the samples of plant remains from the individual phases derived from wells and units. In addition, a number of samples were selected from some of the postholes, hearths and pits. The latter samples however have no clear archaeological dates and may represent any of the occupation phases. The positions of all the analysed samples in relation to the occupation phases and archaeological contexts are presented in figure 19.1.

The seeds and fruits were studied under a binocular incident light microscope at magnifications of 6× to 50×.

19.2.2 The preservation of plant remains

For the interpretation of plant remains in terms of palaeoecology and subsistence, various factors relating to the preservation of plant material are of great importance. In any archaeological context, and hence also that of Schipluiden, (almost) every botanical sample will have been influenced by man. The influence may have been either direct, in that many plants will have found their way into the settlement having been gathered for consumption or use as fuel and possibly

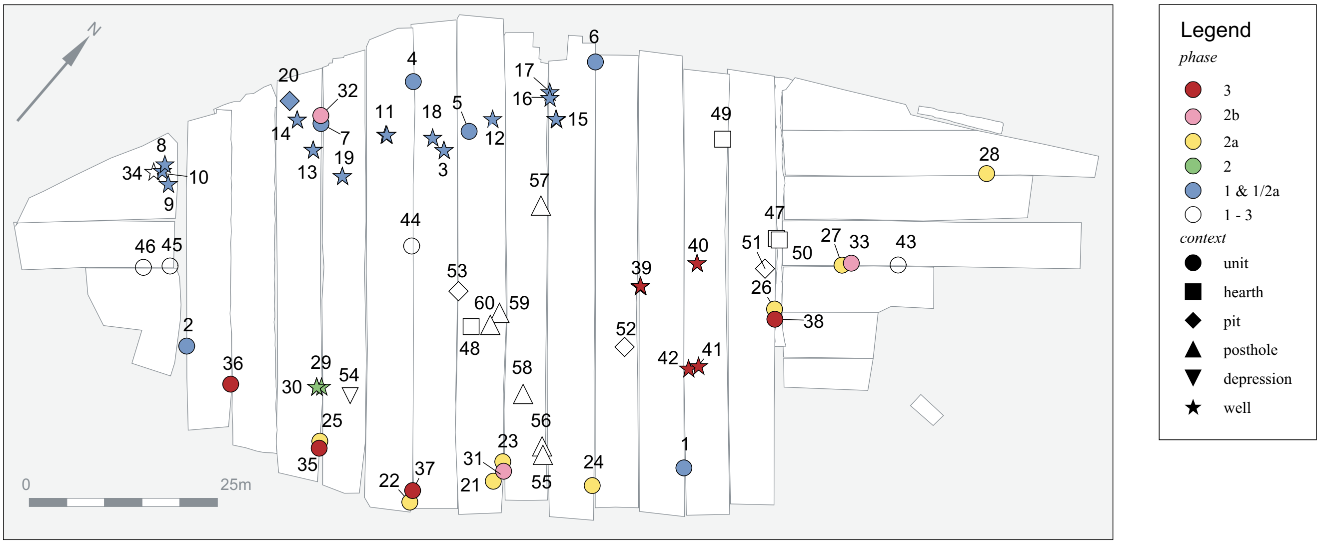


Figure 19.1 Position of the botanical samples, indicated according to occupation phase and archaeological context.

other purposes (medicine, magic), or indirect, for example via animal husbandry. Trampling, grazing and manuring are important factors interfering with the natural pattern of plant and seed distribution (see Groenman-van Waateringe in Therkorn *et al.* in press). At any site there will consequently always be a mixture of natural and man-affected data.

It should also be noted that archaeological sites present us with a complex taphonomy, the result of many different site-formation and archaeological-deposition processes that have led to mixing of botanical remains. At this site, for example, samples from the sequence of natural deposits represent a random mixture of plant remains from a time-span of many years, up to a century (see chapter 2). By contrast, well samples represent a much shorter time-span and may even reflect a single deposition event (section 3.4.2). The specific context of the Schipluiden site significantly biased the preservation of plant remains (*i.e.* waterlogged versus charred remains) and the diversity of plant species represented in the assemblages. Generally speaking, the wells yielded large, diverse assemblages of waterlogged remains, especially the wells from occupation phases 1/2a and to a lesser degree those from phase 2. The samples from wells dated to phase 3 however show surprisingly little (or no) diversity in waterlogged remains. This is probably attributable to differences in preservation conditions. Various factors, for example the wells' high position on the dune (*i.e.* above groundwater level for a long time), the fact that they were not closed off after their period of use but remained exposed, and the formation of (acid) peat, may all have affected the preservation of the waterlogged remains. It is hence quite well possible that waterlogged plant remains from the last occupation phase are underrepresented.

Contrary to the well fills, the stratified natural deposits proved to contain mainly charred remains and a small range of waterlogged remains, except for Unit 19N (phases 1/2a). Almost without exception, the postholes and hearths yielded only charred remains. The distribution of charred remains according to the different occupation phases is also rather uneven. Rather striking is that the samples from the early occupation phases (1 and 2a) contained small numbers and low frequencies of charred remains, whereas charred remains dominate the macrofossil records of phases 2 and 3. In all the samples, the range of species represented by charred remains was much smaller (some 55 different taxa) than that represented by waterlogged remains, which comprised more than 130 different taxa. The plant macrofossil assemblages of waterlogged (Appendix 19.1) and charred remains (Appendix 19.2) are presented separately. In both tables the species have been arranged according to the type of environment in which they most probably grew.

19.2.3 Ecological groups

For the reconstruction of the local environment during the Neolithic occupation all wild plant species identified in the archaeobotanical record (represented by both waterlogged and charred remains) were grouped according to the habitats in which they most probably grew. This approach is based on ecological criteria (*i.e.* indicator values of species) derived from modern plant ecology (see for example Behre/Jacomet 1991; Van der Veen 1992 for a discussion). Using this approach the macrofossil record was divided into seven ecological groups distinguished with regard to environmental factors such as salinity, moisture and nutrient and light requirements characteristic of groups of species. These ecological groups are:

1) salt marsh plants
2) plants of freshwater marshes
3) plants of wet to damp grasslands
4) plants of dry grasslands
5) arable weeds and ruderals
6) plants of damp, nitrate-rich soils and
7) shrubs

The (pie) eco-diagrams were subsequently used in an attempt to illustrate the environmental conditions characteristic of the occupation phases, and to indicate the evidence of diachronic changes in an inter-phase comparison of environmental conditions (fig. 19.2). The diagrams show the numbers of species represented in the macrofossil assemblages for each ecological group. Separate diagrams are given for samples from stratified deposits and samples from wells. The samples of all the phases reflect different types of vegetation in different ratios.

19.3 Reconstruction of the former vegetation

In this section the composition of the archaeobotanical assemblage will be discussed on the basis of the ecological groups in an attempt to reveal environmental patterns in the occupation phases.

19.3.1 Occupation phases 1-2a

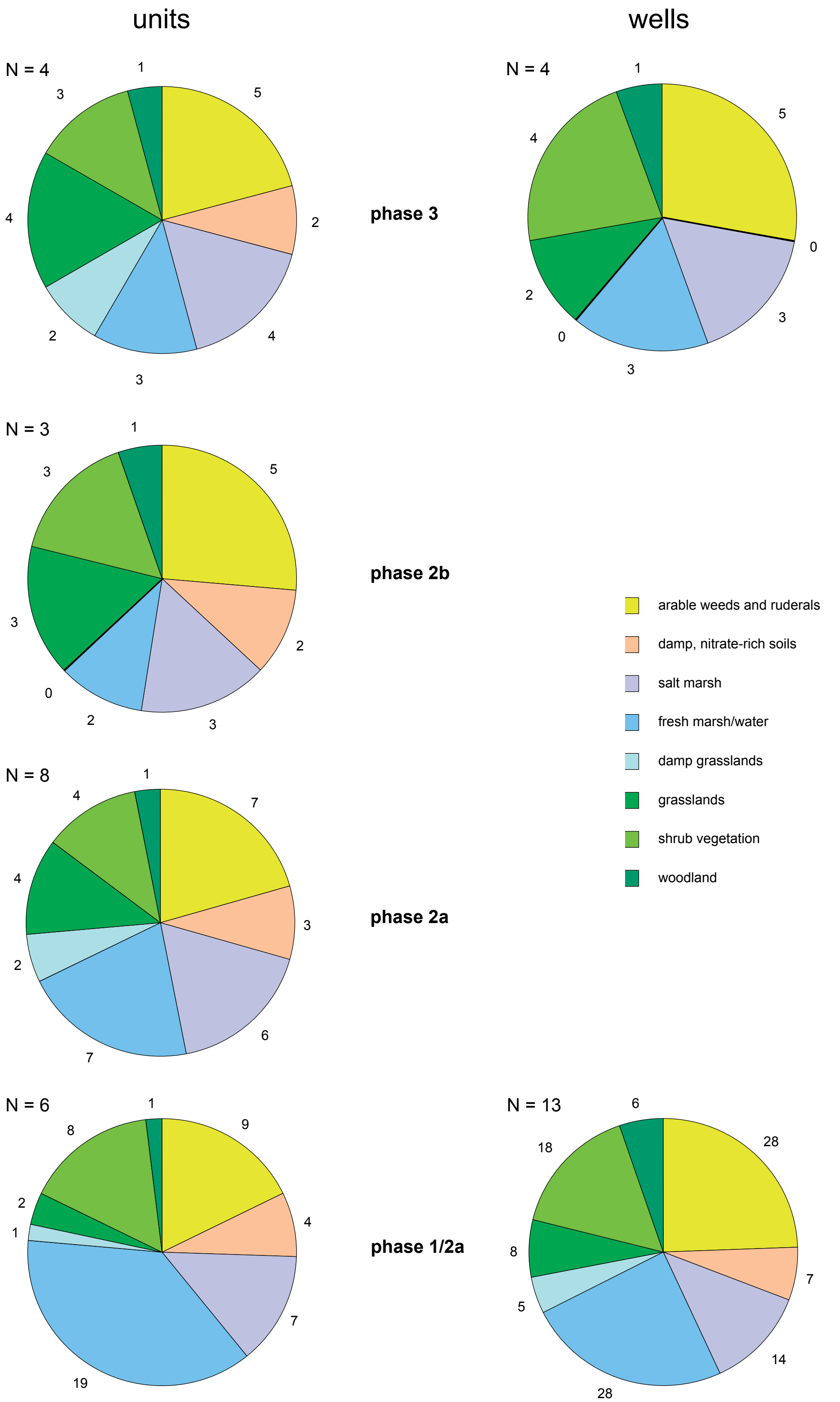
A number of plant species provide indisputable evidence of brackish conditions at and/or around the settlement during the early occupation phases. Seed remains of halophytic plants (*i.e.* plants with a preference for saline habitats) were found in samples recovered from wells and units that were dated to phases 1 and 1/2a on the basis of stratigraphical and archaeological evidence. The question is whether these plants favouring brackish conditions actually represent the vegetation at the site itself during the early phase of human occupation or whether they were imported into the settlement for example together with animal dung/fodder and hence represent conditions in the settlement's immediate or even more distant surroundings.

During the early occupation phases (1 and 1/2a) there must have been a creek adjacent to the dune (see chapter 14). This and other nearby bodies of water must have been brackish, since they were suitable for halophilous plants such as *Ruppia maritima*, *Zannichellia palustris* and possibly *Potamogeton pectinatus*. Typical salt marsh plants, such as *Salicornia europaea*, *Suaeda maritima* and *Spergularia marina/media,* may have grown on the mud flats bordering the tidal creek and also on the lower parts of salt-marshes that were regularly flooded by the sea (figs. 19.3a-b). *Suaeda maritima* may also have occurred on the drift litter, for example along a tidal creek where such remains were deposited.

Salt marsh plants (figs. 19.3c-d) such as *Aster tripolium, Limonium vulgare, Glaux maritima, Spergularia marina/ media*, *Juncus gerardi*, *Atriplex littoralis* and *Carex distans* are well represented in the samples and provide evidence of high salt-mash vegetation in the close surroundings of the settlement. This vegetation zone was flooded only a few times a year, during spring tides and storm surges. Other plants that may have grown in the high salt marsh and are represented in the record are *Althaea officinalis, Trifolium repens, Poa pratensis/triviali* and *Agrostis*. The presence of the last three species/taxa will be attributable to grazing. High salt marshes are known to have been quite suitable for grazing and hay production. Stock-keeping was important at the Schipluiden settlement, as can be inferred from the zoological remains recovered (see chapter 22). It is very likely that the animals were pastured on the nearby salt marsh, and many species associated with a salt marsh vegetation may have made their way into the assemblage together with animal dung. This assumption is also supported by the diversity of plant species, which are typical of dung and hay assemblages. In Schipluiden, the diversity of species is characteristic of many samples recovered from the water pits but also from the units dated to phase 1/2a. They comprise halophilous plants, but also freshwater plants. These plants cannot have grown together in the same places at the same time.

Good evidence for a discussion on this issue is provided by the plant remains recovered from one of the wells on the northwestern slope of the dune (feature 14-19 sample 11), which was dated to phase 1/2a. Striking aspects of this plant assemblage are the great diversity of plant species and the unusual preservation conditions. The matrix of plant remains consisted of compact layers of waterlogged stems of reed (*Phragmites*) and vegetative remains of hedge mustard (*Sisymbrium officinale*) and other herbaceous (unidentified) plants that were deposited in the upper part of the pit depression, presumably as a secondary fill. They were accompanied by seed remains deriving from species which today favour arable fields and ruderal places as their primary habitats. They include *Chenopodium album*, *Solanum nigrum*, *Persicaria maculosa*, *P. lapathifolia* and *Stellaria media*. The sample also yielded remains of a number of halophytic plants characteristic of salt marsh vegetations, including *Salicornia europaea*, *Suaeda maritima*, *Aster tripolium*, *Atriplex littoralis*, *Juncus geradi* and *Limonium vulgare*.

The presence of *Sisymbrium officinale* stem and valve fragments accompanied by seed remains is particularly


units
wells
N = 4
1
5
2
4
3
2
4
3
phase 3
N = 4
1
5
0
3
3
0
2
4
N = 3
1
5
2
3
2
0
3
3
phase 2b
arable weeds and ruderals
damp, nitrate-rich soils
salt marsh
fresh marsh/water
damp grasslands
grasslands
shrub vegetation
woodland
N = 8
1
7
3
6
7
2
4
4
phase 2a
N = 6
1
9
4
7
19
1
2
8
phase 1/2a
N = 13
6
28
7
14
28
5
8
18

interesting. Today, this species is associated with ruderal places and it occasionally grows as a weed in arable land. The archaeobotanical records suggest that this plant grew as a weed in cereal fields during the Neolithic. At the Neolithic lakeside settlement of Hornstaad Hörnle on the shore of Lake Constance in Germany, for example, charred seed remains of this species were found in stored cereals (Maier 1999). At Schipluiden, this species may also have been a weed, which found its way into the record in the form of waste produced in the processing of cereals.

All in all, the range of habitats represented in the assemblage and the preservation conditions (layers of compacted plant remains) could lead to the conclusion that these remains represent (stored) animal fodder, part of which was gathered in a freshwater marsh (reed stems) and a saline marsh, the other part consisting of waste produced in crop processing. The environmental conditions and the early agrarian society concerned however make it unlikely that the collection of animal fodder was common practice, though it may have taken place occasionally, for example if cattle were kept (sheltered) in the settlement during the calving period.

The rich waterlogged seed assemblages of both of the early occupation phases include many plants indicative of a freshwater marsh vegetation. Most were recovered from wells dated to phase 1/2a. Seed remains derive from species restricted to freshwater environments (including *Lycopus europaeus*, *Mentha aquatica/arvensis, Eupatorium cannabinum, Rumex hydrolapathum, Iris pseudacorus, Stachys palustris*) but also from species that tolerate slightly brackish conditions (including *Schoenoplectus lacustris*, *Phragmites australis*, *Sonchus palustris*, *Epilobium hirsutum*, *Cladium mariscus, Carex otrubae* and *Solanum dulcamara*). Most of these plants are tall herbs and their range suggests well-developed stands of marsh vegetation. The only places where these plants may have grown in the rather brackish environment of the early occupation phases are the depressions between the dunes where freshwater accumulated, and possibly the lower (wet) parts of the slopes of the dune.

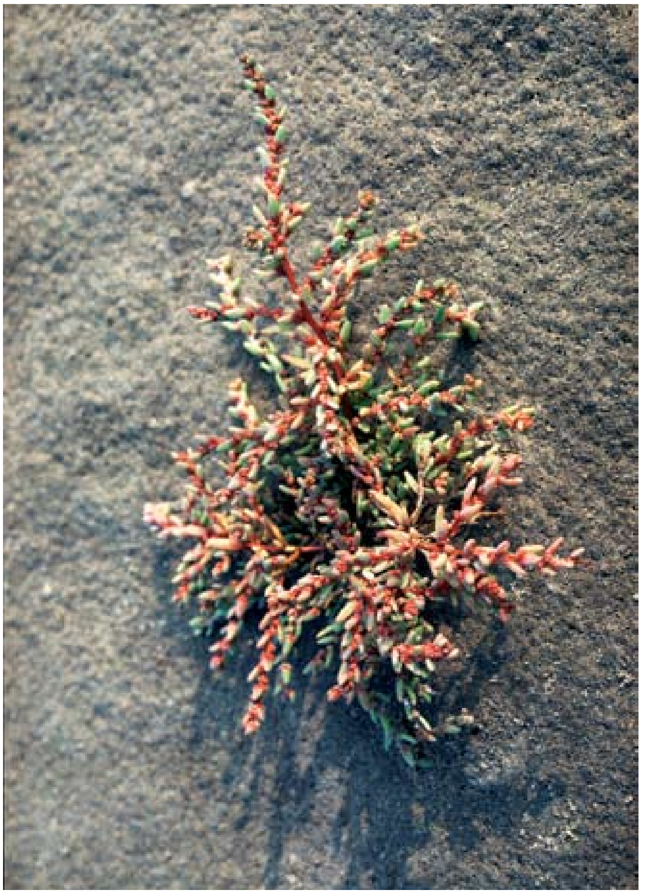
Although plants such as *Solanum dulcamara* and *Eupatorium cannabinum* favour wet environments as their primary habitats, they can also grow on rather dry soils, for example in calcareous dune environments. They may hence have grown on the lower parts of the dune slopes. Bakels (in Raemaekers *et al.* 1997) has described a similar pattern for the Middle Neolithic dune settlement Wateringen 4 in the Dutch coastal area.

There were only a few aquatic plants in the record indicative of freshwater conditions (which however also tolerate slightly brackish conditions), including *Ceratophyllum demersum*, *Potamogeton natans* and *Potamogeton pectinatus*. The seed remains of these plants were recovered in only small numbers from well samples 8 and 19 and pit sample 20 dated to phases 1/2a and from the samples from phase 2a. There must hence have been (natural) bodies of open (possibly fresh) water at or close to the settlement, unless the wells afforded a suitable environment for these aquatics.

The occurrence of alder (*Alnus glutinosa*) fruit remains in the samples from the wells dated to phase 1/2a is a bit puzzling. Especially during the early phases of occupation the settlement's surroundings were probably too brackish for this tree to have grown here. The fruit remains were either imported from some source fairly distant from the site or there must have been habitats suitable for this species nearby after all. Alder may have occurred in a shrub vegetation, in particular together with hazel, dogwood and hawthorn, but its preferred habitat will have been a wet alder carr vegetation. Further evidence supporting the presence of such a vegetation in the vicinity of the site is provided by remains of plant species such as *Solanum dulcamara* and *Lycopus europaeus*, which are characteristic of an alder carr vegetation.

The rich seed assemblage of phases 1 and 1/2a also includes many potential arable weeds and plants from ruderal habitats. Dominant (both ubiquitous and abundant) among the waterlogged seed remains of this group are *Atriplex patula/prostrata*, *Chenopodium album*, *Persicaria maculosa*, *Polygonum aviculare*, *Plantago major*, *Stellaria media*, *Ranunculus sceleratus* and *Urtica dioica*. They were accompanied by less common specimens of *Galium aparine*, *Solanum nigrum*, *Brassica rapa*, *Fallopia convolvulus*, *Rumex crispus*, *Capsella bursa-pastoris*, *Sisymbrium officinale* and *Chenopodium glaucum/rubrum*. The plants of this group represent different types of environments, including arable fields, places trodden by man and animals (paths), places in the vicinity of houses and various other ruderal habitats. Several species among the seed remains are well-known arable weeds from Neolithic contexts (Bakels 1988b, 2000), for example *Chenopodium album, Brassica rapa, Galium aparine*, *Solanum nigrum*, *Persicaria maculosa, Fallopia convolvulus* and *Vicia hirsuta*. The Schipluiden assemblage also contains remains of these plants preserved by charring (with the exception of *Fallopia convolvulus*), which were consistently found together with charred cereal grain and chaff remains, suggesting that they arrived together with

◂Figure 19.2 Composition of the analysed samples of waterlogged and charred botanical macroremains, presented according to phase and context (units or wells). The segments show the numbers of identified species.



the cereals and are hence to be inter-preted as arable weeds (see the discussion in section 19.4.2).

A combination of species such as *Chenopodium glaucum/rubrum*, *Capsella-bursa pastoris*, *Solanum nigrum*, *Atriplex patula/prostrata* and *Chenopodium album* may point to extremely nutritious environments, for example rubbish dumps or dung heaps. Plants such as *Ranunculus sceleratus*, *Persicaria maculosa* and *Stellaria aquatica* may have found suitable habitats for example around the watering places for the domestic animals where nitrogen-enriched soil will have favoured their expansion. Species characteristic of a tread-resistant vegetation (for example typical of paths) including *Plantago major*, *Polygonum aviculare* and *Capsella bursa-pastoris* are abundantly represented by the seed remains, suggesting that such a vegetation was quite common in and around the settlement, especially in the early occupation phases.

There is clear evidence (from both the analysed and the hand-picked samples) of the presence of a well-developed shrub vegetation dominated by species such as sloe (*Prunus spinosa*) and crab apple (*Malus sylvestris*) in phases 1 and 1/2a. A number of other species would also have grown in such a vegetation, including hazel (*Corylus avellana*), elder (*Sambucus nigra*), hawthorn (*Crataegus monogyna*), dewberry (*Rubus caesius*), blackberry (*Rubus fruticosus*), rose (*Rosa*) and juniper (*Juniperus communis*), at least during phase 1/2a. Although all these plants may have been brought to the settlement from elsewhere as they may all have been gathered for consumption, it is very likely that they formed part of the local vegetation (see the discussion in section 19.5.1). The dune slopes may well have supported such a shrub vegetation, which would then have resembled the type of vegetation characteristic of young dunes today (Haveman *et al.*1999). Various herbaceous plants that favour shady spots on sandy soils, for example *Moehringia trinervia* and *Glechoma hederacea*, may have grown in this shrub vegetation. Other herbaceous plants such as *Silene otites* and *Carex arenaria* may have grown in more open places on the dune. Three other plants, namely *Anthriscus sylvestris, Torilis japonica* and *Silene dioica,* may also have found their habitats in the dune shrub vegetation.

19.3.2 Occupation phase 2b

There is a decrease in the remains of halophytes towards phase 2b, suggesting decreasing marine influence in the site's surroundings. The range of halophytic species is smaller than that from the previous phase. Plants characteristic of the higher tidal flats and lower parts of the salt marsh are either absent (*Salicornia europaea* and *Spergularia marina/media*) or occur only sporadically (charred seeds of *Suaeda maritima* and *Ruppia maritima*) in samples from phase 2. The waterlogged seed assemblage however does contain various plant species characteristic of the high salt marsh, including *Atriplex littoralis* type, *Aster tripolium*, *Juncus gerardi*, *Carex distans* and *Apium graveolens*. Although all these remains were found in samples from phase 2 they cannot be dated to any specific part of that phase. Three species characteristic of high salt marshes were however recovered from samples datable to phase 2b, namely *Althaea officinalis*, *Hordeum marinum* and *Carex distans*, all of which were encountered as charred remains. This implies that there was still a salt marsh vegetation in the area, though by now presumably further away from the settlement and/or in some stage of desalination.

The brackish environment presumably began to give way to a freshwater environment some time towards the end of the second occupation phase, as suggested by the presence of species characteristic of wet (fresh) grasslands such as *Daucus carota*, *Lychnis flos-cuculi* and *Hypericum tetrapterum*, all of which were recovered from well sample 29, which was dated to phase 2. The spread of wet grasslands may have been caused by both the desalination process and human activity in the area (for example pasturing cattle).

The charred seed assemblage dated to phase 2b includes a number of species that may have grown as weeds in cultivated land or as ruderals in the settlement area (including *Atriplex patula/prostrata*, *Brassica rapa*, *Persicaria maculosa*, *Solanum nigrum* and *Stellaria media*; see the discussion in section 19.4.2).

The most abundant of the shrub remains was sloe (*Prunus spinosa*), whose stones, most of which were charred, and remains of plum flesh were encountered in units dating from phase 2b. They were accompanied by less common remains of crab apple (*Malus sylvestris*) and occasional specimens of hazel (*Corylus avellana*) and dogwood (*Cornus sanguinea*).

The presence of seed remains of enchanter's nightshade (*Circaea lutetiana*) (fig.19.4) in one of the well samples (29) dating from phase 2 is of particular interest. *Circaea lutetiana* is a common woodland plant and is also found in

◂Figure 19.3 Some characteristic salt marsh plants of the Schipluiden environment, (waterlogged) seeds of which were found in large quantities in the fills of wells from the earliest phases.

a glasswort (*Salicornia europaea)*
b annual-seablite (*Suaeda maritima*
c sea aster (*Aster tripolium)*
d sea milkwort (*Glaux maritima)*

Figure 19.4 Seed of enchanter's-nightshade (*Circea lutetiana*), a species characteristic of woodland habitats, sample 29, no. 7145, phase 2 (magnification 12×).

other shady places on damp rich or calcareous soils. Its presence in the macrofossil record suggests that there were habitats of this kind in the area, perhaps at some distance from the site. The club-shaped fruits of this species are covered with hooked bristles and are dispersed by animals, which could explain how it made its way into the settlement. *Circea lutetiana* has some medicinal properties, so it may also have entered the assemblage as a medicinal plant.

19.3.3 Occupation phase 3

Samples from the last occupation phase show a clear change to a freshwater environment. One sample (36) from a deposit dating from phase 3 yielded revealing evidence of a freshwater marsh in the form of numerous seeds of *Lythrum salicaria* (which do not grow in brackish conditions) plus remains of other freshwater marsh plants such as *Eupatorium cannabinum* and *Euphorbia palustris* and a plant indicative of wet (fresh) grasslands (*Lychnis flos-cuculi*).

Interestingly, remains of species associated with brackish habitats (including *Ruppia maritima*, *Hordeum marinum*, *Apium graveolens* (fig. 19.5) and *Althaea officinalis*) were all preserved in charred condition. Among the charred seed remains are also remains of species such as *Atriplex patula/prostrata*, *Chenopodium album*, *Galium aparine*, *Solanum nigrum* and *Vicia hirsuta*, some of which have arable fields as their primary habitats (see the discussion in section 19.4.2).

Dominant among the shrub remains are fragments of stones and flesh of sloes (*Prunus spinosa*), occasionally accompanied by remains of crab apple (*Malus sylvestris*) and hazel (*Corylus avellana*).

19.4 Cultivated plants (subsistence and diet)

19.4.1 Cereals

The remains of cultivated plants were restricted to two cereal crops, namely emmer (*Triticum dicoccon*) and naked barley (*Hordeum vulgare* var. *nudum*). Both grains and chaff remains were recovered. With the exception of a few waterlogged chaff remains of emmer, all grain kernels and the chaff of both cereals were charred. Only relatively small numbers of grains were found (at most a few dozen specimens per sample) and many had been deformed during the charring process. The largest concentration of chaff remains consisted of about a hundred and twenty glume bases of emmer recovered from the dune sand Unit 25 (sample 43).

Emmer and naked barley were found together in samples from all the occupation phases, although those from phase 1/2a contained much smaller quantities of cereal remains than those from phases 2a/2b and 3 (see Appendix 19.2). An interesting feature of the cereal assemblage is an increased frequency of emmer remains accompanied by a decreased frequency of barley remains in the samples from phases 2a, 2b and 3. Emmer grain and chaff remains were regularly encountered in almost all the samples associated with these occupation phases, implying that emmer was the primary cereal during the second and third occupation phases.

Figure 19.5 Wild celery *(Apium graveolens),* plant characteristic of high salt marsh vegetation, in Schipluiden represented by waterlogged and charred seeds, the latter interpreted as an arable weed. Young leaf-stalks of wild celery may have been collected as plant food.

Emmer (*Triticum dicoccon*) is a hulled wheat in which the chaff is strongly fused to the grain. This means that a special processing method must be used to obtain a clean grain product. In the case of emmer, threshing causes the cereal ear to break up into spikelets, which must then be processed further, for example by parching and pounding, to release the grain from the chaff (Hillman 1981, 1984). Threshing/pounding remains of emmer found at the Schipluiden settlement consist of spikelet fragments including glume bases, spikelet forks and also some rachis segments (figs. 19.6 a, b). These remains suggest that at least some stages of emmer processing took place at the settlement itself.

The morphology of barley grains preserved at the site is characteristic of the naked variety (*Hordeum vulgare* var. *nudum*). The grains are rounded in cross-section and in the case of some specimens fine transverse wrinkling was observed on the surface. The grains also have a narrow ventral furrow that runs all the way to the apex. Many grains are somewhat asymmetric, suggesting that the variety represented in the assemblage is six-rowed barley (fig. 19.7a). The assemblage also includes a few more or less flattened grains showing some resemblance to the grains of hulled barley. They probably represent milk-ripe naked barley grains that were harvested before they were fully ripened, presumably in order to avoid the loss of grain (see for example Maier 1999).

Naked barley does not require the processing necessary for hulled cereals. In naked barley, the grains are contained loose in the ears and they fall clear of the chaff during threshing. The presence of rachis internodes characteristic of free-threshing, six-rowed barley contributes relevant evidence to the interpretation of barley remains in general. The basal parts of three spikelets (one median and two laterals) were encountered at the distal end of the internodes (fig.19.7b). Remains of glumes, lemma and the hairy rachilla were also observed on some specimens. Interesting are the lateral spikelets, which are pedicellate, and not sessile as in present-day naked and hulled six-rowed barley (Van Zeist/Palfenier-Vegter 1983).

The archaeobotanical record indicates that pedicellate lateral spikelets are characteristic of prehistoric naked six-rowed barley. They have been found at various Neolithic sites, for example Swifterbant (Van Zeist/Palfenier-Vegter 1983), Hazendonk and Hekelingen (Bakels/Zeiler 2005) in the Netherlands and a Rössen settlement near Langweiler in Germany (Knörzer 1971). Villaret-von Rochow (1967) suggested that pedicellate lateral spikelets are a primitive feature, deriving from the ancestor of cultivated barley (wild barley *Hordeum spontaneum*).

The slender form of some rachis internodes is indicative of the lax-eared type. The assemblage however also contains short and broad specimens, including individual internodes and rachis fragments. They are usually assumed to be characteristic of the dense-eared variety, but may also occur in the lowermost part of the ear in the lax-eared type.

The cereal remains found at Schipluiden are in agreement with the evidence of the cultivation of emmer and naked barley as the main crops in the Middle Neolithic. Evidence of the cultivation of these cereal crops has also been found at other Middle and Late Neolithic sites in the Netherlands, including Hazendonk (Bakels 1981), Swifterbant (Van Zeist/

Figure 19.6 Emmer (*Triticum dicoccon*), sample 21, no. 2142, phase 2a.
a grains (magnification 8×)
b chaff remains, including spikelet forks and glume bases (magnification 10×)

Figure 19.7 Naked barley (*Hordeum vulgare* var. *nudum*), sample 3, no. 9404, phase 1.
a grains (magnification 8×)
b pedicellate rachis internodes (magnification 10×)
c rachis segment (magnification 10×)

Palfenier-Vegter 1983), Hekelingen (Bakels 1988a), Schokland P14 (Gehasse 1995) and Wateringen (Raemaekers *et al*. 1997). Exceptional evidence comes from one site, Vlaardingen (van Zeist 1970) in the coastal area, where *Triticum aestivum* was the dominant crop in one of the contexts.

19.4.2 Evidence of local crop cultivation

One of the most intriguing questions concerning the site's subsistence is: did the inhabitants of Schipluiden cultivate their own crops, or was grain imported from somewhere else? If the evidence presented above is assumed to imply the first scenario, the next question to be answered is: *where* did the people of Schipluiden grow their cereal crops?

Producer and consumer sites

Ethnographic studies of various cereal-processing stages (Hillman 1981, 1984; Jones 1984) proved to be of great importance for identifying cereal production and processing activities in archaeobotanical assemblages. These studies suggest that producer and consumer sites can be distinguished on the basis of the presence or absence of waste produced in the early stages of crop processing. At producer sites there will be waste representative of the entire crop-processing sequence. At consumer sites, by contrast, only grain in fully processed form (in the case of free-threshing cereals) and semi-cleaned spikelets (in the case of glume wheats) are to be expected. If the Neolithic Schipluiden settlement had been a consumer site, we would have encoun-tered only the clean grain product in the case of naked barley. Besides this grain, the samples however also contained waste produced in early processing stages, including rachis inter-nodes and rachis segments (figs.19.7b, c). This leads to the conclusion that barley was cultivated locally.

The situation concerning emmer is more complicated. Although the cereal remains point to the presence of semi-cleaned spikelets, this is not persuasive evidence of the local production of emmer (only of its local processing). It is generally agreed that emmer wheat was transported and stored in the form of semi-cleaned spikelets. The grains were then dehusked prior to food preparation, presumably on a daily basis (*e.g.* Hillman 1984; Van der Veen 1992). This means that glume bases and spikelet forks of emmer may actually occur at both producer and consumer sites. In the case of glume wheats, straw nodes are the only residues of the early processing stage providing conclusive evidence of local cultivation. Unfortunately they cannot be identified to species level. The straw encountered among the Schipluiden remains

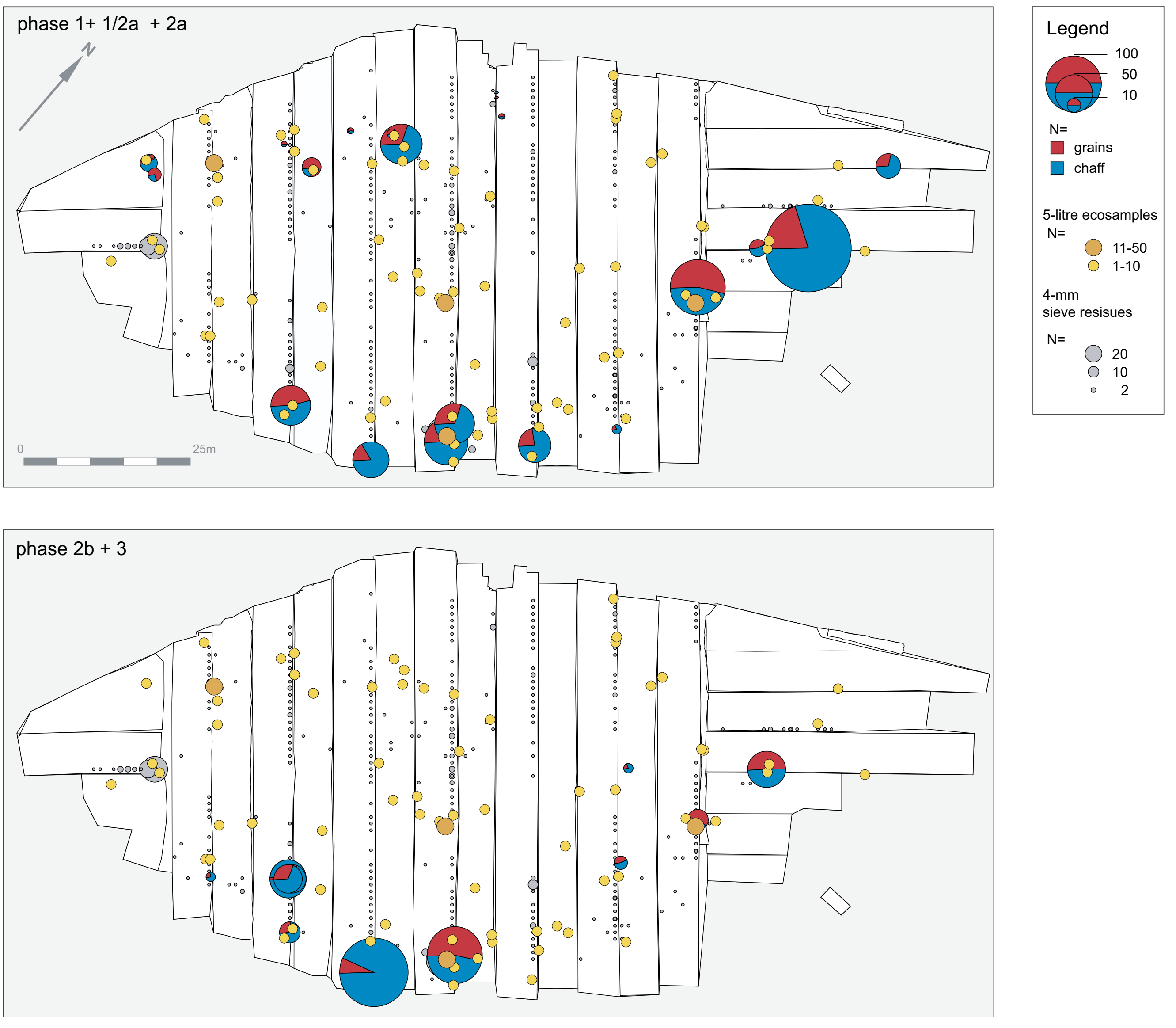


Figure 19.8 Charred cereal remains, quantity and ratio of grains and chaff in analysed samples, plotted on the distribution of charred cereal grains found in the 4-mm sieve residues and charred cereals and chaff recorded in the systematic assessment of 300 5-litre 'ecosamples'.

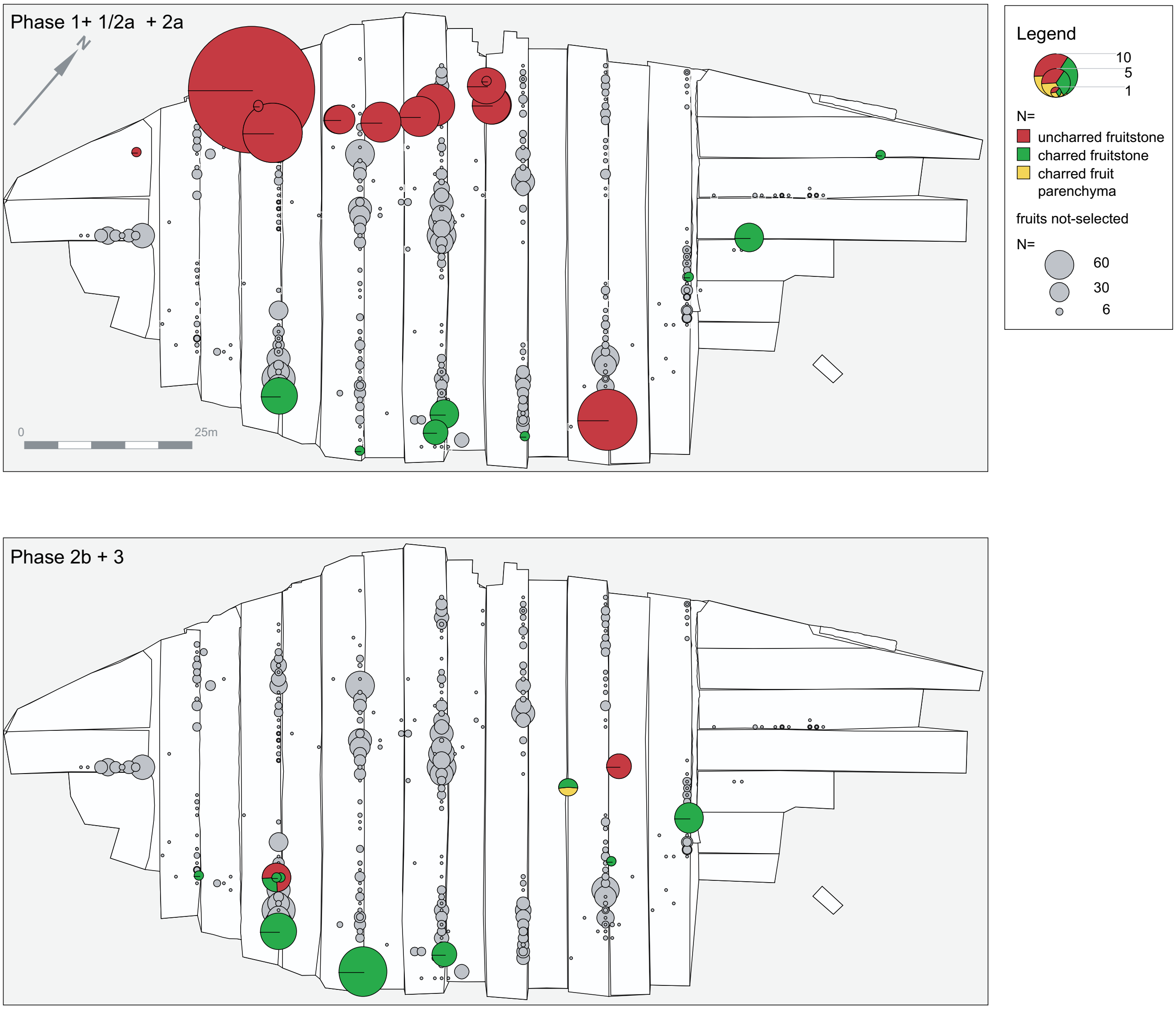


Figure 19.9 Numbers of charred and waterlogged stones of sloe in analysed samples plotted on the distribution of sloe remains found in the 4-mm sieve residues and recorded in the systematic assessment of 300 5-litre 'ecosamples'.

a phases 1-2a. Sloe was preserved in waterlogged condition in wells of phase 1/2a on the northwestern side of the dune and in one sample from Unit 19S; in charred condition in some samples from Unit 18, along the southeastern margin.

b phases 2b-3. Waterlogged remains were preserved only at the base of two wells.

may derive from either of the two cereals and is only indicative of local crop processing in general. The chaff remains of emmer preserved in the archaeobotanical record therefore offer no clear information on the origin of the emmer encountered in the Schipluiden settlement. If conclusive evidence of the local production of barley should in the future be obtained, it may be assumed that other cereals were also cultivated locally.

Spatial evidence

The results of an assessment examination (fig. 19.8) show a relatively uniform distribution of charred plant remains (especially seed remains of wild plants) throughout the occupation area, implying that the entire dune area was used. The distribution of charred plant remains may therefore be assumed to reflect 'true' human activity areas within the settlement. More specifically, in view of earlier homogenisation and trampling processes, they are to be seen as representing the final phase of the site's occupation. The analysis of the samples provided some insight into this issue.

The spatial distribution of charred cereal and chaff remains indicates the crop-processing areas within the settlement. It shows a focus on the southeastern and northeastern slopes of the dune in the early occupation period (phases 1, 1/2a and 2a), and on the southeastern slope in occupation phases 2b and 3 (fig. 19.8b). There seems to have been another activity area close to the top of the dune in phase 2. Interestingly, charred remains of one of the main gathered plants – sloe (*Prunus spinosa*) (figs. 19.9a, b) – show a very similar distribution pattern. Together, these concentrations of charred plant remains may reflect actual activity areas that were most probably situated near the houses. This may also imply that each household processed its own cereals and other plant food. The study carried out by Knörzer (unpublished) at the Rössen culture site near Langweiler suggests that charred chaff remains are found mainly near the larger houses (Bakels 1991).

Weed floral evidence

The evidence provided by the weed flora is also essential for the interpretation of cereal production and processing (*e.g*. Hillman 1981, 1984; Jones *et al*. 1995). The complex taphonomy of charred weeds however often makes it difficult to distinguish between field weeds and ruderals. This is partly due to the fact that many environments disturbed by man, especially arable fields and ruderal habitats, may have changed considerably over time (see for example Bakels 1998), making it necessary to employ present-day classifications with some adjustments. Knörzer (1971) for example suggested that most carbonised weed seeds will have found their way into a settlement along with a crop (after Bakels 1978). Hillman (1984) has furthermore convincingly demonstrated that "charred seeds of typically ruderal species found consistently in association with crop 'cleanings' are likely to have arrived on the site – and got into fires – primarily as contaminants of crop products" and are hence to be regarded as field weeds. In the Schipluiden assemblage, the numbers and frequencies of charred remains of plants that nowadays have arable fields and/or ruderal places as one of their principal habitats are rather small. However, the fact that charred seed remains of plants such as *Chenopodium album, Galium aparine*, *Persicaria maculosa*, *Solanum nigrum*, *Brassica rapa* and *Vicia hirsuta* were consistently found together with charred grain and chaff remains suggests that they arrived at the site together with the harvested cereals. We consequently assume that these plants represent weeds of cultivated crops. A few other potential crop weeds were encountered among the charred seed remains: *Atriplex patula*/*prostrata*, *Capsella bursa-pastoris*, *Sisymbrium officinale* and *Malva*. They were presumably exposed to fire during the crop processing or discarded on fires.

A striking feature of the assemblage of charred remains as a whole is the degree of correlation between the occurrence of charred grain and chaff remains accompanied by field weeds on the one hand, and the occurrence of charred seed remains of plants characteristic of high salt marsh vegetations on the other. In samples from all phases, but especially those from phases 2 and 3, the frequencies of high salt marsh species parallel those of cereal and arable weed remains (table 19.1). The charred remains of species characteristic of high salt marshes/drift deposits (including *Althaea officinalis, Apium graveolens, Hordeum marinum, Carex distans, Ruppia maritima and Suaeda maritima*) may therefore also have arrived at the settlement as contamination of cereals. Taken together, these lines of evidence suggest that the cereal fields lay somewhere at the high (outer) margins of the salt marsh or on beach on other low dunes at some distance from the settlement. An alternative explanation could be that the remains of high salt marsh plants made their way onto the site along with animal fodder collected in salt marshes. The archaeobotanical evidence from the Late Neolithic settlement near Aartswoud in the Netherlands adds much credibility to the interpretation of charred brackish plants as field weeds. On the basis of the ubiqui-tous presence of charred remains of *Althaea officinalis*, *Atriplex spp*. and *Scirpus* sp., Pals (1984) convincingly postulated the possibility of small-scale agriculture on the highest parts of the levees in the salt marsh environment. Crop cultivation has been proven at other, contemporary sites (Zandwerven, Zeewijk) in this region by marks of the ard, an instrument that probably became available in Western Europe around the time of the period of occupation of the Schipluiden site, but for which we as yet have no evidence of its use at such an early time in our country.

Experimental evidence

Small-scale farming experiments conducted by Van Zeist *et al*. (1976) in the coastal region of the northern Netherlands have shown that it is actually possible to cultivate crops in the salt marsh, on the condition that the area is not flooded by salt water too often, especially not during the seedling stage. This means that any crop fields will have been restricted to the highest parts of the salt marsh, such as marsh bars and natural levees, which will have been inundated only during storm surges. Furthermore, the risk of flooding during autumn and winter meant that the sowing had to be done in spring. The experiments showed varying resistance to brackish influences among the cultivated plants. Barley (*Hordeum vulgare*), for example, was cultivated with

phase context	1 Unit 19S	1 well	1/2a Unit 19N	1/2a well	2a Unit 17/18	2 Unit	2 well	2b Unit 15/16	2/’3 well	3 Unit 10/11	3 well
cereals											
Hordeum vulgare var. nudum	.	•	•	•	•	•	.	•	.	•	•
Hordeum vulgare, rachis internode	.	•	.	•	•	•	.	•	•	•	.
Triticum dicoccon	•	.	.	•	•	•	•	•	•	•	•
Triticum dicoccon, glume base	•	.	.	•	•	•	•	•	•	•	•
Triticum dicoccon, spikelet fork	•	.	.	•	•	•	•	•	•	•	•
Triticum, rachis indernode	•	.	.	.	.	.	.	.	.	.	.
Hordeum/Triticum, rachis internode	•	.	.	.	.	.	.	•	.	.	.
Cerealia	•	.	.	•	•	•	•	•	.	•	•
Poaceae, stem fragment	.	•	.	•	.	.	.	.	.	•	•
arable weeds and ruderals											
Atriplex patula/prostrata	.	.	.	•	•	.	.	•	.	•	•
Brassica rapa	.	.	.	.	.	.	.	•	•	.	.
Capsella bursa-pastoris	.	.	.	.	.	•	.	.	.	.	.
Chenopodium album	.	.	.	•	.	.	.	.	.	•	•
Galium aparine	.	•	•	•	•	.	.	.	.	•	•
Galium tricornutum	.	.	.	•	.	.	.	.	•	.	.
Malva	•	.	.	.	•	.	.	.	.	•	•
Persicaria maculosa	.	.	•	.	.	•	.	•	.	.	.
Plantago major	.	.	.	.	.	.	.	.	.	•	.
Polygonum aviculare	.	.	.	•	•	.	•	.	.	•	.
Rumex crispus type	.	.	.	•	.	.	.	.	•	.	.
Solanum nigrum	.	.	.	.	•	.	•	•	.	•	•
Stellaria media	.	.	.	.	•	.	.	•	.	.	.
Vicia hirsuta	.	.	.	.	.	•	.	.	.	.	•
salt marsh plants											
Althaea officinalis	.	.	•	.	•	•	•	•	.	•	•
Atriplex littoralis	.	.	.	.	•	.	.	.	.	.	.
Apium graveolens	.	.	.	.	.	.	.	.	.	•	•
Carex distans	.	.	.	.	.	.	.	•	.	.	.
Hordeum marinum	•	•	•	•	•	•	.	•	.	•	•
Ruppia maritima	.	.	.	.	•	•	•	.	.	•	.
Suaeda maritima	.	.	.	.	.	.	•	.	.	.	.

Table 19.1 Charred remains of cereals, weeds/ruderals and brackish plants, listed according to occupation phases and archaeological context.

success, while bread wheat *(Triticum aestivum)* gave only very low yield. An interesting feature of the weed association observed in the experimental fields is that various halophytes, including *Suaeda maritima*, *Glaux maritima, Salicornia europaea, Spergularia marina/media,* grew in the fields together with arable weeds restricted to a freshwater environment, for example *Polygonum aviculare, Persicaria maculosa* and *Solanum nigrum.*

Conclusions

Overall, when all the evidence presented above is combined, it seems very likely that the cereals represented among the Schipluiden remains were cultivated locally, but probably outside the settlement. During the early phases of occupation the crop fields, which were presumably small, will have been restricted to the highest parts of the salt marshes (lying furthest inland), which were in some stage of desalination towards phase 2b. There may also have been small fields around the dwellings on the dune, especially in phase 1, when the influence of the sea was still intense, or on other low dunes in the site’s surroundings.

The distance between a settlement and its arable fields may have varied substantially – in the case of the Neolithic lakeside dwelling of Hornstaad-Hörnle in Germany, for example, it is estimated to have been 700 m (Maier 1999), whereas the closest areas suitable for agriculture for the

Neolithic inhabitants of Çatalhöyük lay some 10-12 km from the settlement (Fairbairn *et al*. 2002).

19.5 Wild food plants, gathering and processing

19.5.1 Fleshy fruits and berries

The remains of wild berries and other fleshy fruits identified in the Schipluiden assemblage indicate that a wide range of edible fruits was available in the area when the site was occupied. The following species represent this category of plant foods: sloe (*Prunus spinosa*), crab apple (*Malus sylvestris*), hawthorn (*Crataegus monogyna*), dogwood (*Cornus sanguinea*), elder (*Sambucus nigra*), juniper (*Juniperus communis*), dewberry (*Rubus caesius*), blackberry (*Rubus fruticosus*) and rose (*Rosa*). Nut food deriving from hazel (*Corylus avellana*) is also considered in this group.

It is very likely that all these plants were gathered as food. Different species however seem to have been gathered to varying extents in different occupation phases. Sloe plums, crab apples and hazelnuts were gathered throughout all occupation phases. In addition, hawthorn, dewberries and blackberries, elderberries, rose hips and juniper berries may also have been gathered in phase 1/2a. Dogwood drupes may have been the additional fruit species gathered in phase 2.

The remains of sloe plums and crab apples were particularly well represented in all the analysed samples. Sloe plum remains also clearly dominated the charred remains in the 4-mm sieve residues (fig. 19.10). The frequent and relatively abundant occurrence of sloe and crab apple remains among the remains of all occupation phases suggests that the fleshy fruits of both species were collected in larger quantities than other fruits. This further suggests that crab apple and sloe shrubs were readily available around the settlement, or at a relatively short distance from the site. Scatters of both shrubs may well have grown on the dune.

The charred remains of crab apple include pips, fragments of fruit flesh (fruit parenchyma) and a few specimens of apple halves. The edges of the apple halves are contracted along the margins, showing that the apples were dried prior to charring (fig. 19.11). They may have been exposed to fire as part of the drying process required to preserve them for storage and later consumption (possibly in winter). They may also have been baked in ashes before being consumed. The presence of charred (often complete) plums in addition to fruit stone remains (fig. 19.12) suggests that sloes were processed in the same way. So wherever the apples and sloe plums grew, they were evidently plentiful enough to be gathered for storage.

The abundant concentration of waterlogged sloe plums (sample 20, over 500 complete fruits) found together with fish bones (and other bone remains) in the basal fill of a special 'deposition pit' dated to phases 1/2a (section 3.5.3) constitutes possible evidence of a special technique employed in fruit storage (fig. 19.13).

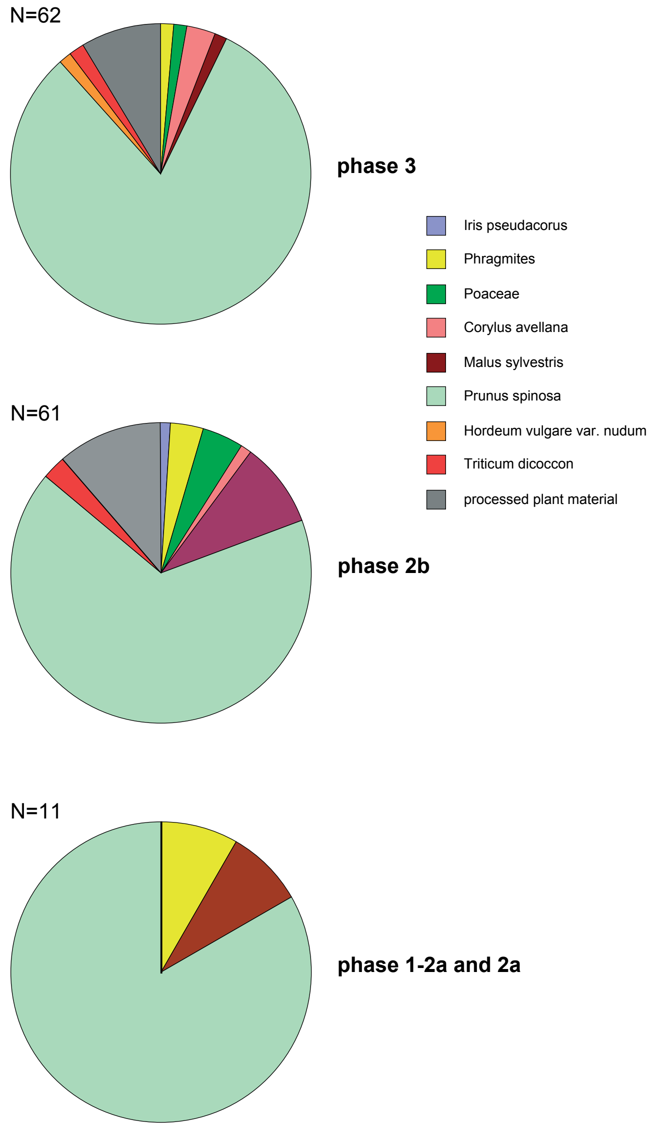


Figure 19.10 Species represented among the charred botanical macroremains, recovered by wet sieving through a 4-mm screen, showed according to phase. Sloe plum clearly dominates the charred remains, while other food plant species are represented in varying numbers in the samples from the different occupation phases. The low diversity characterising the samples from the earlier phases could be attributable to taphonomic factors.

Ethnographic records add some credibility to the interpretation of this archaeobotanical find. For example, ethnographic accounts of various North American peoples assert that one of the methods used to preserve fairly tart fruits such as crab apples and elderberries was to place them in a (wooden or bark) container and cover them with water and sometimes a layer of fish or animal grease or oil.

Figure 19.11 Charred part of a crab apple (*Malus sylvestris*) showing the contracted edge (arrow; no.10,440; magnification 5×) and recent wild crab apples.

Figure 19.12 Charred part of a sloe plum (*Prunus spinosa*) showing preserved fruit flesh (no. 1930; magnification 5×) and recent sloe plums.

Such a container would then be stored in a cool place, for example an underground pit. This method would soften the fruits and make them sweeter (Kuhnlein/Turner 1991; Kari 1995). A similar method used to preserve the sloe plums (and perhaps also crab apples) of Schipluiden would certainly have enhanced their palatability.

Figure 19.13 Waterlogged sloe plums *in situ* at the base of the fill of pit 12-48, showing preserved stones and fruit flesh (magnification 2×).

Other fruits that may also have been gathered in fairly large quantities (at least in phases 1/2a) are rose hips and dewberries. This is suggested by the fairly regular frequencies of rose and dewberry remains in the archaeobotanical record. The low frequencies of remains of hazel, hawthorn, juniper, blackberry and elder suggest that these species were either not available (in quantities large enough for processing) close to the site or they were not of (quantitative) importance in the local diet. Some fleshy fruits and berries, for example blackberries and dewberries, are difficult to preserve for later consumption, so they may have been consumed only during the gathering season. Berries that are eaten immediately, without being processed first, have a relatively small chance of becoming incorporated in the fossil record.

19.6 Conclusions

The evidence shows that the landscape surrounding the Schipluiden site was very diverse in all the occupation phases. The composition of plant remains shows that the local vegetation underwent at least one major change, from a brackish to a freshwater environment. This took place some time during occupation phase 2 (possibly in phase 2b). There is clear evidence of the presence of a well-defined shrub vegetation on the dune, with sloe and crab apple as the dominant species in all the occupation phases. Various herbaceous plants may have formed part of this shrub vegetation. So the dune was surrounded by a diverse landscape comprising brackish and freshwater marshes during the early occupation phases (1 and 1/2a), and freshwater marsh and wet grasslands during the later phases (2b and 3). There may also have been (small) woods in the close vicinity (indicated for phase 2). The weed flora represents different types of environments in and around the settlement, including arable fields, places trodden by man and animals, areas where rubbish was deposited and various other ruderal habitats.

The plant food subsistence activities included cereal cultivation and gathering. The high salt marsh and possibly also nearby low dunes offered possibilities for small-scale agriculture. Emmer and naked barley were the two cultivated crops. Both cereals were grown side by side in all the occupation phases, though emmer may have been the dominant crop in phases 2b and 3, after the shift from brackish to freshwater conditions. Evidence of local cultivation comes in various forms: (1) waste produced in the early stage of the processing of naked barley, though the evidence for emmer is rather meagre due to the absence of chaff remains characteristic of the early stage of processing of this crop, and (2) charred remains of high salt marsh plants encountered in frequencies paralleling those of charred cereal and field weeds, implying that the cereal fields lay in the high parts of the salt

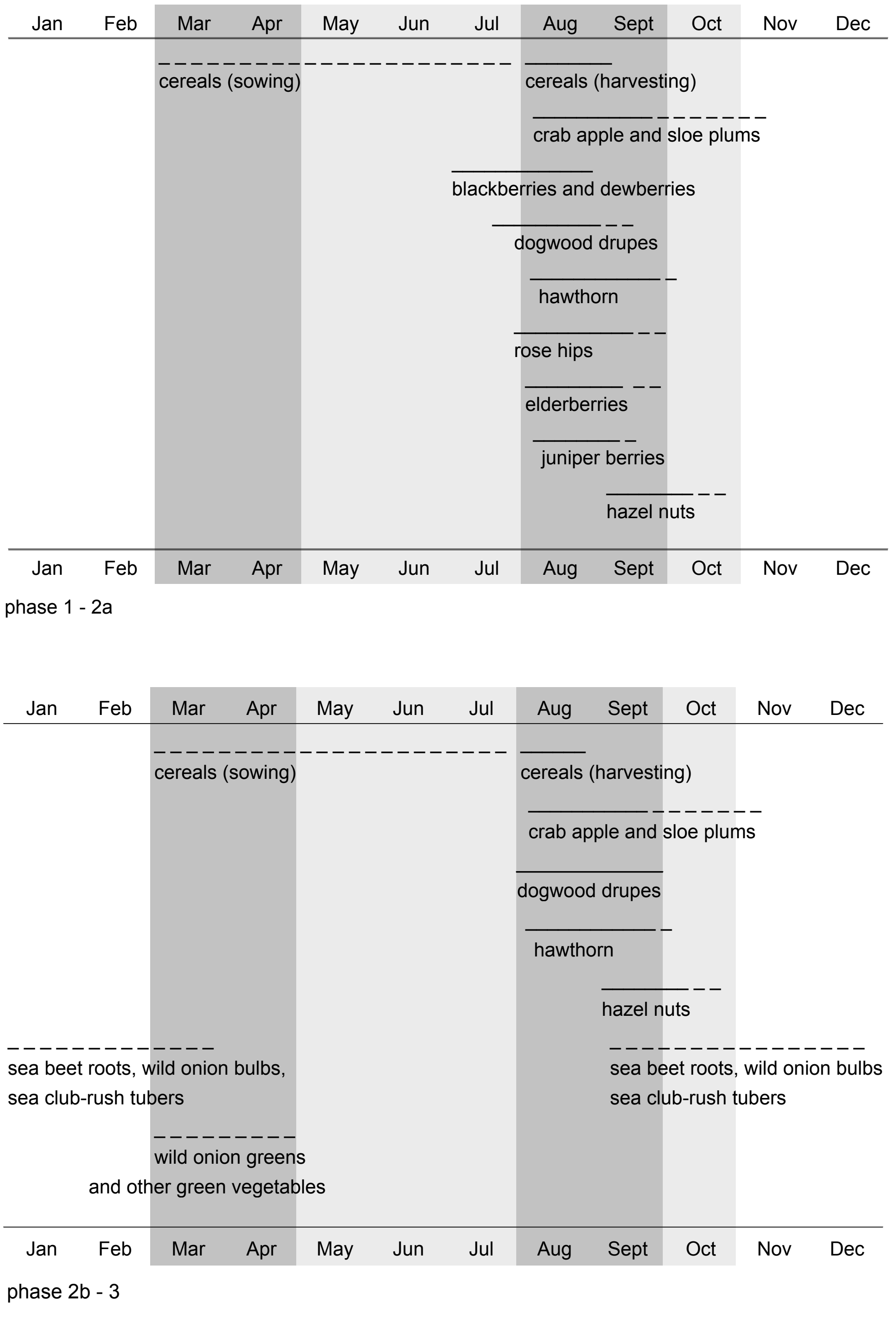


Figure 19.14 Botanical macroremains as indicators of the possible seasons of site occupation for phases 1-2a and 2b-3.

marsh (indicated for phases 1 and 1/2a), and on other low dunes nearby (indicated for phases 2b and 3).

Cereal chaff is evidence that crops were processed at the settlement itself. It may be assumed that the threshing and cleaning of the grains took place near the houses. These activities may have involved practices such as the parching of the spikelets of emmer wheat and possibly the burning of the threshing remains of both cereals. Besides theses cereals, the diet included a broad spectrum of gathered wild plants, including fruits and berries, roots and tubers (later discussed in chapter 20). Evidence of continuity in the exploitation of wild plants indicates that the inhabitants obtained a large proportion of their plant foods by gathering in all the occupation phases.

The archaeobotanical evidence suggests that the site was occupied for the greater part of the year (figs.19.14 a, b). Summer would have been the period of cereal harvesting and, if extended to early autumn, the optimum season for gathering the full range of fruits and berries. Hazelnuts may have been gathered later in the autumn. The sowing of the cereals on the high salt marsh will have started in spring.

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Legende to Appendices 19.1 and 19.2

CAT	catkins
CLX	calix
FLS	flowers
FRS	fruits
GLB	glume bases
LEM	lemma bases
NTS	nuts
PAR	parenchym
PPM	processed plant material
RAI	rachis internodes
SPF	spikelet forks
STB	stem bases
STEM	stems
TUB	tubers
VAL	pod fragment

Appendices

19.1 Waterlogged plant remains identified in the Schipluiden assemblage, listed according to occupation phases and types of vegetation (in pochette).

19.2 Charred plant remains identified in the Schipluiden assemblage, listed according to occupation phases and types of vegetation (in pochette).

19.3 Glossary of the scientific, English and Dutch names of plants mentioned in the text.

Scientific names	*English names*	*Dutch names*
Agrostis	*bent grass*	*struisgras*
Alisma plantago-aquatica	*water-plantain*	*grote waterweegbree*
Allium	*onion*	*look*
Alnus glutinosa	*alder*	*zwarte els*
Althaea officinalis	*marsh-mallow*	*echte heemst*
Anthriscus sylvestris	*cow parsley*	*fluitenkruid*
Apium graveolens	*wild celery*	*selderij*
Arctium lappa	*greater burdock*	*grote klit*
Aster tripolium	*sea aster*	*zulte*
Atriplex littoralis	*shore orache*	*strandmelde*
Atriplex patula	*common orache*	*uitstaande melde*
Atriplex prostrata	*spear-leaved orache*	*spiesmelde*
Beta vulgaris subsp. maritima	*sea beet*	*strandbiet*
Bidens tripartita	*trifid bur-marigold*	*veerdelig tandzaad*
Bolboschoenus maritimus	*sea club-rush*	*heen*
Brassica rapa	*turnip*	*raapzaad*
Brassica/Sinapis	*cabbage/mustard*	*kool/mosterd*
Capsella bursa-pastoris	*shepherd's-purse*	*gewoon herderstasje*
Carduus/Cirsium	*thistle/thistle*	*distel/vederdistel*
Carex arenaria	*sand sedge*	*zandzegge*
Carex distans	*distant sedge*	*zilte zegge*
Carex disticha	*brown sedge*	*tweerijige zegge*
Carex elongata	*elongated sedge*	*elzenzegge*
Carex hirta	*hairy sedge*	*ruige zegge*
Carex otrubae	*flase fox-sedge*	*valse voszegge*
Carex remota	*remote sedge*	*ijle zegge*
Carex riparia	*greater pond-sedge*	*oeverzegge*
Carex rostrata	*bottle sedge*	*snavelzegge*
Carex vesicaria	*bladder sedge*	*blaaszegge*
Carex vulpina	*true fox-sedge*	*voszegge*
Ceratophyllum demersum	*rigid hornwort*	*grof hoornblad*
Cerealia	*cereals*	*granen*
Chenopodiaceae	*fathen family*	*ganzenvoetfamilie*
Chenopodium album	*fat hen*	*melganzevoet*
Chenopodium ficifolium	*fig-leaved goosefoot*	*stippelganzenvoet*
Chenopodium glaucum	*glaucous goosefoot*	*zeegroene ganzenvoet*
Chenopodium rubrum	*red goosefoot*	*rode ganzenvoet*
Circaea lutetiana	*enchanter's-nightshade*	*groot heksenkruid*
Cirsium arvense	*creeping thistle*	*akkerdistel*
Cirsium oleraceum	*cabbage thistle*	*moesdistel*
Cirsium palustre	*marsh thistle*	*kale jonker*
Cirsium vulgare	*spear thistle*	*speerdistel*
Chenopodium album	*fat-hen*	*melganzenvoet*
Chenopodium ficifolium	*fig-leaved goosefoot*	*stippelganzenvoet*
Chenopodium glaucum	*glaucous goosefoot*	*zeegroene ganzenvoet*
Chenopodium rubrum	*red goosefoot*	*rode ganzenvoet*
Circaea lutetiana	*enchanter's-nightshade*	*groot heksenkruid*
Cirsium arvense	*creeping thistle*	*akkerdistel*
Cirsium oleraceum	*cabbage thistle*	*moesdistel*
Cirsium palustre	*marsh thistle*	*kale jonker*
Cirsium vulgare	*spear thistle*	*speerdistel*
Cladium mariscus	*great sedge / saw-sedge*	*galigaan*
Conium maculatum	*hemlock*	*gevlekte scheerling*
Cornus sanguinea	*dogwood*	*rode kornoelje*
Corylus avellana	*hazel*	*hazelaar*
Crataegus monogyna	*hawthorn*	*eenstijlige meidoorn*
Cyperaceae	*sedge family*	*cypergrassenfamilie*
Daucus carota	*wild carrot*	*peen*
Eleocharis palustris	*spike-rush*	*gewone waterbies*
Eleocharis uniglumis	*spike-rush*	*slanke waterbies*
Elytrigia atherica	*sea couch-grass*	*strandkweek*
Elytrigia repens	*couch-grass*	*kweek*
Epilobium hirsutum	*great hairy willowherb*	*harig wilgenroosje*
Eupatorium cannabinum	*hemp-agrimony*	*koninginnenkruid*
Euphorbia palustris	*marsh spurge*	*moeraswolfsmelk*
Euphrasia	*eyebright*	*ogentroost*
Fallopia convolvulus	*black bindweed*	*zwaluwtong*
Fallopia dumetorum	*copse-bindweed*	*heggenduizendknoop*
Galeopsis bifida	*lesser hemp-nettle type*	*gespleten hennepnetel type*
Galeopsis speciosa	*large-flowered nettle*	*dauwnetel*
Galeopsis tetrahit	*common hemp-nettle*	*gewone hennepnetel*
Galium aparine	*cleavers*	*kleefkruid*
Galium tricornutum	*rough corn bedstraw*	*driehoornig walstro*
Glaux maritima	*sea milkwort*	*melkkruid*
Glechoma hederacea	*ground ivy*	*hondsdraf*
Hordeum marinum	*sea barley*	*zeegerst*
Hordeum vulgare	*six-row barley*	*gerst*
Humulus lupulus	*hop*	*hop*
Hypericum perforatum	*perforate St John's-wort*	*sint-janskruid*
Hypericum tetrapterum	*square-stalked St John's-wort*	*gevleugeld hertshooi*
Iris pseudacorus	*yellow flag / yellow iris*	*gele lis*
Juncus	*rush*	*rus*
Juncus articulatus	*jointed rush*	*zomprus*

Scientific names	English names	Dutch names
Juncus bufonius	*toad rush*	*greppelrus*
Juncus gerardi	*mud rush / salt marsh rush*	*zilte rus*
Juniperus communis	*juniper*	*jeneverbes*
Lathyrus/Vicia	*vetchling/tare*	*lathyrus/wikke*
Limonium vulgare	*common sea-lavender*	*lamsoor*
Linaria vulgaris	*common toadflax*	*vlasbekje*
Lychnis flos-cuculi	*ragged-robin*	*echte koekoeksbloem*
Lycopus europaeus	*gipsywort*	*wolfspoot*
Lythrum salicaria	*purple loosestrife*	*grote kattenstaart*
Malus sylvestris	*crab apple*	*appel*
Malva	*mallow*	*kaasjeskruid*
Medicago lupulina	*black medick*	*hopklaver*
Mentha aquatica	*water mint*	*watermunt*
Mentha arvensis	*corn mint*	*akkermunt*
Moehringia trinervia	*three-nerved sandwort*	*drienerfmuur*
Odontites	*bartsia*	*helmogentroost*
Oenanthe aquatica	*fine-leaved water-dropwort*	*watertorkruid*
Oenanthe fistulosa	*tubular water-dropwort*	*pijptorkruid*
Oenanthe lachenalii	*parsley water-dropwort*	*zilt torkruid*
Persicaria hydropiper	*water-pepper*	*waterpeper*
Persicaria lapathifolia	*pale persicaria*	*beklierde duizendknoop*
Persicaria maculosa	*persicaria / red shank*	*perzikkruid*
Persicaria mitis	*tasteless water-pepper*	*zachte duizendknoop*
Phalaris arundinacea	*reed-grass/reed-canary grass*	*rietgras*
Phragmites australis	*common reed*	*riet*
Plantago major	*greater plantain*	*grote en getande weegbree*
Poa	*meadow-grass*	*beemdgras*
Poa compressa	*flattened meadow-grass*	*plat beemdgras*
Poa nemoralis	*wood meadow-grass*	*schaduwgras*
Poa palustris	*swamp meadow-grass*	*moerasbeemdgras*
Poa pratensis	*smooth meadow-grass*	*veldbeemdgras*
Poa trivialis	*rough meadow-grass*	*ruw beemdgras*
Poaceae	*grass family*	*grassenfamilie*
Polygonum aviculare	*knotgrass*	*gewoon varkensgras*
Potamogeton	*pondweed*	*fonteinkruid*
Potamogeton natans	*broad-leaved pondweed*	*drijvend fonteinkruid*
Potamogeton pectinatus	*fennel-leaved pondweed*	*schedefonteinkruid*
Prunus spinosa	*sloe*	*sleedoorn*
Ranunculus sceleratus	*celery-leaved crowfoot*	*blaartrekkende boterbloem*
Rosa	*rose*	*roos*

Scientific names	English names	Dutch names
Rubus caesius	*dewberry*	*dauwbraam*
Rubus fruticosus	*blackberry / bramble*	*gewone braam*
Rumex crispus	*curled dock*	*krulzuring*
Rumex hydrolapathum	*water dock*	*waterzuring*
Rumex obtusifolius	*broad-leaved dock*	*ridderzuring*
Ruppia maritima	*beaked tasselweed*	*snavelruppia*
Salicornia europaea	*glasswort*	*kortarige zeekraal*
Sambucus nigra	*elder*	*gewone vlier*
Schoenoplectus lacustris	*common club-rush*	*mattenbies*
Schoenoplectus tabernaemontani	*grey club-rush*	*ruwe bies*
Scrophularia nodosa	*common figwort*	*knopig helmkruid*
Silene dioica	*red campion*	*dagkoekoeksbloem*
Silene otites	*spanish catchfly*	*oorsilene*
Sisymbrium officinale	*hedge mustard*	*gewone raket*
Solanum dulcamara	*bittersweet*	*bitterzoet*
Solanum nigrum	*black nightshade*	*zwarte en beklierde nachtschade*
Sonchus asper	*prickly sow-thistle*	*gekroesde melkdistel*
Sonchus palustris	*marsh sow-thistle*	*moerasmelkdistel*
Sparganium emersum	*unbranched bur-reed*	*kleine egelskop*
Sparganium erectum	*branched bur-reed*	*grote en blonde egelskop*
Sparganium natans	*least bur-reed*	*kleinste egelskop*
Spergularia media (subsp. angustata)	*greater sea-spurrey*	*gerande schijnspurrie*
Spergularia marina	*lesser sea-spurrey*	*zilte schijnspurrie*
Stachys palustris	*marsh woundwort*	*moerasandoorn*
Stachys sylvatica	*hedge woundwort*	*bosandoorn*
Stellaria aquatica	*water chickweed*	*watermuur*
Stellaria media	*chickweed*	*vogelmuur*
Suaeda maritima	*annual-seablite*	*schorrenkruid*
Thalictrum minus	*lesser meadow-rue*	*kleine ruit*
Torilis japonica	*upright hedge-parsley*	*heggendoornzaad*
Trifolium campestre	*hop trefoil*	*liggende klaver*
Trifolium repens	*white clover*	*witte klaver*
Triticum dicoccon	*emmer*	*emmer*
Triticum aestivum	*bread wheat*	*(brood)tarwe*
Triticum	*wheat*	*tarwe*
Typha	*bulrush*	*lisdodde*
Urtica dioica	*stinging nettle*	*grote brandnetel*
Valerianella locusta	*lamb's lettuce, cornsalad*	*gewone veldsla*
Verbena officinalis	*vervain*	*ijzerhard*
Veronica arvensis	*wall speedwell*	*veldereprijs*
Vicia hirsuta	*hairy tare*	*ringelwikke*
Zannichellia palustris	*horned pondweed*	*zannichellia*

20 Roots, tubers and processed plant food in the local diet

Lucy Kubiak-Martens

The remains of roots and tubers are a special aspect of the Schipluiden subsistence system: the gathering of starch-rich underground plant organs. Such remains are fairly frequently found in archaeological contexts but are often dismissed as unidentifiable plant material, and consequently underestimated, especially in relation to cereal remains. Recently developed methods for the identification of charred remains of vegetative tissues have changed this situation, and also our understanding of local subsistence at the Schipluiden settlement.

The remains of processed plant food found at Schipluiden are likewise unique. They allow significant advances in our understanding of the local diet, but they also provide detailed insight into European Neolithic subsistence in general.

20.1 Introduction

The role of root foods in past human diet has long been the subject of scholarly interest. For example, David Clarke (1976), who drew attention to the potential of plant resources for the subsistence economies of early Holocene hunter-gatherers, suggested that the edible biomass of temperate Europe was concentrated especially in resources such as roots and tubers. However, the lack of archaeobotanical evidence prevented a direct assessment of their significance not only in Clarke's model of Mesolithic Europe (Zvelebil 1994) but also in the European subsistence system as a whole. Techniques recently developed by Jon Hather (University College London) for the identification of charred remains of parenchymatous tissues deriving from soft vegetative organs such as roots, tubers, rhizomes and bulbs have changed this situation (Hather 1991, 1993, 2000). These new methods have been successfully applied at a number of archaeological, mainly pre-agrarian sites in temperate Europe. They have shown that root foods are among the resources that contributed substantially to pre-agrarian diet (see *e.g*. Perry 1999; Kubiak-Martens 1999, 2002; Mason/Hather 2000; Mason *et al*. 2002). Evidence of the use of wild roots and tubers by agrarian societies in temperate Europe has only just begun to be recovered (Hather 2000).

Other plant food remains that often confront us with identification problems are remains of processed plant material, such as processed cereal food (including porridge and bread remains) and mushes made from various fruits, nuts, seeds, roots and tubers or inner bark tissue. These remains occur fairly frequently in archaeobotanical contexts but are usually dismissed as unidentifiable plant material. This makes the remains of root foods and processed plant foods from Neolithic Schipluiden presented in this chapter of particular interest. These remains expand the range of consumed plant taxa and demonstrate that much evidence available in archaeological contexts may be missed if only standard recovery and identification methods are applied.

20.2 Methods

20.2.1 Preservation and recovery

Remains of vegetative plant tissue are generally very fragile, and therefore have a very small chance of being preserved in the archaeological record compared with remains of seeds or nutshells. This is due to the fact that soft tissues are often rich in water and oil, and are therefore susceptible to damage when exposed to fire (especially if they are not dried prior to charring) and readily fracture during the process of recovery from an archaeological site. The problem of identification therefore relates to fragments of tissue rather than whole organs (Hather 2000). Intact preservation of a whole organ is more common in the case of small vegetative organs. Tubers of lesser celandine (*Ranunculus ficaria*) for example often survive charring and subsequent taphonomic and recovery processes. That explains why they are relatively often encountered in archaeological contexts (Bakels 1988; Mason/Hather 2000; Bakels/Van Beurden 2001).

Remains of processed plant foods are very diverse. They may derive from either processed cereal food or mushes prepared from many other food plants and plant parts. In archaeological assemblages they may be preserved for example as clumps of coarsely ground cereal grains, isolated fragments of finely comminuted plant material or food residues (crusts) adhering to pottery fragments.

At Schipluiden, charred remains of parenchymatous tissues and remains of processed plant material were recovered during the analysis of the botanical samples. The hand-picked samples and 4-mm sieved samples (together over 500 samples) were also scanned for both categories of plant remains. In total, almost 100 pieces of parenchymatous tissue and fragments of processed plant foods were sorted to select potentially identifiable remains for a scanning electron microscope examination.

20.2.2 Methods of identification

The identification of charred remains of vegetative plant tissues and remains of processed plant material requires the use of a scanning electron microscope (SEM). The examinations concerned were carried out at the SEM laboratory in the National Herbarium in Leiden. Fragments of selected parenchymatous tissues and processed plant material were first fractured with a scalpel blade in order to obtain fresh surfaces and were mounted on SEM stubs using double-sided carbon tape strips. The fragments were then gold-coated and examined using a JOEL JSM-5300 scanning electron microscope. The specimens were described and photographed.

The anatomy of parenchymatous remains was examined with special attention being paid to the anatomical characters of the vascular tissue. Anatomical criteria outlined by Hather (1991, 1993, 2000) for the identification of charred remains of parenchymatous tissues and the BIAX *Consult* reference collection of vegetative plant parts were used in the identification.

The use of SEM is also essential for identifying processed plant material. The process of food preparation, which often involves grinding or pounding, destroys any morphologically recognisable plants remains. The traditional method for identifying seed remains (examination under a binocular microscope) is therefore insufficient. An alternative method such as examination under a scanning electron microscope provides an opportunity to explore the micro-morphological and anatomical features of very small fragments of plant remains (*e.g.* chaff remains, fragments of epidermis) that occasionally survive the process of food preparation.

20.2.3 Chemical analyses

Selected remains of processed plant material were subjected to chemical analyses in order to estimate their nutritional composition. The analyses were conducted by professor Jaap Boon at the FOM Institute for Atomic and Molecular Physics of the Foundation for Fundamental Research on Matter in Amsterdam (see chapter 20a for details).

The remains were analysed using Direct Temperature resolved Mass Spectrometry (DTMS). In principle, this method implies the mass spectrometric monitoring of a sample heated on a Pt/Rh filament. Compounds adsorbed or sequestered in the sample are evaporated before the non-volatile residue is thermally decomposed to smaller fragments. The result is a dataset that consists of mass spectra (mass range 20-1000 Dalton) collected as a function of time/temperature.

This method has been used to analyse complex organic materials, often in association with inorganic substances. Typical recent applications are carbonised grains and peas (Braadbaart 2004), carbonised food residues and residues encrusted on ancient pottery (Oudemans/Boon 1996). Although residues on pottery have often undergone severe thermal exposure either on the exterior of the pots or as burnt food residues on the interior, information can nevertheless be obtained on various elements, including fatty components (various acylglycerols, free fatty acids, various sterols), polycyclic aromatics deriving from soot, phenolic compounds from wood fires and various heteroaromatic compounds released from proteins and polysaccharides charred to varying extents. The degree of preservation to a great extent depends on the original burning and charring conditions (see chapter 20a).

20.3 Root foods

The remains of parenchymatous plant foods are represented in the Schipluiden assemblage as charred root fragments of the sea beet (*Beta vulgaris* subsp. *maritima*), bulbs of the wild onion/leek (*Allium* sp.) and tubers of the sea club-rush (*Bolboschoenus maritimus*). In addition, there were fragments of isolated parenchyma with no vascular tissue preserved, so no further identification was possible.

20.3.1 Sea beet (Beta vulgaris subsp. maritima) roots

Charred remains of sea beet roots were recovered from the analysed well sample 31 (phase 2) and from the manually collected sample no. 3351 (Unit 20). The plant remains were identified on the basis of anatomical characters observed in parenchymatous and vascular tissue (fig. 20.1-2).

The storage root of *Beta* can be identified on the basis of a particular type of anomalous secondary growth. Each bundle of vascular tissue has a cambium associated with it, which divides to produce vascular and storage parenchyma. This process is repeated many times, observable in transverse section in the form of concentric rings of vascular tissue between which are the bands of storage parenchyma (Hather 1993, 2000). In the charred remains preserved in sample no. 3351, these concentric rings of vascular tissue had survived in part; the areas of parenchymatous tissue can be observed between them (fig. 20.1).

Sea beet (fig. 20.3) occurs naturally on shingle beaches, tidal drift deposits and the drier areas of salt marshes in temperate Europe (Langer/Hill 1991). The plant is a biennial dicotyledon with succulent leaves and fleshy roots growing to lengths of up to 30 cm and thicknesses of 3-4 cm. The roots are rich in starch and sugar, which are concentrated in the parenchymatous tissue. From such direct evidence as charred root fragments recovered from the occupation deposits at Schipluiden we can infer that sea beet roots were

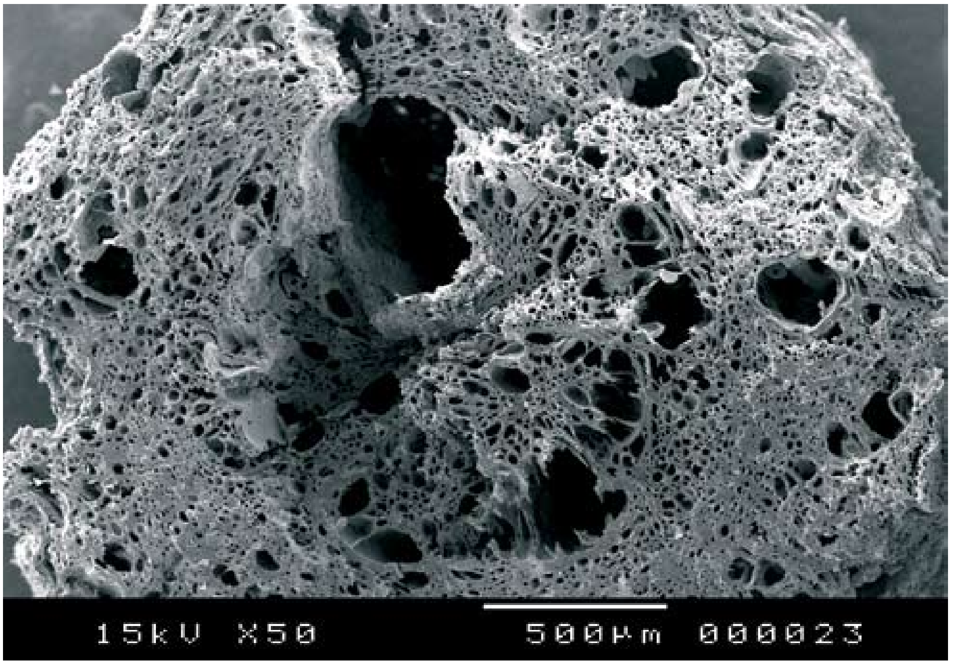

Figure 20.1 SEM micrograph of charred root fragment of sea beet (*Beta vulgaris* subsp. *maritima*) from sample no. 3351. Visible are concentric rings of vascular tissue (partly deteriorated) and storage parenchyma (transverse surface, magnification 50×).

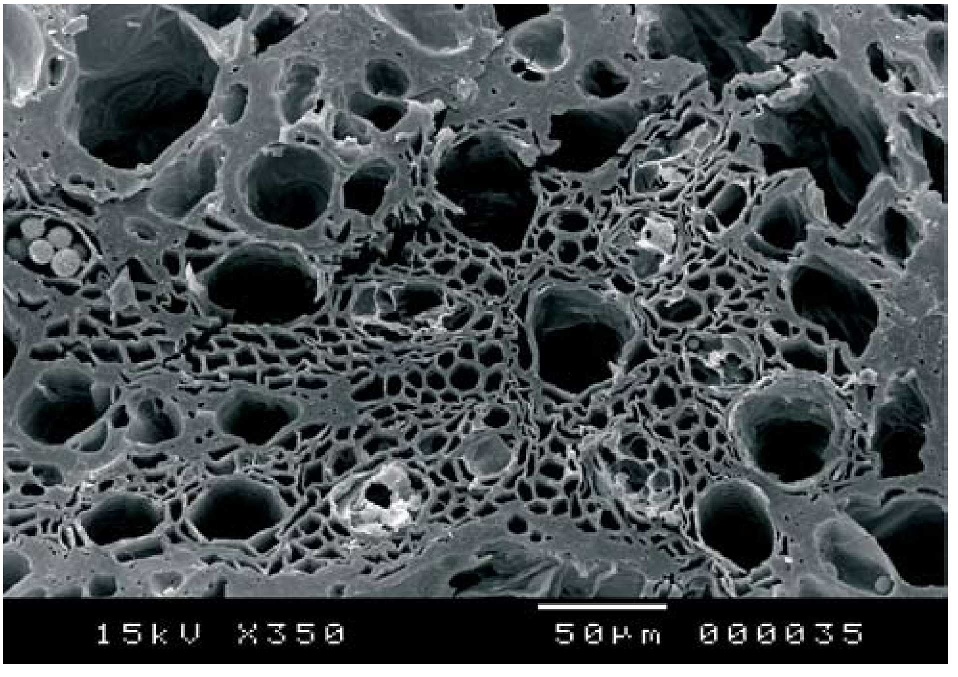

Figure 20.2 SEM micrograph of charred fragment of parenchymatous tissue, deriving from sea beet (*Beta vulgaris* subsp. *maritima*) root found in sample 31. Ground tissue with remnants of vascular tissue (transverse surface, magnification 350×).

gathered as food. They will have been readily available in many places with favourable conditions for this plant near the settlement. We can further suggest that the roots were exposed to domestic fire as part of their cooking process. According to many ethnographic accounts of the North American indigenous people, one of the most common methods used to make roots digestible and palatable involved cooking in an underground pit, though some roots were simply roasted over a fire or baked in hot ashes (Turner *et al*. 1990; Kuhnlein/Turner 1991).

Evidence of the gathering of sea beet roots as plant food has also been found in other archaeological contexts,

Figure 20.3 Specimen of *Beta vulgaris* subsp. *martima*, showing the edible root. After Körber-Grohne 1994.

Figure 20.4 Charred bulb of wild onion/leek (*Allium* sp.) from sample no. 2388 (magnification 5×).

including two late Mesolithic sites in the *Veenkoloniën* (peat district) in the Dutch province of Groningen (Perry 1999), the late Mesolithic Ertebølle settlement at Tybrind Vig in Denmark (Kubiak-Martens 1999) and the late Bronze Age site at Mile Oak in Britain (Hather 2000). The presence of charred perianths identified in Late Neolithic shell middens near Aartswoud in the Netherlands also indicates exploitation of sea beet as a food plant (Pals 1984).

20.3.2 Wild onion/leek (Allium sp.) bulbs

One almost complete elongated bulb and a few bulb fragments of wild onion/leek (*Allium* sp.) were encountered in 4-mm sieved samples nos. 2388 and 4633 (both from Unit 20). The identification was based on both the morphology of the bulb remains and the anatomy of the parenchymatous and vascular tissue.

The preserved charred bulb was 12 mm long and measured 6 mm across (fig. 20.4). A distinct scar was observed at the distal end of the bulb. Internally the bulb fragments comprised fairly closely packed bands of storage parenchyma (fig. 20.6). They were separated by a system of cavities, formed by the expansion of water vapour during the process of charring. Vascular tissue was preserved in the form of vascular bundles, randomly arranged within the parenchymatous tissue. They were amphicribal concentric in arrangement, with xylem elements embedded in a phloem tissue (fig. 20.7). Combined morphological and anatomical criteria allowed identification only to genus level. Reliable identification of the species concerned here requires more

Figure 20.5 Sand leek (*Allium scorodoprasum),* showing small onions.

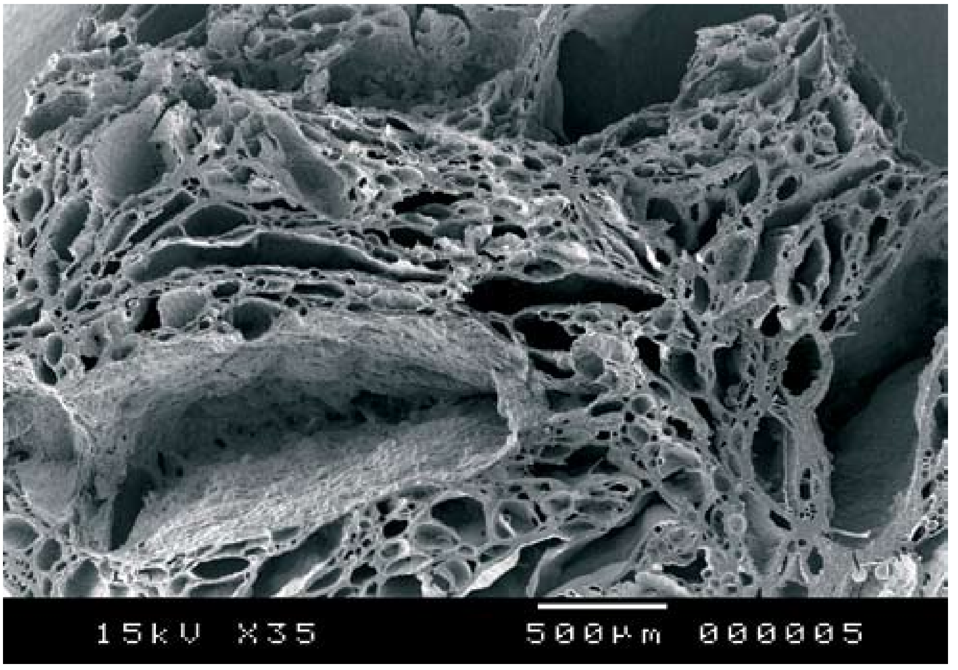

Figure 20.6 SEM micrograph of transverse section through *Allium* sp bulb, showing storage parenchyma and vesicular cavities (transverse surface, magnification 35×).

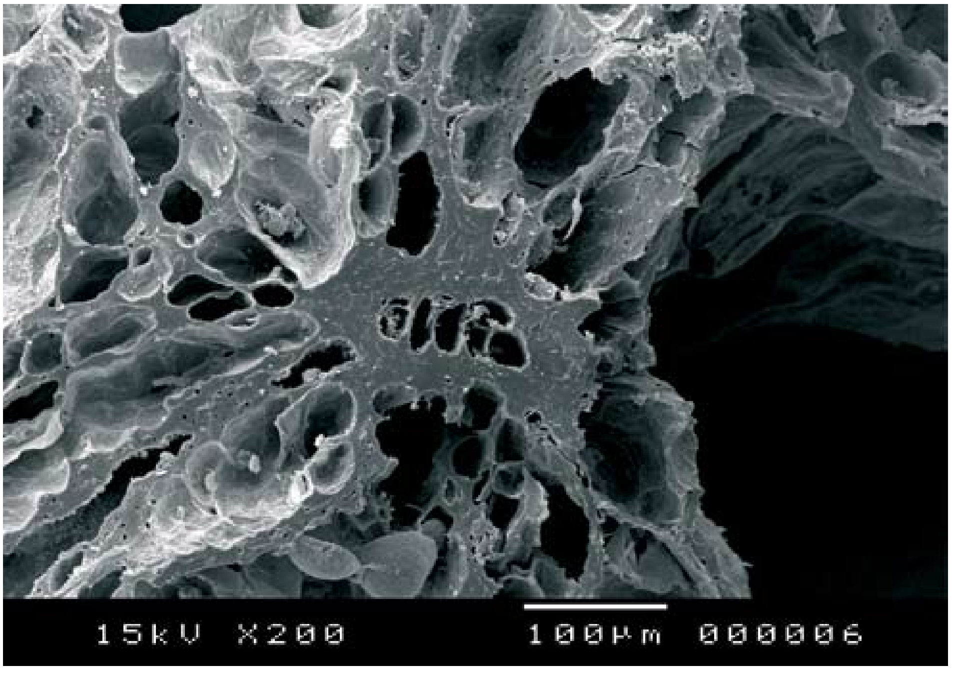

Figure 20.7 SEM micrograph of an individual vascular bundle in *Allium* sp. parenchymatous tissue. Xylem elements are embedded in phloem tissue. Charring caused the phloem to deteriorate to a solid ring of carbon; the xylem vessels have survived almost intact (transverse surface, magnification 200×). Detail of fig. 20.6.

detailed anatomical study of the diversity of the parenchymatous and vascular tissues within the genus *Allium.*

There are four native *Allium* species in the Netherlands (which may still be found here today) that produce more or less elongated bulbs: *Allium schoenoprasum*, *A. scorodoprasum*, *A. ursinum* and *A. carinatum*. On the basis of their environmental requirements, we may assume that at least two of these species will have grown in the vicinity of the site: sand leek (*Allium scorodoprasum*, fig. 20.5), which finds its optimum conditions in sandy dune shrubs and grassy habitats, and chive (*Allium schoenoprasum*).

The charred bulb remains found in the Schipluiden assemblage suggest that the plants were brought to the settlement and became charred when exposed to cooking fire. Many (if not all) members of the lily family store their main carbohydrates as inulin rather than starch. Cooking is therefore required to improve their digestibility and palatability. At Schipluiden, the bulbs (and also the green leaves) may have been used as food and/or added to other foods as flavourings. Although all roots have the highest concentrations of stored substances between autumn and early spring, they can be gathered and used throughout the greater part of the year. The bulbs of the lily family may however have been difficult to locate after the green tops had died in late summer. For the inhabitants of the Schipluiden settlement they may have been the first green vegetables to appear in spring. The small size of the *Allium* sp. bulb recovered suggests that the bulb and probably the leaves were gathered in spring. For comparison, the author collected bulbs of ramsons (*Allium ursinum*) in late March (before flowering time) and latter in mid June. The spring bulbs were approximately 1 cm in length and 4 mm across, while the summer bulbs measured approximately 4 cm in length and 1 cm across. The bulbs collected in spring very closely resembled the archaeological find.

Evidence obtained at other archaeological sites adds much credibility to this interpretation. Charred bulb and fragmentary bulb remains of wild garlic or ramson (*Allium* cf. *ursinum*) were encountered at the Late Mesolithic Ertebølle site at Halsskov in Denmark. They were interpreted as remnants of food lost in cooking fires (Kubiak-Martens 2002). Revealing evidence also comes from the Neolithic lakeshore settlements in Switzerland, where large amounts of *Allium* pollen were recovered from many organic layers (Heitz-Weniger 1978). In addition, pollen of *Allium* (possibly *ursinum*) was retrieved from the contents of a pot (Hadorn 1994). This points directly to the use of *Allium* either as a green and/or root vegetable or for flavouring other food.

Many ethnographic records provide evidence of regular use of various species of wild onions, leek, garlic and chives of the genus *Allium* in the traditional diet of indigenous peoples in North America (Turner *et al*. 1990, Kuhnlein/Turner 1991). Often, both the green leaves and the bulbs were consumed. Some species, for example nodding onion (*Allium cernuum*) and chives (*Allium schoenoprasum*), were gathered in spring (before flowering) for their green leaves and bulbs, and again in autumn for their bulbs. The Thomson Indians of British Columbia, for example, harvested the bulbs of nodding onion in spring and cooked them in underground pits. They sometimes used the bulbs to flavour other foods, too. The strong-tasting bulbs of wild leek (*Allium tricoccum*) were reportedly eaten by various groups in eastern Canada. They were eaten raw, and also cooked in soups and stews.

20.3.3 Sea club-rush (Bolboschoenus maritimus) tubers

Charred remains of sea club-rush (*Bolboschoenus maritimus*) were encountered in the 4-mm sieved sample no. 2362 (phase 3). The identification was based on the anatomy of parenchymatous and vascular tissues. All the remains had well-preserved parenchymatous and vascular tissue, which indicates that the tubers were charred in a dry, rather than a fresh state.

The charred remains preserved at Schipluiden were picked out under a light microscope as parenchyma fragments with clearly curved outer surfaces. When the fragments were refitted they were found to derive from ovoid organs, approximately 2 cm long and 1 cm in diameter (fig. 20.8). Internally, the tuber fragments were composed of isodiametric polygonal parenchyma cells measuring 30 to 50 μm across (fig. 20.10). Vascular bundles were randomly arranged within the parenchymatous tissue (fig. 20.11) and characteristic thick fibre sheaths were observed that were much wider at the xylem pole than at the phloem (fig. 20.12).

Figure 20.8 Charred tuber of sea club-rush (*Bolboschoenus maritimus*) from no. 2362 (magnification 5×).

Figure 20.9 Sea club-rush (*Bolboschoenus maritimus)* with tubers in the present-day salt marsh environment of the Land van Saeftinge, province of Zeeland.

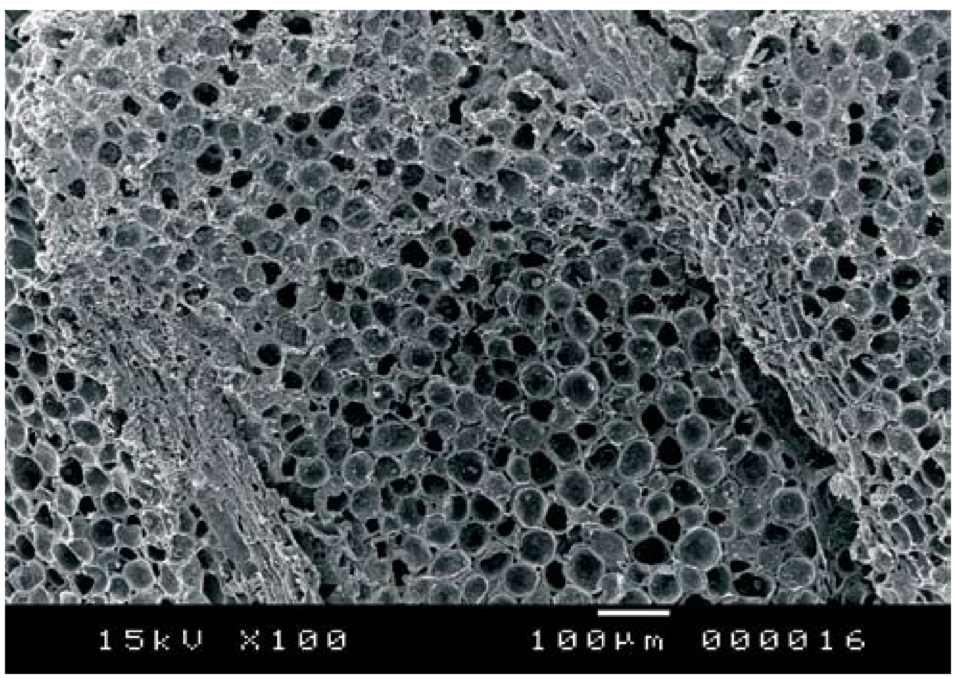

Figure 20.10 SEM micrograph of parenchymatous tissue of *Bolboschoenus maritimus* in longitudinal surface. Tracks of the vascular system are visible (magnification 100×).

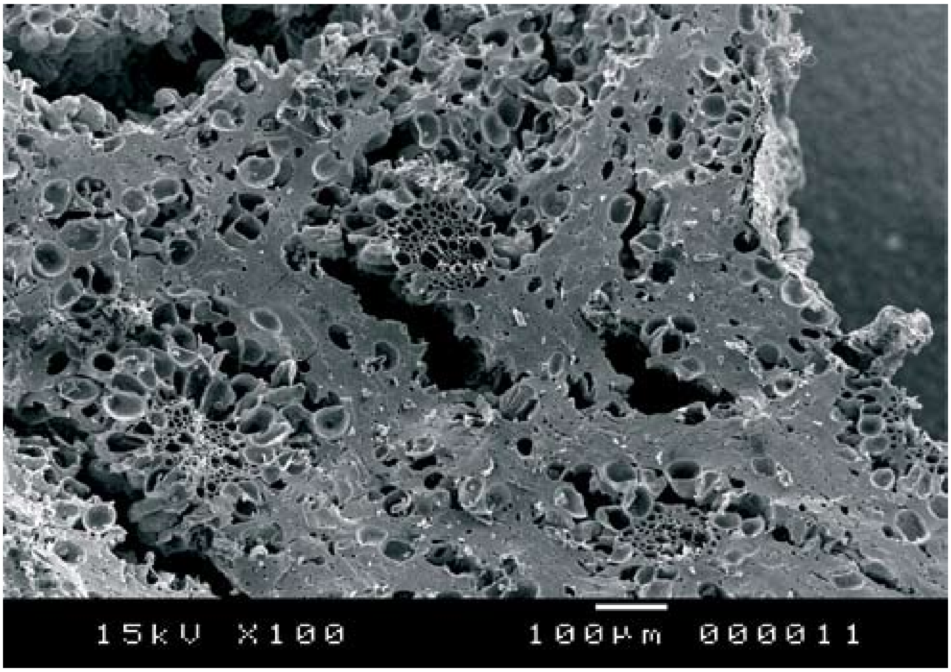

Figure 20.11 SEM micrograph of vascular bundles randomly arranged within the parenchymatous tissue of a *Bolboschoenus maritimus* tuber (transverse surface, magnification 100×).

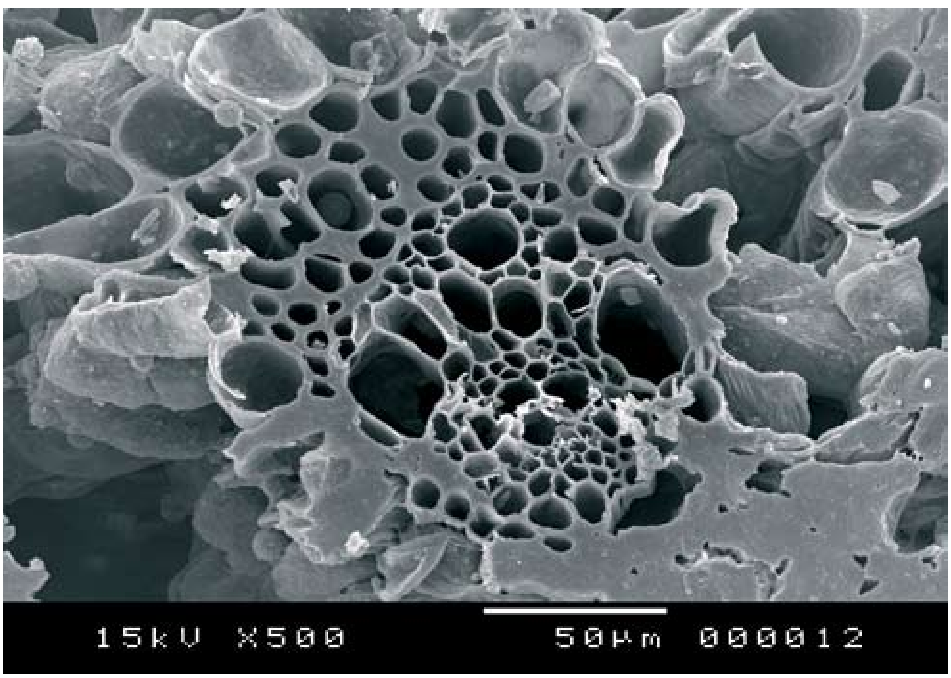

Figure 20.12 SEM micrograph of an individual vascular bundle in the parenchymatous tissue of a *Bolboschoenus maritimus* tuber. Note the thick fibre sheath, that is much wider at the xylem pole than at the phloem (transverse surface, magnification 500×). Detail of fig. 20.11.

Sea club-rush finds its optimum conditions in brackish marsh vegetations but can also grow in freshwater marshes. The tubers are formed as terminal swellings of the rhizomes. They are ovoid, up to 4 cm long and 2 cm in diameter (fig. 20.9).

The probability of tubers of sea club-rush having been introduced into the settlement as gathered food is supported by archaeobotanical finds recovered at other sites. For example, charred remains of rhizomes of the closely related club-rush (*Scirpus* sp.) were found together a

b

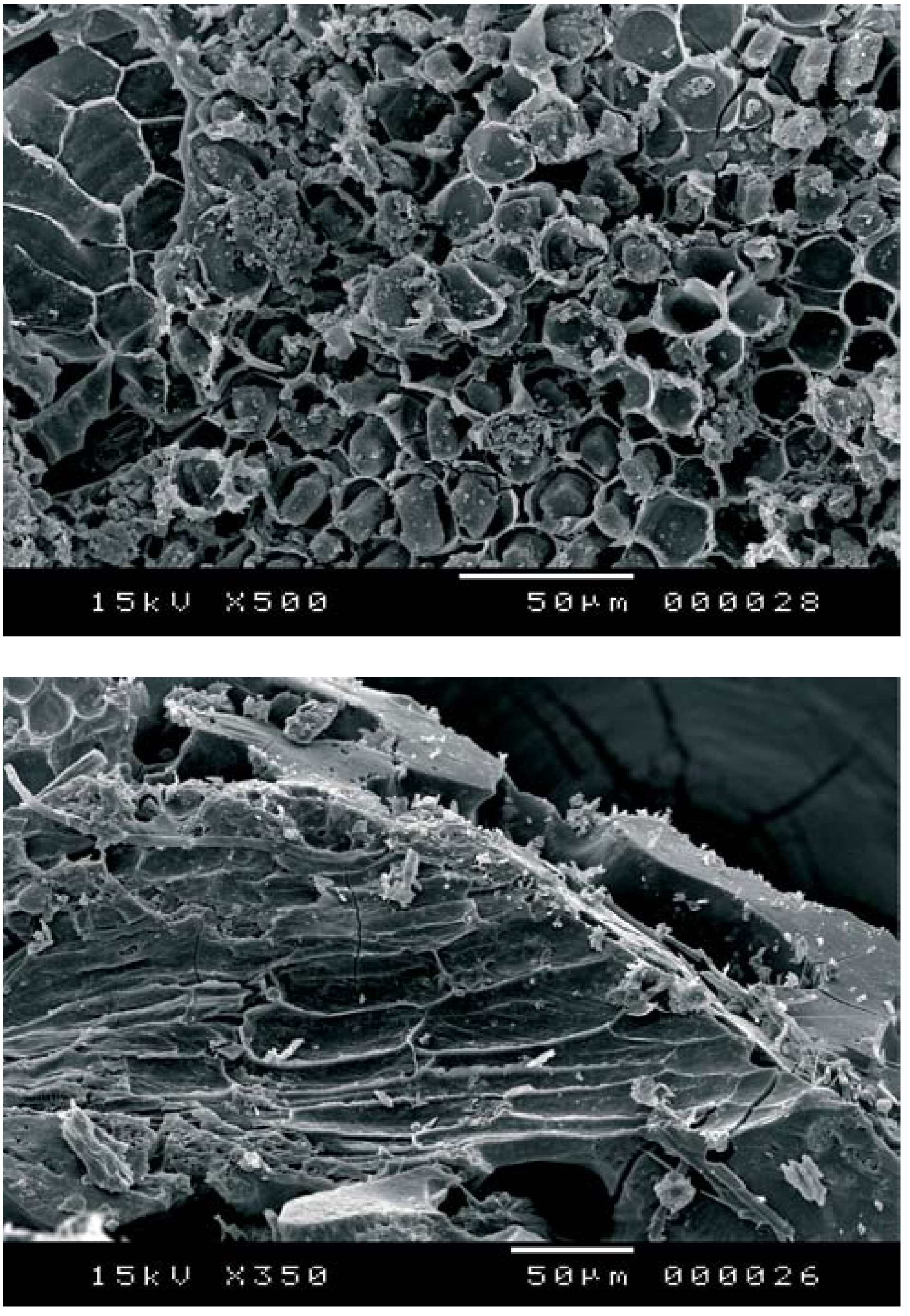

Figure 20.13 Plant food mush made from roots or tubers with the addition of leaf/stem food, sample 2876, (magnification 500×).
a isolated parenchymatous tissue characteristic of root or tuber
b stem/leaf fragment embedded within parenchymatous matrix

with charred vegetative tissues of other edible plants at two Late Mesolithic sites in the aforementioned *Veenkoloniën* in the Dutch province of Groningen (Perry 1999).

20.3.4 Processed root food

Isolated fragments of charred finely comminuted plant material dating from all the occupation phases were frequently found in both the analysed and the 4-mm sieved

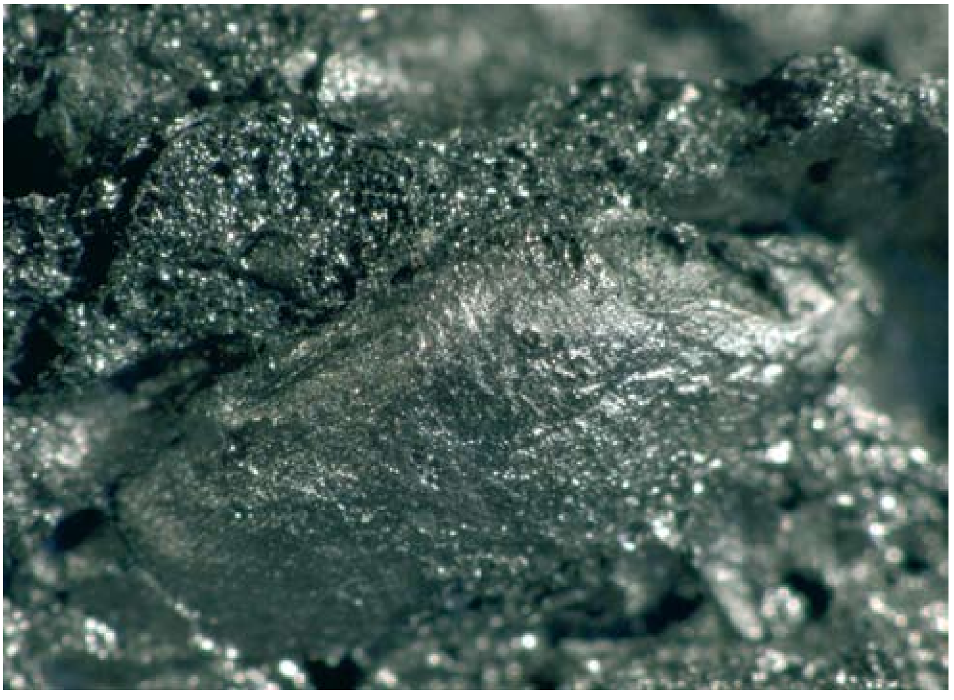

Figure 20.14 Charred remains of processed emmer (*Triticum dicoccon*) in a porridge-like food, made of coarsely crushed emmer grains, no. 7074, phase 2a.
a overall view (5×)
b detail (20×)

samples. On closer examination under the scanning electron microscope, some fragments of no. 2876 from Unit 20 were found to consist of processed parenchymatous tissue deriving from either root or tuber organs (fig. 20.13a). Fragments of stem/leaf epidermis were seen to be embedded in the parenchymatous matrix (fig. 20.13b). The combination of two

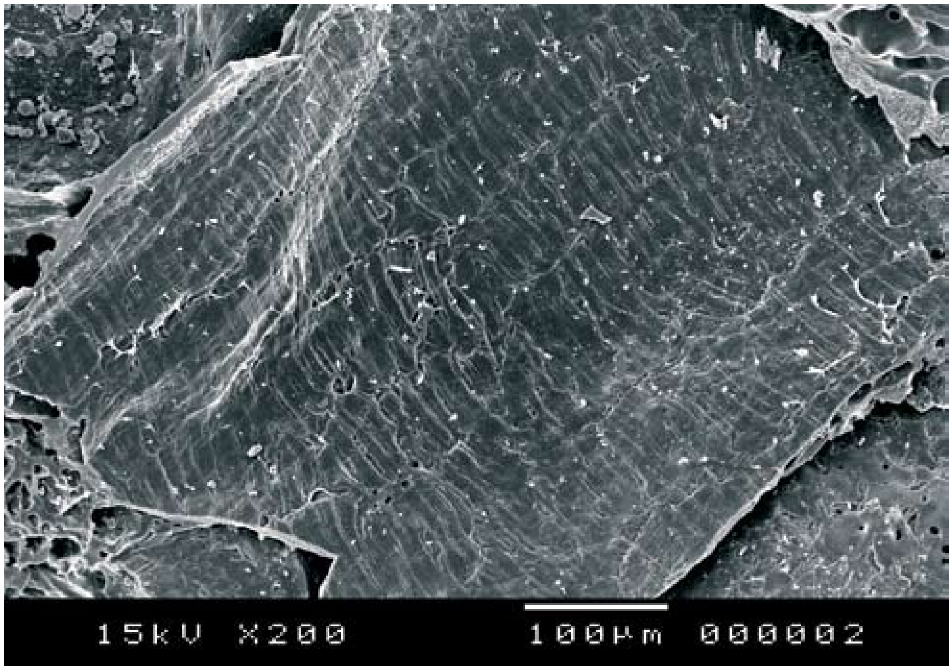

Figure 20.15 SEM micrograph showing transverse cell layers of emmer (*Triticum dicoccon*) grain epidermis recovered from encrusted material, no. 4084, phase 2b (magnification 200×).

different categories of plant material cannot possibly be interpreted in any other way than as representing a plant-food mush made from roots or tubers with the addition of green leaves and/or stems. The type of root/tuber food used to make this mush could not be identified because no vascular system had survived within the parenchymatous tissue.

20.4 Processed plant food

20.4.1 Cereal food remains

An interesting feature of the Schipluiden plant assemblage, especially with respect to the occupants' subsistence is the presence of charred remains of processed cereal food. Two, relatively large, fragments of cereal products were found in the 4-mm sieved samples nos. 7292 and 7074, both dated to phase 2a. Both fragments consist almost exclusively of emmer (*Triticum dicoccon*) grains, mixed with a small quantity of chaff remains (fig. 20.14a). No weed seeds were noted. The whole and fragmented grains (coarsely crushed and not ground) were embedded in a featureless, rather glassy matrix (fig. 20.14b). The nature of the matrix suggests that the cereals were cooked with the addition of some liquid (possibly water) and were eaten as porridge. Chemical analysis revealed no evidence of preserved milk or meat fats. Neither did it yield any evidence of starch. A question that needs to be addressed is whether high temperatures of the fires may have affected the preservation of organic molecules in archaeological remains. An experiment using present-day emmer grains showed that the molecular composition of residues that were exposed to a temperature of 250 ºC still consisted of starch and protein. The amount of polysaccharides however decreased when the residues were heated to a temperature higher than 310 ºC (Braadbaart *et al*. 2004).

These remains of processed emmer food are of special interest for at least two reasons. They represent the remnants of food (final products) that formed part of the diet of the people who lived at Schipluiden, and they are the earliest direct evidence of the processing of cereal food so far found in the Netherlands. Remains of processed cereal food were previously known only from the Neolithic lakeshore settlements in Switzerland (Lake Neuchâtel) and Germany (Lake Constance, Maier 1999).

20.4.2. Food residues on pottery

Selected specimens of charred food residues that were encrusted on the exterior surfaces of pots when the food contained in the pots boiled over during cooking, and burnt food residues from the interiors of pots were subjected to scanning electron microscope examination and chemical analyses.

A thick layer of crust was scraped from the exterior rim of pot fragments no. 4084, from phase 2b. Under the scanning microscope this crust was found to comprise a featureless matrix with inclusions of epidermal fragments of emmer (*Triticum dicoccon*) grain (fig. 20.15), suggesting that (at least some of the) food was made from emmer grain. Chemical analysis showed that proteins contributed to the

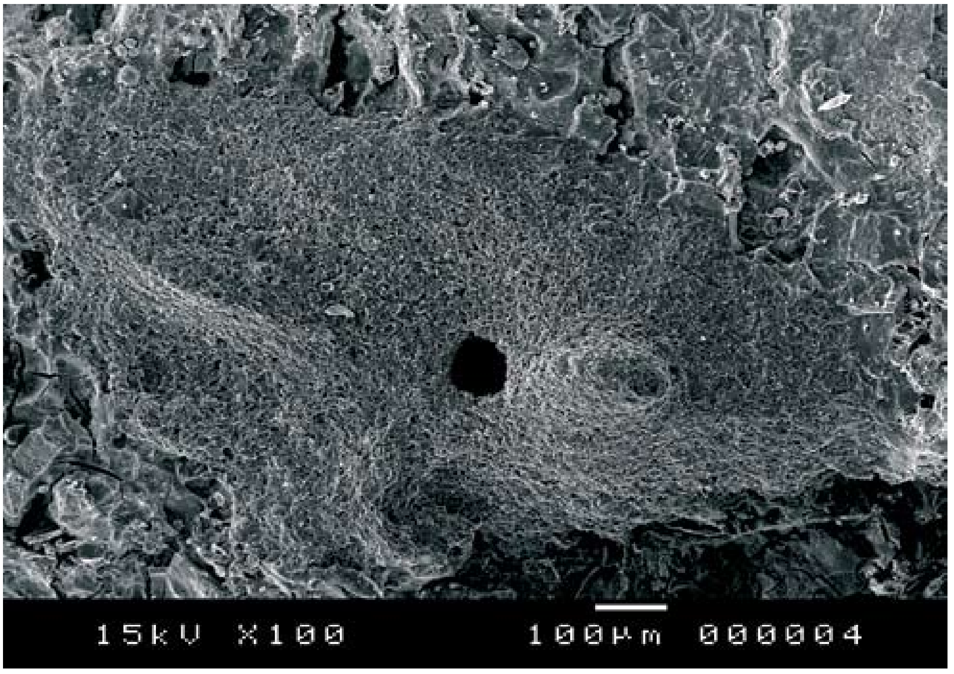

Figure 20.16 SEM micrograph of encrusted material showing remains of orache/seablite (*Atriplex/Suaeda*) embedded within the matrix, no. 3206, phase 2a (magnification 100×).

nutritional spectrum, though it could not be ascertained whether they were of plant or animal origin. There was however no evidence of starch and/or fats (chapter 20a). The absence of starches in the chemical matrix could be explained by the relatively high degree of charring, which may have destroyed the organic compound.

Under SEM examination, another fragment of encrusted remains (no. 3206, phase 2a) was found to have a rather fine texture, comprising remains of the seeds of possibly orache/seablite (*Atriplex/Suaeda*) embedded in the matrix (fig. 20.16). The seed remains indicate that we are dealing with either plant food made from cereals (in this case the

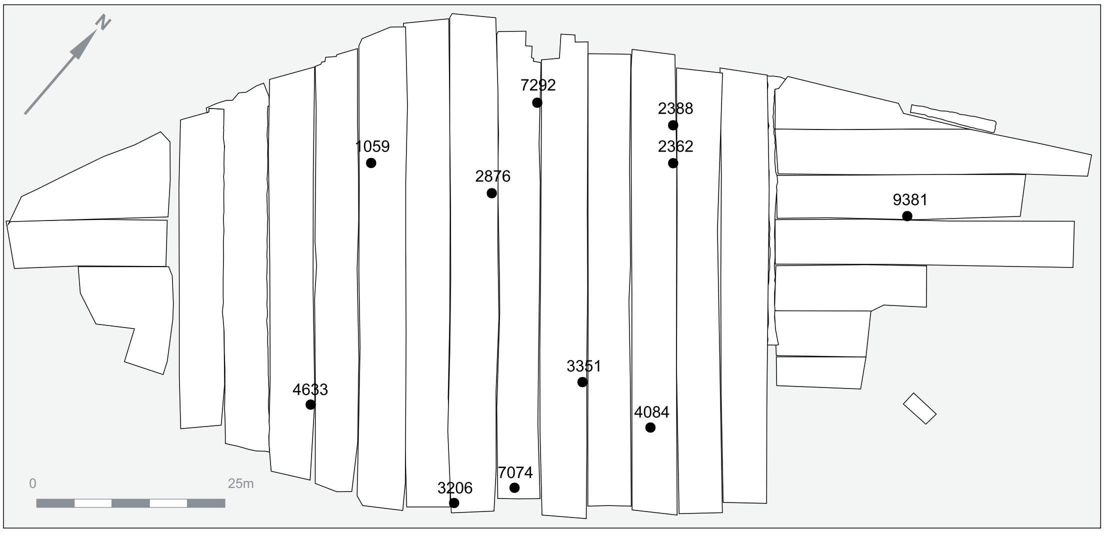

Figure 20.17 Points at which the samples discussed in this chapter were taken.

Atriplex/*Suadea* seeds will have made their way into the assemblage as weeds) or a plant food mush made from chenopod seeds. Many members of the Chenopodiaceae family are well known for their edible seeds that are rich in protein and carbohydrate. Some of the members of this family, for example various species of *Chenopodium* and *Atriplex,* are indeed assumed to have been a source of food in past human diets (Kuhnlein/Turner 1991; Moore *et al.* 2000).

Two other fragments of food residues had a very fine matrix in which no morphological or anatomical features could be made out under the SEM. Chemical markers obtained for very fine residues preserved on the interior of a small pot (no. 1059, Unit 20) point to a relatively uniform dissociation of the organic matter. The spectrum indicates unsaturated fatty acids, proteins and cholesterol. The observed composition points to a plant oil source. The combination of proteins and compounds deriving from plant oil suggests that plant seeds were the source of the organic matter. There are no preserved diglycerides that could support a milk source for the lipids (see chapter 20a). The Schipluiden archaeobotanical record presents us with at least two plant species that can be seen as potential sources of seed oil, namely turnip (*Brassica rapa*) and dogwood (*Cornus sanguinea*). *Brassica rapa* is well-known for its oleaginous seeds (rape seeds) and edible vegetative parts. The status of turnip as a cultivated crop is somewhat obscure. Although remains of the seeds of turnip have been found in archaeobotanical contexts at Neolithic sites and are commonly known from sites from the Bronze Age onwards, it is not certain whether the plant was actually cultivated or occurred only as a weed in arable fields (Bakels 1997). Turnip oil is liquid as it contains unsaturated fatty acids, and it can therefore be used for cooking and also for burning in oil lamps (Bieleman 1992). *Cornus sanguinea* grows naturally at the edge of woods and its stones are very rich in oil, which can be used for both consumption and burning.

Evidence of charred proteins in combination with saturated fatty acids and a mono-unsaturated fatty acid was also provided by residues encrusted on the interior of a pot fragment (no. 9381, phase 3). Several sterols suggest a plant oil source. The composition resembles that of no. 1059 (see chapter 20a).

20.5 Conclusions

The study of charred remains of parenchymatous root foods and processed plant foods provided evidence of the diversity of the diet of the Schipluiden occupants. The study also demonstrated the great potential of appropriate recovery and identification techniques for reconstructing past human diets.

The root food remains indicate a different direction in the Schipluiden subsistence system, towards the gathering of starch-rich underground plant organs, and point to the exploitation of various ecological zones: the coastal area for sea beet roots and more local ecological zones for bulbs of wild onion/leek in phase 2, and for tubers of fresh/brackish wetland plants such as sea club-rush in phase 3. Although root foods can be consumed throughout the greater part of the year, they have their highest concentration of stored substances between autumn and early spring. At Schipluiden, the root foods may have been especially appreciated during the winter months, when other plant foods were in scarce supply.

The remains of emmer and other processed plant foods recovered at Schipluiden are equally unique. They allow significant advances in our understanding of local subsistence and diet, and they certainly provide detailed insight into the daily life of the Neolithic occupants of Schipluiden.

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20a Analytical report on some archaeological charred residues from Schipluiden

Jaap Boon

Residues on ceramic pottery found in Schipluiden were investigated with direct temperature resolved mass spectrometry to determine whether they contain organic constituents that can be related to food preparation. Some residues on the outside shows aromatic compounds from soot precipitation. Charred proteins were also common. There is evidence for lipids but only fatty acids remain and some compounds with a cholesterol origin indicative for an animal origin. One residue microscopically identified as a porridge shows evidence for lignocellulosic constituents from resistant plant cells of woody tissues. Compared to preserved residues from other archaeological sites, the ones from Schipluiden are poorly preserved on the molecular level and therefore hard to relate to food substances.

20a.1 Introduction

Five samples of charred remains from the Schipluiden site were submitted by Lucy Kubiak-Martens for chemical analysis. One sample is a presumed resides of porridge while others were removed from pottery sherds. The nature of the material was unknown to the analysts.

Direct Temperature resolved Mass Spectrometry was the analytical technique used. In principle, this method implies the mass spectrometric monitoring of a sample that is heated on a Pt/Rh filament. Compounds adsorbed or sequestered in the sample are evaporated before the non-volatile residue is thermally decomposed to smaller fragments. The result is a dataset that consists of mass spectra (mass range 20-1000 Dalton) collected as a function of time/temperature.

This methodology has been used for analysis of complex organic materials often in association with inorganic substances. Typical recent applications are carbonised grains and peas (Braadbaart 2004), carbonised food residues and coatings on ancient pottery (Oudemans/Boon 1996; Oudemans *et al*. 2005a, b). Recently the methodology has been applied to various archaeological objects from the Louvre (Regent/Rolando 2002). Residues on pottery have often undergone severe thermal exposure either on the exterior of the pots or as burned food residues on the interior. My laboratory has been involved in a number of studies of such residues since 1990. In a number of cases it has been possible to retrieve data on fatty components (various acylglycerols, free fatty acids, various sterols), polycyclic aromatics from soot, phenolic compounds from wood burning fires, and various heteroaromatic compounds released from weakly and strongly charred proteins and polysaccharides. The degree of preservation depends highly on the original burning and charring conditions.

The samples were analysed as received. Aliquots of about 50 microgram of the power were homogenised in ethanol in a glass micro mortar and applied to the filament probe. The instrument use was a JEOL SX102-102A tandem mass spectrometer. The MS condition were: 16 eV electron ionisation, 8kV acceleration voltage, scan range m/z 20-1000 at a rate of 1 s/scan. Data were processed in a JMA7000 data system and software.

20a.2 Results

Results are presented as mass spectra and mass chromatograms in figures 20a.1-5. A short interpretation of the data is presented here. The questions from Kubiak-Martens concern the nature of the residues observed on the pottery with a focus on proteins, fats and cereal polysaccharides. The data are summarized in table 20a.1. The lipid fractions are clearly recognizable in the data by their molecular ions and fragment ions. Only sample 9381 shows some evidence for intact acylglycerides with C16 and C18 fatty acid moieties [m/z 550 (C16/C16), 578 (C16/C18) and 604 (C18/C18)] but the relative amounts are very low compared to samples from other archaeological contexts (see for example Oudemans *et al*. 2005a, b). Sample no. 7163 shows the most prominent pattern of polycyclic aromatic hydrocarbons [m/ 128 and 142 from naphtalenes and m/z 252, 276, 302 and 326 from perylene and higher homologues].

Polysaccharides and lignocellulosic complexes have been subject to extensive studies in our group (Pastorova *et al.,* 1993 and 1994, Van der Heijden *et al.;* 1993; Van der Haage *et al.* 1993). Residues from lignified matter were discovered in sample no. 7292 as m/z 85 and 114 from pentoses, m/z 144 and 126 from hexoses and lignin derived guaiacyl and syringyl markers at m/z 164 and 194. Proteins as heteropolymers with a polyamide backbone show very complex peak patterns in DTMS. Charred proteins are often rather aromatised and characterised by m/z 67, 92, 94, 107,

file number	DTMS code	material	fats/oils/resins	proteins	polysaccharides	other
no. 7292	11nov04012	charred processed cereal food	fatty acids C16:0 & C18:0 tocoferol	charred	hexosan and pentosan plus G/S lignin	reduced sulfur
no. 4084	11nov04011	charred crust on pottery	sequestered C16:0 & C18:0	charred	none	PAH soot reduced sulfur
no. 1059	11nov04013	charred crust on pottery	cholesterol, oxycholesterol phytosterols fatty acids C16:0, C18:0, C18:1, OHC18:1 cross-linked oils	charred	none	reduced sulphur (lots)
no. 7163	11nov04010	charred crust on pottery	trace of C16:0 and C18:0 FA	charred	none	PAH soot reduced sulphur
no. 9381	11nov04009	charred crust on pottery	cholesterol, oxycholesterol and phytosterols C16:0 , C18:0, C18:1 and OH-C18:1 FA Acylglycerols	charred	none	reduced sulphur

Table 20a.1 Summary of the main compounds observed in the DTMS data.

108, 117,131, 145, and 186. Studies by Oudemans *et al*. (2005a, b) and Braadbaart (2004) demonstrate the gradual loss of characteristic features at higher exposure temperatures. One feature recognized recently in charred protein reference material studies is the mass peak m/z 27 [HCN] that shows a steady increase at the higher analysis temperatures. HCN is presumably released from N-containing aromatic compounds. The presence of this feature is a sure sign of nitrogen compounds in the charred mass. Elemental analysis indeed confirmed this (Braadbaart 2004). The presence of HCN released at high temperature in the analytical profile was confirmed by mass chromatography in samples no's 9381, 7163, 4048, and 7292.

20a.3 Sample analysis description

Sample no. 7292; DTMS code 11nov04012)

The DTMS Total Ion Current trace (TIC) is relatively broad (scan 60-110) pointing to multiple polymeric fractions. There are no evaporating smaller compounds in this sample. The summation spectra in figure 20a.1 are summarised over three scan ranges (60-75 (a); 75-85(b); 85-95(c)). The range of 60-75 (a) shows peaks at 95, 96, 109, 110, 114 (pentose mass markers), 126 (hexose mass marker) pointing to partially charred polysaccharides. The peaks at 124, 150, 164, 178, 180, 194, 208 and 210 point to a partially preserved guaiacyl-syringyl lignin. These peaks have a somewhat higher intensity in the range 75-85 (b). The high relative intensity of m/z 44 from CO_2 resulting from decarboxylation points to the presence of acid groups which are usually an indication of oxidative conditions. The latter and the peak pattern demonstrate that the residue contains oxidized and thermally altered ligno-polyssaccharides compared to fresh lignocellulosic plant matter. The m/z 64 (see c) is strong evidence for incorporation of reduced sulfur presumably from sulfate reduction by anaerobic bacteria. At lower scans very small amounts of the C16:0 and C18:0 fatty acids are observed and a peak at m/z 430 from tocoferols (partial spectrum not shown).

In conclusion: no evidence for preserved milk and meat fats, nor for starches. The lignopolysaccharide complex point to preserved lignocellulosic fractions from more woody plant parts. Can a possible contamination from peatified plant part of soil debris be excluded?

Sample 4084; DTMS code 11nov04011

The TIC, mass spectra and mass chromatograms are shown in figures 20a.2a-c. The TIC is rather broadened and peaks at scan 90 pointing to a highly condensed thermally resistant organic matter. A main peak in the spectrum is m/z 44 (CO_2) from decarboxylation of acids groups in the organic matter. Mass m/z 34 (H_2S) and m/z 64 (SO_2 or S_2) point to incorporation of sulfur in the organic matter. The range from 40-85 (a) shows peaks at m/z 252,276,302 from polycyclic aromatic hydrocarbons (PAH) (see also 7163 with a much stronger signature of soot) from soot deposited. There is evidence for m/z 256 and 284 from palmitic (C16) and stearic (C18) fatty acid in sequestered form, which is evidenced in the mass chromagram of m/z 129 (general fatty acid fragment ion) and m/z 284 (stearic acid molecular ion). The sample shows a complex envelope that resembles charred proteins. Further evidence for nitrogen compound

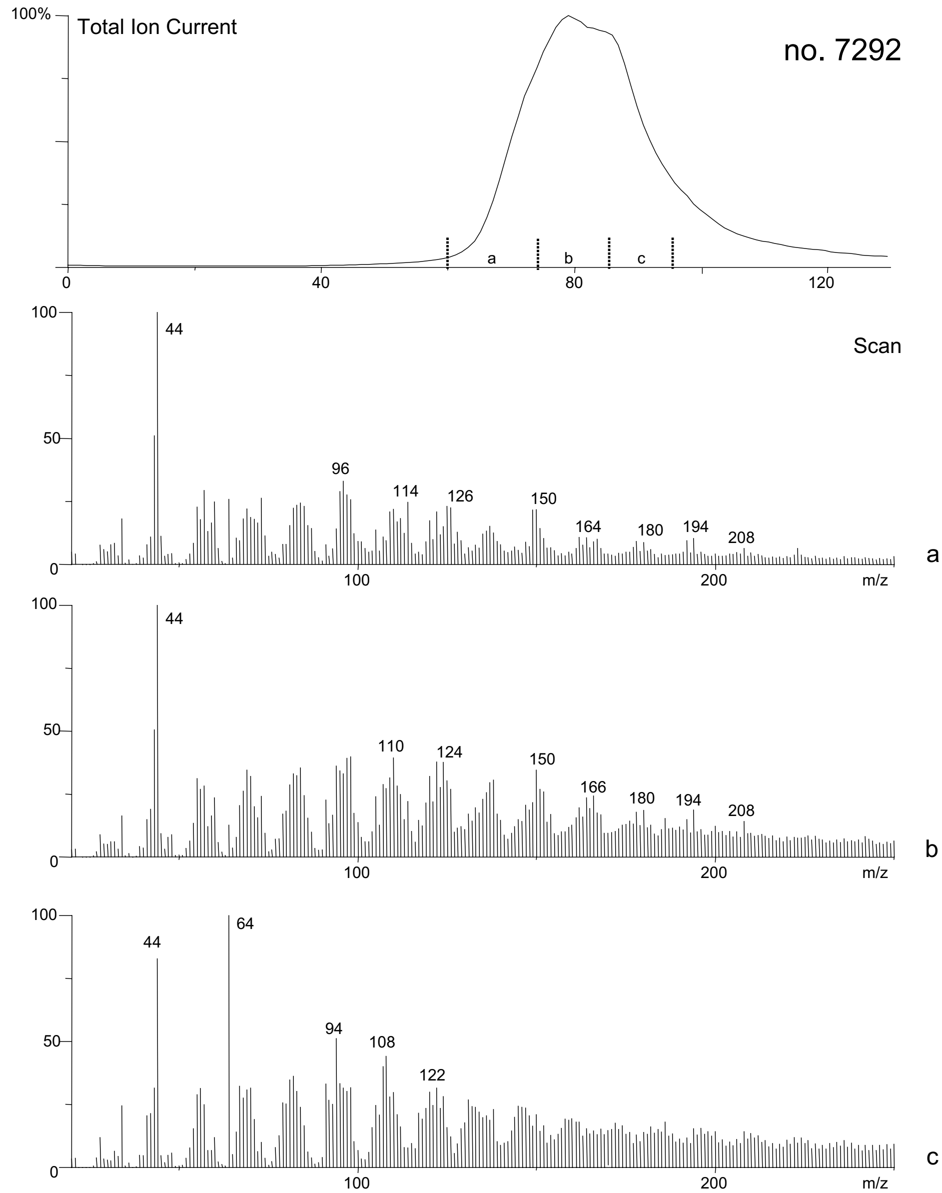

Figure 20a.1 DTMS data of Schipluiden no. 7092 charred food (?) material showing a total ion current profile and the mass spectra summarised over in the scan ranges corresponding to thermally induced dissociation events of lignocellulosic materials (scan range a, b and c). Mass spectrum a corresponds to pentose and hexose polysaccharides with some peaks for guaiacyl and syringyl lignin.

incorporation is found in the profile of m/z 27 (HCN) in figures 20a. 2a-b. The prominence of m/z 78, 91, 92, 128, 142 from alkyl benzenes and naphtalenes points to high degrees of carbonisation and condensation.

In conclusion: No evidence for starch and fats. Food source hard to give but proteins are contributing to the signature. Evidence for soot is present.

Sample 1059; DTMS code 11nov04013

The TIC, mass spectra and mass chromatograms are shown in figure 20a.3. TIC ranges from scan 55-100 pointing to a condensed residue. The mass chromatogram of significant marker peaks point to a relatively uniform dissociation of the organic matter in the sample with the exception of m/z 386 from cholesterol. Peaks m/z 129 (general marker for fatty acids) and m/z 284 from stearic acid point to sequestered fatty acids. M/z 117 (from tryptophane) and m/z 27 are evidence for proteins. Further inspection of figure 20a.3 demonstrates a rich peak pattern. The zone is interpreted as a DTMS of a charred protein possibly mixed with some plant oils. The scan range from 59-73 shows a peak pattern from dehydrated phytosterols (C27:368;

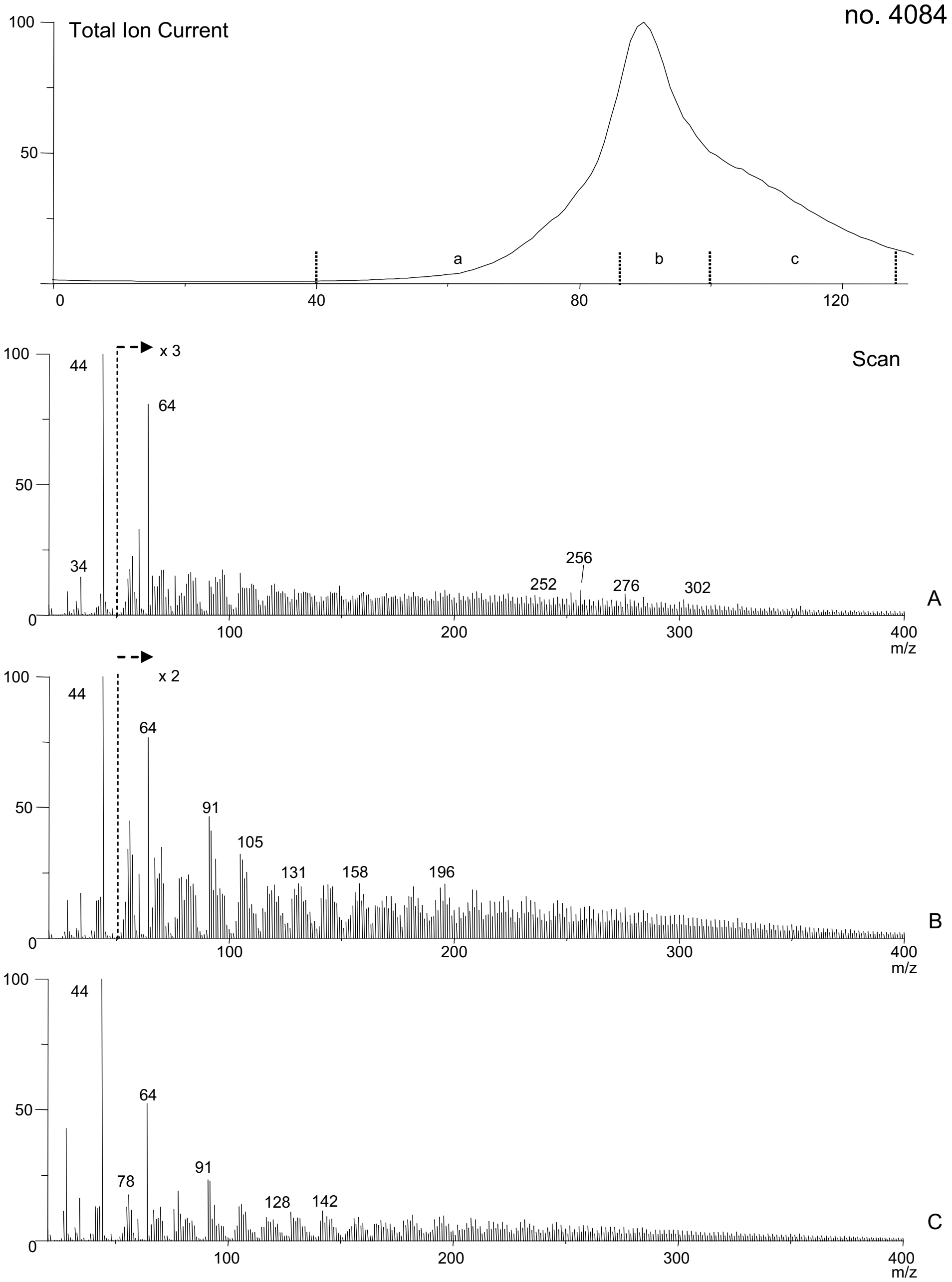

Figure 20a.2a

C28:382 and C29:396) and an oxycholesterol at m/z 400. The highest peak at m/z 386 in combination with 368 points to cholesterol. There are several peaks from fatty acids such as m/z 256 (C16:0), 264 (acylium ion of C18:1), m/z 280 (C18:2, but more likely a dehydration product of OH-C18:1) and 284 (C18:0). The fatty acid moieties in this sample shows a remarkable degree of preservation. I suspect that this is caused by the very abundant presence of reduced sulfur evidenced by m/z 34 (H_2S) and 64 (S_2) with its isotope at 66. No acyldiglycerides were observed suggesting that the fatty acids are eliminated directly from the organic matter.

In conclusion: sulfur plays a role in the preservation of the unsaturated fatty acids and sterols. The observed composition points to a plant oil source. There are no preserved diglycerides that could support a milk source for the lipids.

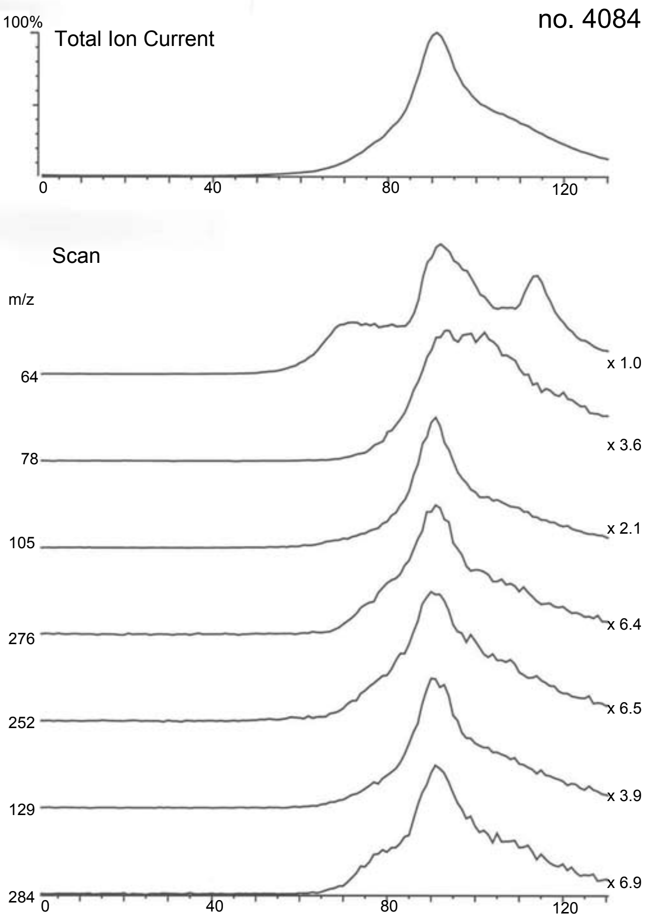

Figure 20a.2b

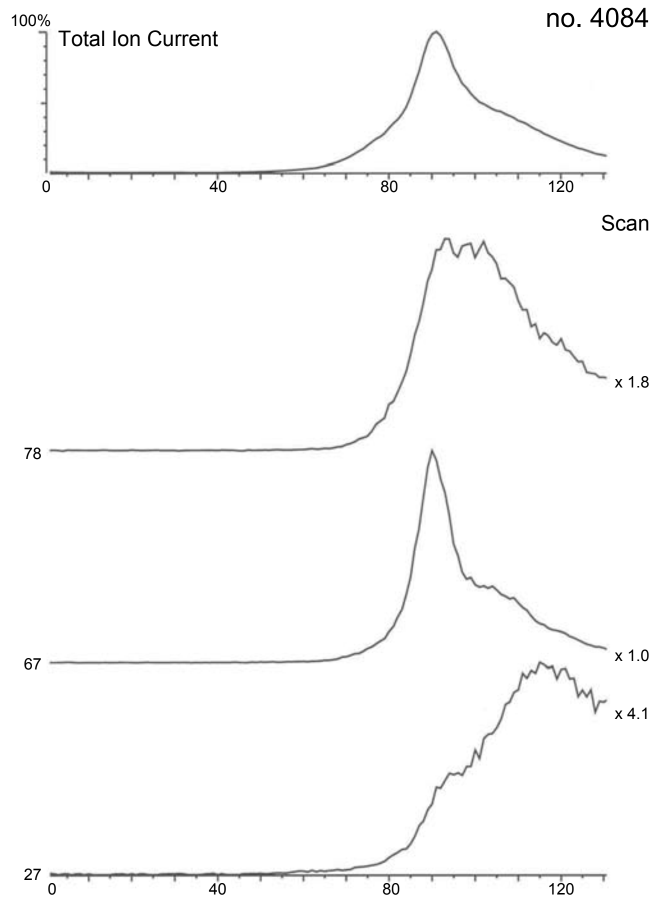

Figure 20a.2c

Figure 20a.2 DTMS data of Schipluiden no. 4084 charred material on pottery.

a Total ion current profile and the mass spectra summarised over in the scan ranges A, B and C.

b Mass chromatograms of selected single ion profiles plotted as a function of temperature showing fatty acids (m/z 129 and 284), polycyclic aromatic hydrocarbons (m/z 252 and 276) and condensed fractions (m/z 105 and 78). Mass 64 is indicative for various forms of sulfur compounds because of its multiple peak profile. The profiles are normalized to maximum intensity per channel hence the multiplication factors.

c Mass chromatograms as selected single ion profiles as a function of temperature of charred proteins (m/z 27 and 67) and condensed fractions (m/z 78).

The combination of proteins and plant oil derived compounds suggest that plant seeds might be the source of the organic matter.

Sample no. 7163; DTMS code 11nov04010

The TIC is very broad. The spectral data (20-75) suggest strongly the presence of soot by the PAH with molecular ions at m/z 252, 276, 302, 326 (see also fig. 20a.4). These compounds desorb clearly before the dissociation event from the charred protein. The thermal behaviour of m/z 64 that shows five separate elimination events is extremely peculiar and points to multiple forms of sulfur. There are some tiny amounts of sequestered C16:0 and C18:0 fatty acids.

In conclusion: no evidence for starch, but clearly evidence for charred proteins and soot.

Sample no. 9381; DTMS code 11nov04009

The DTMS data in the lower temperature range (see fig. 20a.5) shows evidence for cholesterol (m/z 386 and 368), oxycholesterol (m/z 400) and phytosterols (m/z 382 and 396). The sterols evaporate already in the scan range of

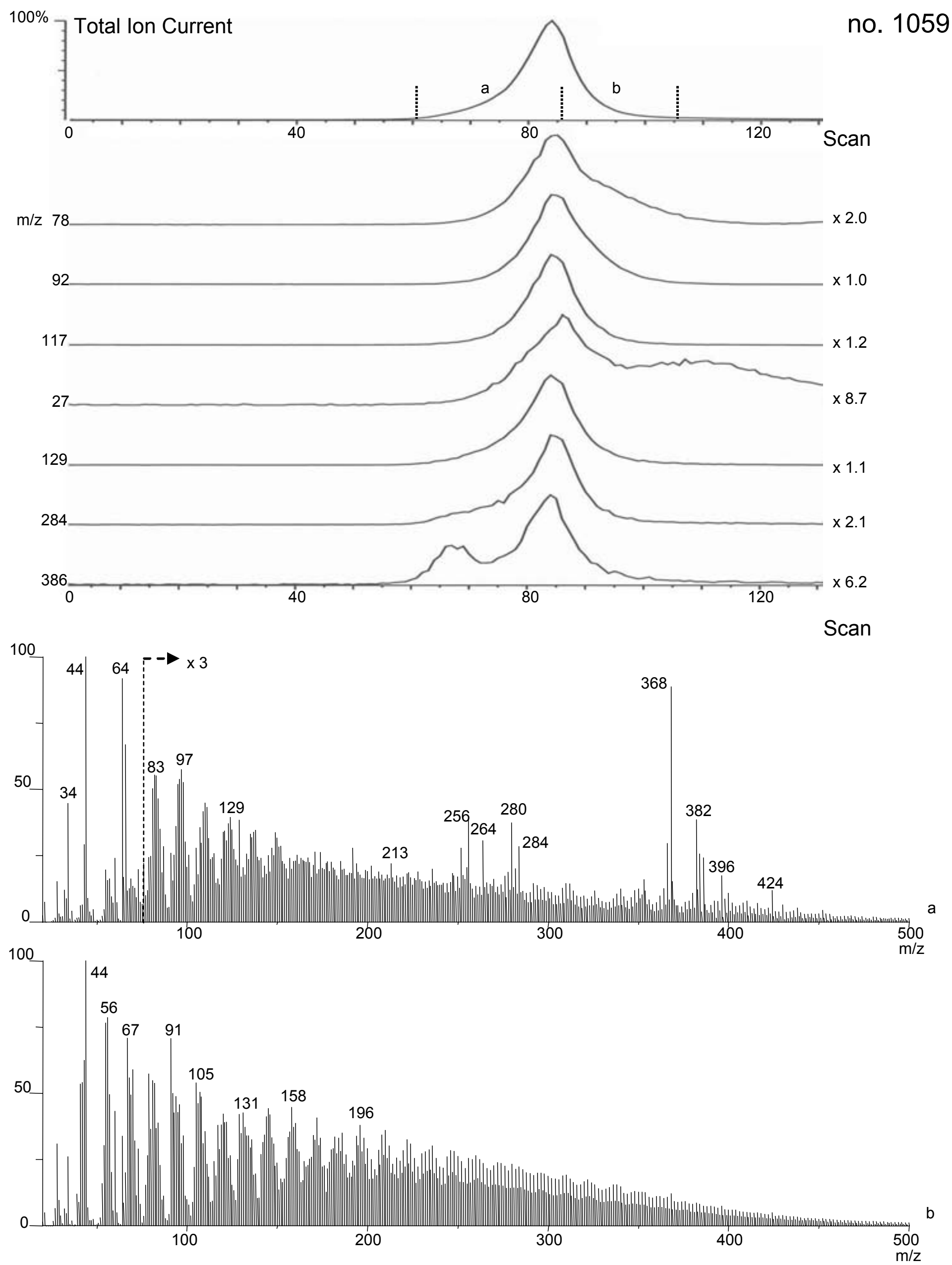

Figure 20a.3 DTMS data of Schipluiden no. 1059 charred crust on pottery showing a total ion current trace, mass chromatograms and summary spectra over scan range a and b. The mass chromatograms of selected single ion profiles plotted as a function of temperature show the profiles of appearance of cholesterol (m/z 386), fatty acids (m/z 129 and 284), charred proteins (m/z 27, 117, and 92) and condensed fractions (m/z 78). The profiles are normalized to maximum intensity per channel hence the multiplication factors.

30-40 (a) which means that they are loosely adsorbed. The fatty acids of this sample show C16:0, C18:0, C18:1 and OH-C18:1 or C18:2 but these are sequestered in the condensed organic matter part of the sample because they appear between scan 50 and 125. The distribution pattern resembles the data from sample 1059. Reduced forms of sulfur also play a role in this sample. The cross-linked material shows evidence for proteins (see fig. 20a.5) mass chromatograms of m/z 117, 67, 27 and the spectra in fig. 20a.5). In this sample some diacylglycerols from C16/C16, C16/C18:1, C16/C18 and C18/C18 are observed pointing to some preservation of the biological glycerol ester bond.

In conclusion: no evidence for carbohydrates and polysaccharides. Evidence for charred proteins in combination with saturated and a monounsaturated fatty acid. Several sterols suggest a plant oil source. The composition of the sample resembles sample 1059.

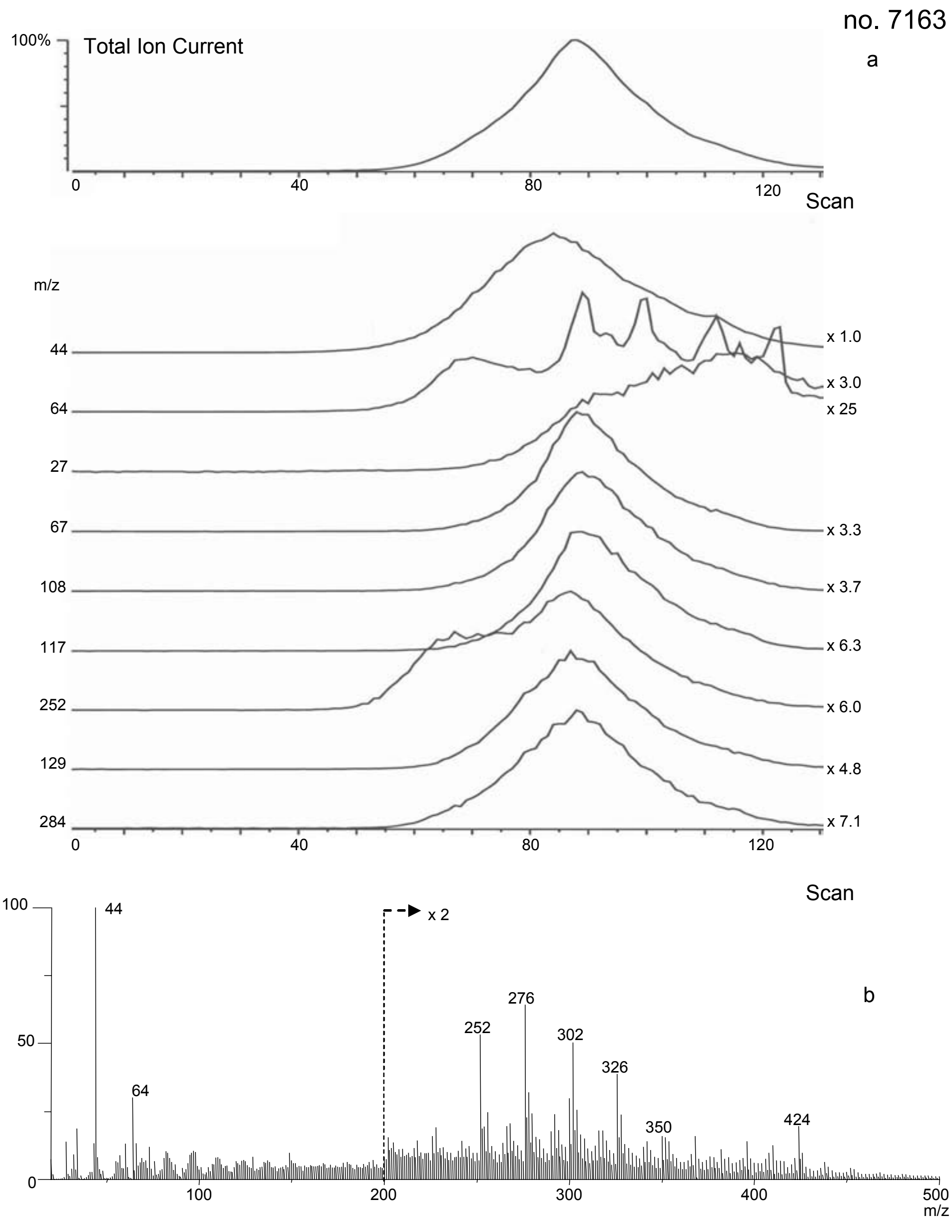

Figure 20a.4 DTMS data of Schipluiden no. 7163 charred crust on pottery showing a total ion current trace, mass chromatograms and the summary spectrum over scan range from 50-90 (b). The mass spectrum (b) shows an intense pattern of polycyclic aromatic hydrocarbons from soot. Note the peculiar multiple peak pattern of m/z 64 pointing to multiple emission events and thus forms of sulfur in the crust. The profiles are normalized to maximum intensity per channel hence the multiplication factors.

20a.4 Final remarks

I have assumed that the samples are not contaminated. The sequestered nature of many features is a kind of guarantee that no foreign materials have been introduced. Sulfur plays presumably an important role in the preservation of the unsaturated fatty acids. In contrast to other residues from the Roman Iron Age analysed earlier by Oudemans, there are very few acylglycerols preserved. Is the soil perhaps rather acidic? This is unfortunate because these compounds play an important role in the identification of animal fats and milk fats. There is no evidence for starch but sample 7292 shows preserved thermally altered lignocelluloses. It is not very likely that this sample represents porridge. The proteins were recognisable by some tracer features but their degree of charring is relatively high.

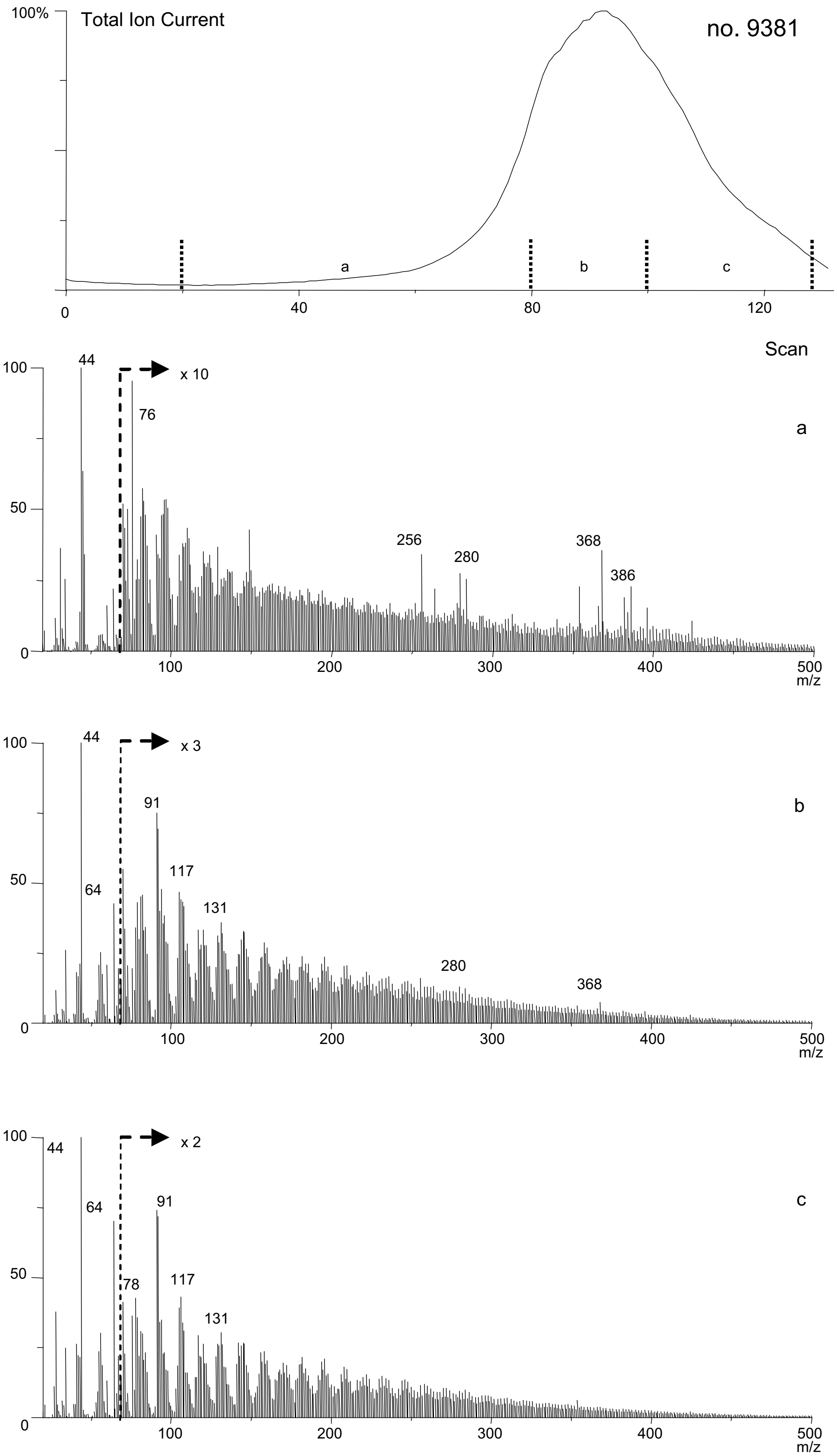

Figure 20a.5 DTMS data of Schipluiden no. 9381 charred material on pottery.
a Total ion current profile and the mass spectra summarised over in the scan ranges a, b and c.

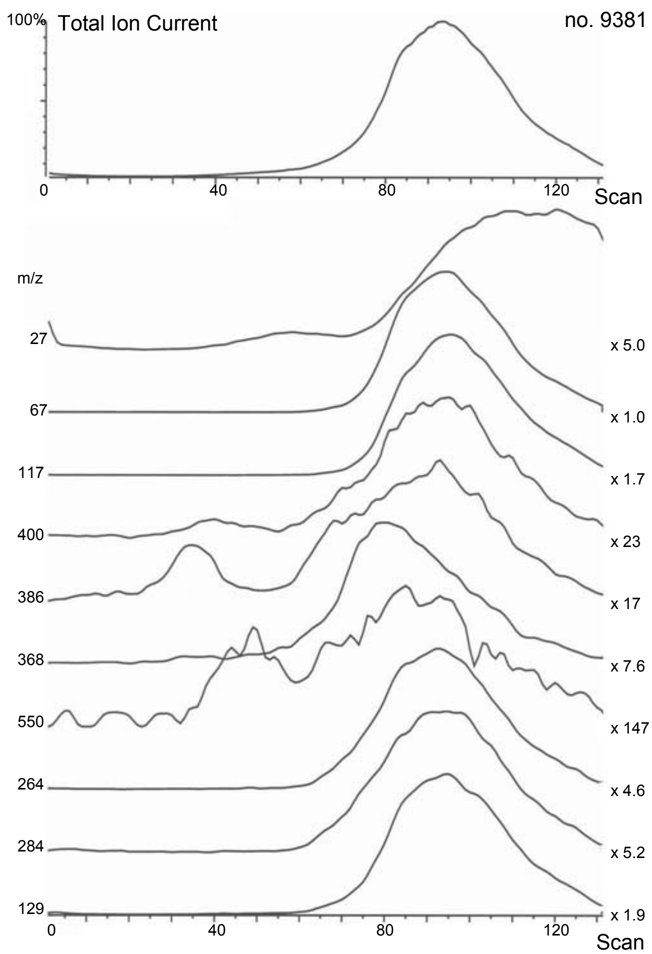

Figure 20a.5 (cont.)
b Mass chromatograms as selected single ion profiles as a function of temperature of fatty acids (m/z 129, 264, 284), diacylglycerols (m/z 550), cholesterols (m/z 368, 386 and 400), charred proteins (m/z 27 and 67) and condensed fractions (m/z 78). The profiles are normalized to maximum intensity per channel hence the multiplication factors.

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21 Wood and charcoal

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Alder (Alnus), *juniper* (Juniperus communis), *Pomoideae and* Prunus *are the most important of the seventeen wood taxa that were encountered on the Schipluiden dune. The range of species is more or less the same in the case of all the distinguished categories and phases. The minimal differences probably have more to do with preferential use of specific wood species for certain applications than with changes in the woody vegetations. Most of the wood species are characteristic of the* Rhamno-Prunetea *class of scrub vegetations typical of dune slopes at some distance from the sea. The junipers also grew in those vegetations. Alder and willow* (Salix) *grew in alder carrs (*Alnetea glutinosae) *on the peat.*

21.1 Introduction

On the basis of the results of the excavation of the Wateringen 4 site, allowance was during the preparation of the Schipluiden excavation made for the possibility of the discovery of wood, but the site was not expected to yield large quantities of wood. Nevertheless, quite a lot of wood was found to have survived in the substantial area covered by the settlement and the associated large dump zones thanks to the waterlogged conditions on the flanks of the dune and in the lowermost features. The recovered wood includes beautifully carved artefacts and posts with pointed ends that formed part of the fences enclosing the dune (see section 11.4.5). Finds of unworked wood – in the form of branches and twigs – provide an impression of the natural tree and shrub vegetation on and around the dune.

Wood in a carbonised form is not dependent on wetland conditions for survival. As charcoal, it is to be found everywhere where a fire once burned and it has not been pulverised by mechanical pressure. Charcoal was indeed found in large quantities on the dune, both in the find layers (section 4.5.6 and 4.6) and in many of the archaeological features, in particular the fills of hearth pits (section 3.5.1). We assume that the firewood was randomly collected in the settlement's surroundings, as is usually the case. If that is correct, the identifications of the firewood also provide information on the woody vegetation in the settlement's immediate surroundings. People may also have needed firewood for specific purposes (for example the smoking of meat), and may in such cases have deliberately selected firewood of a specific type and species.

Wood owes its great importance as a raw material to its many favourable properties. An equally important factor is that the trees and shrubs, that produce the employed wood, are very common in our temperate climate zone. So for most prehistoric cultures the raw material wood was usually literally within reach. Whether this was also the case for the occupants of Schipluiden is not so certain. In phase 1 at least, the dune was surrounded by fairly treeless salt-marsh vegetations, and most woody species probably grew on the slightly higher dunes. In phases 2 and 3 the dune was surrounded by a peat bog and the potential acreage for trees and shrubs increased (see section 14.6).

This chapter discusses the origins of the wood and charcoal and outlines the woody vegetations.

21.2 Materials and method

21.2.1 Wood

All wood on which tool marks were observed in the field was collected, plus some of the wood showing no visible tool marks or signs of use. In total, 660 pieces of wood were examined, 185 of which were artefacts and 475 were pieces showing no, or very few tool marks.

The wood was very irregularly distributed among the distinguished phases. This is due to a major difference between the two dominant contexts: Unit 18 on the southeastern side of the dune and the secondary fill of the pits and wells on the northwestern side. Whereas remains from the beginning of the period of occupation (phases 1-2a and 2a) became incorporated in sediments ensuring their survival, far fewer remains have survived from the end of the period (phases 2b and 3, table 21.1, fig. 21.1).

The wood was initially divided into four categories:

- wooden artefacts, that is, wood that was used to make objects,
- fence posts,
- wood showing marks formed in chopping or carving,
- wood showing no visible tool marks.

It was initially assumed that the wood showing no tool marks derived from trees and shrubs that grew on the dune itself, or that it was washed up on the dune. So it was

	phase	1	1-2a	2a	2b	3	1-3	totals	fence	artef.
alder	Alnus	4	69	79	–	3	4	159	19	19
cornel	Cornus	–	4	3	–	–	–	7	–	–
hazel	Corylus avellana	–	1	–	–	–	–	1	–	4
spindle	Euonymus europaeus	–	4	–	–	–	–	4	1	5
ash	Fraxinus excelsior	–	2	1	–	–	–	3	–	4
juniper	Juniperus communis	4	8	30	2	6	–	50	23	4
privet	Ligustrum	–	1	–	–	–	–	1	–	–
honeysuckle	Lonicera	–	–	–	–	–	–	–	–	1
apple type	Pomoideae	–	11	38	–	–	–	49	4	15
sloe (/cherry/plum)	Prunus (spinosa)	1	18	29	–	–	–	48	42	11
oak	Quercus	–	–	–	–	–	2	2	–	–
purging buckthorn	Rhamnus cathartica	–	–	3	–	–	–	3	–	1
rose	Rosa	–	3	–	–	–	–	3	–	–
willow	Salix (excl. S. repens)	–	22	4	–	–	–	26	2	6
yew	Taxus baccata	–	–	1	–	–	–	1	–	1
elm	Ulmus	–	–	–	–	–	1	1	–	–
guelder rose	Viburnum opulus	–	2	5	–	–	–	7	–	2
	bark	–	11	31	–	1	–	43	–	–
	indet.	–	11	18	1	2	–	32	13	–
Totals		*9*	*167*	*242*	*3*	*12*	*7*	*440*	*104*	*73*

Table 21.1 Unworked natural wood. Wood species versus phase compared with fence posts and artefacts.

assumed that this category in particular would provide information on the local vegetation. In the specific situation of Schipluiden, a large proportion of the apparently unworked wood – branches or trunks, parts of trees and shrubs – could however also very well have been imported by the occupants from fairly distant sources, for example for use as firewood or for fence construction. In that case all the wood found at Schipluiden will more likely represent the high vegetation in the site's wide surroundings. For this reason the two categories ('unworked' and 'showing tool marks') were combined.

The wood was described in the usual manner – *i.e.* the dimensions of each find were specified and the part of the tree or shrub from which it derived. In the latter determination it was assumed that pieces of wood with a diameter smaller than 5 cm are branches, and pieces with a diameter of more than 10 cm are thick branches or trunks. Pieces of wood with a diameter between 5 and 10 cm were interpreted as thick branches or thin trunks. In a few cases the number of annual rings could be determined and the season in which the wood was chopped. The wood species were identified with the aid of a transmitted-light microscope with magnifi-cation up to 400×. The identifications were checked with the aid of the identification literature (Schweingruber 1982) and the reference collection of BIAX *Consult*.

For the discussion of the wooden artefacts, see chapter 11.

21.2.2 Charcoal

All over the site all the find-containing deposits also contained charcoal (section 4.6). The entire site can be said to have been embedded in a blanket of charcoal. Only a small part of all the charcoal – conspicuously large lumps or concentrations – was collected by hand. A representative quantity was moreover spatially recorded in the 4-mm sieved strips. The soil samples taken for the archaeobotanical and archaeozoological analyses of course also contained charcoal.

In selecting charcoal samples for identification, due attention was paid to the distribution among the distinguished occupation phases, and within each phase to a distribution across the different sides of the dune, in order to neutralise any spatial differences. In addition, samples were selected from wells, because they represent a much shorter period of deposition, and of hearth pits, to find out whether specific types of wood were selected for such fires. No samples from phase 2b were selected for various reasons, the most important being that the colluvium of Units 15/16 involved a much greater risk of admixture with older remains than in the case of the larger material categories.

A large proportion of the collected charcoal was not analysed.

It was decided to analyse the charcoal from the layers in the hope of obtaining an understanding of the spatial distribution across the dune per phase. Our efforts were however not entirely successful because fairly little charcoal had

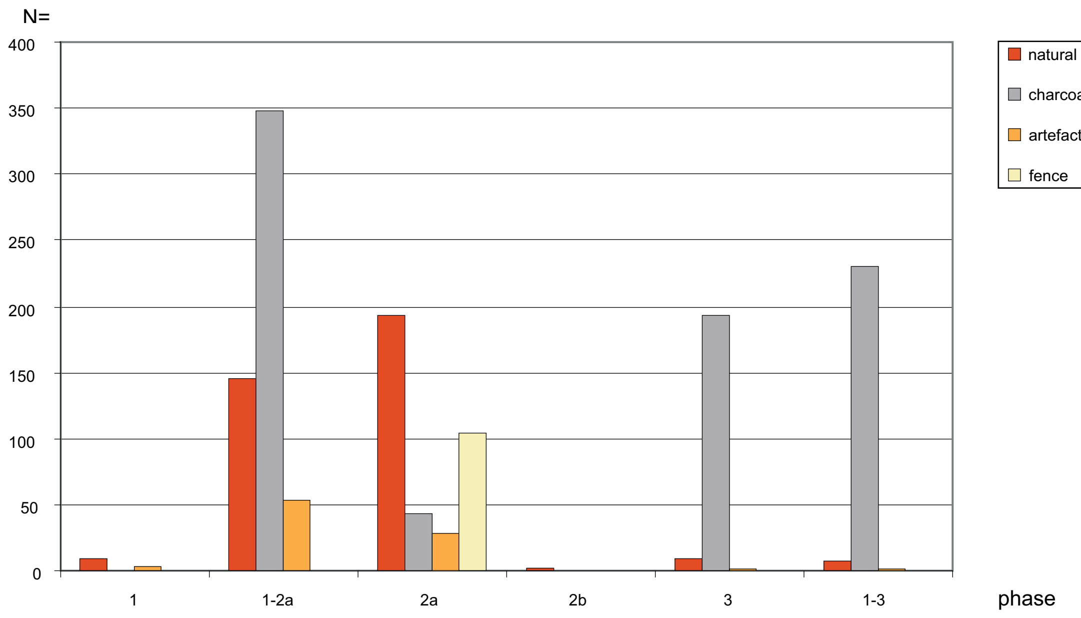

Figure 21.1 Number of wood identifications per wood category showing the unequal coverage of the various phases.

survived from some of the phases, in particular 1 and 2b. We also analysed samples from a few wells and hearth pits and one pit. Differences between the charcoal from the layers and the features could reflect a selective use of wood, in particular of firewood in the hearth pits. In total, 1134 identifications were made.

In charcoal analysis, the number of pieces of charcoal to be identified per context cannot be specified (Heinz 1987; Van Rijn/Kooistra 2001). A hearth pit may for example contain a much narrower range of species than a contemporary find layer due to a selective use of firewood. Usually, the analysis of a sample is discontinued when no new species are for some time encountered in the identification. Experience has shown that in the case of Dutch finds, the identification of 50 to 100 pieces of charcoal per context will usually suffice.

In the analysis of the charcoal samples the wood species was determined, and where possible the part of the tree or shrub from which the wood derived. The charcoal was analysed with the aid of an incident light microscope with magnification up to 400×. The species identifications were checked in the same manner as in the case of the wood samples.

21.2.3 Wood species and wood taxa

In a number of cases it was not possible to identify the wood to species level purely on the basis of anatomical characteristics. This holds for *Alnus*, *Cornus*, *Ligustrum*, *Lonicera*, Pomoideae, *Prunus*, *Quercus*, *Rosa*, *Salix* and *Ulmus*. Various considerations do however allow us to identify likely candidates.

The first of those considerations is the present occurrence of species in the (western) Netherlands. The only *Ligustrum* (privet) species occurring naturally in the Netherlands nowadays is *Ligustrum vulgare* (wild privet); it is likely that this is also the species encountered at Schipluiden. Two *Lonicera* (honeysuckle) species occur in our parts, the general species, especially in the coastal region, being *Lonicera periclymenum* (also referred to as honeysuckle).

The second consideration is the occurrence of seeds among the botanical macro-remains as a frame of reference (chapter 19). Whether the wood represents the same species is of course not certain, but it is very likely. Several species identifications are hence based on this consideration. The genus *Alnus* (alder) was represented only by seeds of *Alnus glutinosa* (also referred to as alder) and the genus *Cornus* (cornel) only by seeds of *Cornus sanguinea* (dogwood). Of the family group of Pomoideae only the berries, pips and fruits of *Crataegus monogyna* (hawthorn) and *Malus sylvestris* (crab apple) were found. The wood of *Prunus* (cherry/plum/sloe) can be identified to species level in a non-committal way. At Schipluiden, only the wood of sloe (*Prunus spinosa*) was positively identified. This is in accordance with the many sloe stones found at the site.

The other botanical material categories yielded no further indications of willow. It may however with some certainty be assumed that creeping willow (*Salix repens*) did not grow at Schipluiden. This low shrub has branches with a diameter of only one centimetre and the branches found at Schipluiden are much thicker.

In some cases samples could not be identified to species level with certainty. Such uncertain identifications are usually referred to by 'cf.'. For convenience of comparison, the uncertain identifications have been grouped under 'indet.' in the tables.

21.3 Results

21.3.1 The wood species per phase (figs. 21.2-3)

The 'unworked' natural wood, the charcoal and the wooden artefacts in principle provide different, complementary pictures of the tree and shrub vegetation. The species spectrum of the wooden artefacts is in principle biased due to (preferential) use of specific types of wood and import from distant sources. If we assume that the charcoal was formed in deliberately made fires and by accidental burning, then we must also assume that the charcoal spectra are probably biased due to the selection of specific types of firewood. The natural wood, finally, may – like the firewood – derive from a wide zone around the dune, which can be interpreted as the central part of the group's daily territory, up to a distance of one hour's travelling or 'a few' kilometres.

The unworked wood provides good information on the first occupation phases (table 21.1). There are five dominant species: alder, Pomoideae, *Prunus* (sloe, plum, cherry), juniper and willow. They will have determined the character of the surrounding vegetation. In addition, a large range of shrubs were represented (each identified in several samples), plus three deciduous trees (*Quercus*, *Fraxinus excelsior*, *Ulmus*) and – remarkably – yew. The greater part of the wood derived from trunks and branches (table 21.2). The scarce data available on phase 1 show that the main tree species were to be found in the area already at the beginning of the occupation period. The evidence on the later phases shows no deviations from these ratios.

The charcoal identifications essentially reveal the same picture for the investigated phases (table 21.3). Of the five dominant species, only juniper was less frequently identified in the charcoal samples. This means that the firewood was randomly selected, except that juniper was not, or only rarely used for making fires. Also conspicuous in the earliest spectrum is the high frequency of purging buckthorn (*Rhamnus cathartica*), for which we have no obvious explanation. Even more surprising is the biased composition of the firewood in each of the four analysed hearth pits. 87% of the charcoal in one of these pits was found to derive from Pomoideae, 84% of that in another pit derived from *Prunus*

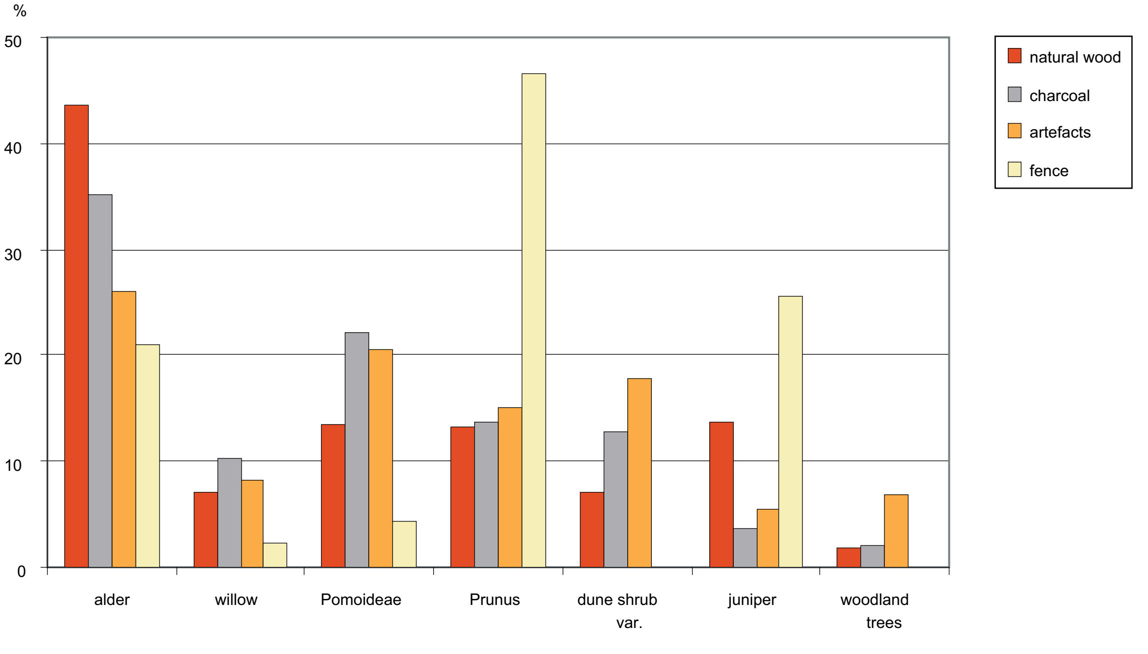

Figure 21.2 Representation of the various wood species in different wood categories. Note the preference for *Prunus* and juniper for the fence posts and the relative importance of alder in all categories.

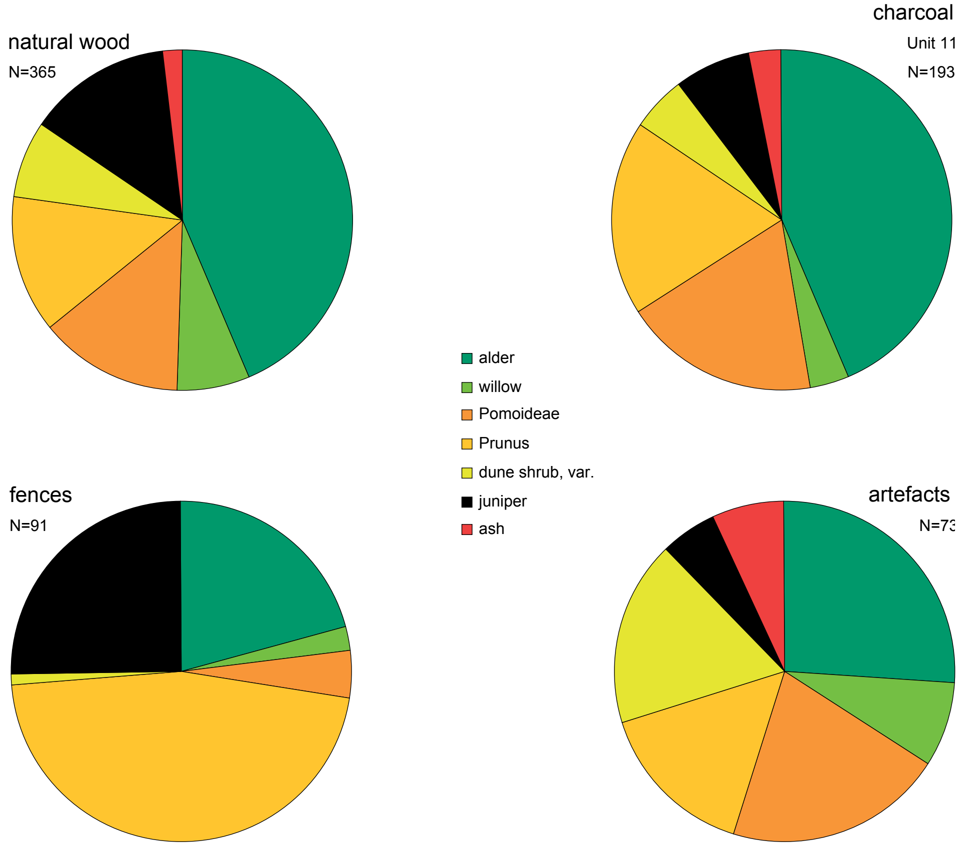

Figure 21.3 Proportions of the main wood species in the different wood categories. Note the comparable compositions of the natural wood and charcoal samples and the selective use of wood for fence posts and artefacts.

and 74 and 80% of the charcoal of the other two pits derived from alder. This is however probably not attributable to a selective use of firewood as alder yields firewood of rather poor quality (Taylor 1981, 45). The three species are moreover the most commonly occurring species at Schipluiden. All that can be said with certainty is that the people who made these fires did not use mixtures of the different species, which suggests that the firewood was collected in different parts of the surrounding area.

The greater part of the identified charcoal derived from branches and twigs, so we may assume that the occupants regularly went on wood-gathering expeditions in their site's surroundings.

The ends of the wooden fence posts constitute a separate source of information within the category of artefacts. They reveal a large-scale, low-profile, utilitarian use of the available wood. We see no evidence of distinct preferences for specific types of wood. Use was made of thin trunks/thick branches of the four prominent species, with a shift in emphasis towards juniper at the expense of Pomoideae. Willow wood was used only once. Perhaps willow was considered unsuitable for fence posts, or perhaps it was reserved for other applications. We may assume a comparable use of wood for the houses. This is indeed confirmed by the Wateringen 4 house, which had (thick) central roof supports made of alder and wall posts consisting of thinner juniper trunks. See chapter 11 for the use of wood for artefacts.

Remarkable is the large proportion of wood of branches or thin trunks (tables 21.2 and 21.4). The high percentage of branches and twigs among the firewood can be easily explained by the gathering of dead wood for fires. The fact that many of the artefacts were made from branches or thin trunks seems strange on the face of it. It implies that no thick trees – other than alder and the Pomoideae – grew in the dune's surroundings.

Most of the wood taxa encountered indeed derive from shrubs and low trees, which do not usually develop thick trunks. When the annual rings were counted, it was found

	tree element	trunk	tr/br	branch	gnarl	root	?	totals
alder	Alnus	2	24	108	2	1	22	159
cornel	Cornus	–	–	7	–	–	–	7
hazel	Corylus avellana	–	–	1	–	–	–	1
spindle	Euonymus europaeus	–	2	2	–	–	–	4
ash	Fraxinus excelsior	1	1	–	–	–	1	3
juniper	Juniperus communis	2	9	28	–	–	11	50
privet	Ligustrum	–	–	1	–	–	–	1
apple type	Pomoideae	3	5	30	–	–	11	49
sloe (/cherry/plum)	Prunus (spinosa)	1	5	39	–	–	3	48
oak	Quercus	1	–	–	–	–	1	2
purging buckthorn	Rhamnus cathartica	1	2	–	–	–	–	3
rose	Rosa	–	–	3	–	–	–	3
willow	Salix (excl. S. repens)	–	3	23	–	–	–	26
yew	Taxus baccata	–	–	–	–	–	1	1
elm	Ulmus	–	1	–	–	–	–	1
guelder rose	Viburnum opulus	–	–	6	–	–	1	7
	bark	38	2	–	–	–	3	43
	indet.	3	5	11	3	1	9	32
Totals		*52*	*59*	*259*	*5*	*2*	*63*	*440*

Table 21.2 Unworked wood. Wood species versus tree elements.

	phase / feature	1	1-2a	2a	2b	3	1-3	hearth pits 15-89	17-253	21-75	2-99	pit 15-80	totals
alder	Alnus	–	80	26	–	84	93	39	4	35	5	4	370
cornel	Cornus	–	4	–	–	1	6	–	–	–	–	–	11
hazel	Corylus avellana	–	1	–	–	–	–	–	–	–	–	–	1
spindle	Euonymus europaeus	–	1	1	–	–	1	1	–	–	–	–	4
ash	Fraxinus excelsior	–	–	–	–	6	9	–	–	–	–	–	15
juniper	Juniperus communis	–	2	–	–	14	14	1	–	3	–	–	34
privet/honeysuckle	cf.Ligustrum/Lonicera	–	–	–	–	2	–	–	–	–	–	–	2
apple type	Pomoideae	–	95	4	–	36	43	2	–	–	48	15	243
sloe (/cherry/plum)	Prunus (spinosa)	–	31	7	–	36	36	–	43	3	–	8	164
oak	Quercus	–	1	–	–	–	1	–	–	–	–	–	2
purging buckthorn	Rhamnus cathartica	–	69	2	–	5	13	–	4	–	–	13	106
rose	Rosa	–	–	–	–	–	–	–	–	–	–	–	–
willow	Salix (excl. S. repens)	–	60	3	–	7	13	6	–	–	2	21	112
yew	Taxus baccata	–	–	–	–	–	–	–	–	–	–	–	–
elm	Ulmus	–	–	–	–	–	–	–	–	–	–	–	–
guelder rose	Viburnum opulus	–	4	–	–	2	1	–	–	–	–	–	7
	bark	–	–	–	–	–	–	–	–	–	–	–	–
	indet.	–	27	–	–	19	4	4	–	3	–	6	63
Totals		–	*375*	*43*	–	*212*	*234*	*53*	*51*	*44*	*55*	*67*	*1134*

Table 21.3 Charcoal. Wood species versus phase compared with some hearth pit samples.

	tree element	trunk	branch	twig	gnarl	root	?	totals
alder	Alnus	10	39	13	30	1	277	370
cornel	Cornus	–	2	4	–	–	5	11
hazel	Corylus avellana	–	–	–	–	–	1	1
spindle	Euonymus europaeus	–	1	–	–	–	3	4
ash	Fraxinus excelsior	3	1	–	2	–	9	15
juniper	Juniperus communis	–	12	8	3	–	11	34
privet/honeysuckle	cf.Ligustrum/Lonicera	–	–	2	–	–	–	2
apple type	Pomoideae	8	34	40	7	–	154	243
sloe (/cherry/plum)	Prunus (spinosa)	2	37	7	12	–	106	164
oak	Quercus	1	–	–	–	–	1	2
purging buckthorn	Rhamnus cathartica	2	29	5	–	–	70	106
rose	Rosa	–	–	–	–	–	–	–
willow	Salix (excl. S. repens)	–	12	17	1	–	82	112
yew	Taxus baccata	–	–	–	–	–	–	–
elm	Ulmus	–	–	–	–	–	–	–
guelder rose	Viburnum opulus	–	–	–	–	–	7	7
	bark	–	–	–	–	–	–	–
	indet.	–	1	3	12	–	47	63
Totals		*26*	*168*	*99*	*67*	*1*	*773*	*1134*

Table 21.4 Charcoal. Wood species versus tree elements.

that even some of the thin branches were many years old. Apparently local growing conditions were not optimum. That would indeed be in accordance with the almost complete absence of large deciduous trees (ash, oak and elm). Finally, no relation was observed between branch thickness and the number of annual rings. There would have been such a relation if the occupants had fairly regularly lopped branches from the same trees and bushes. Although few data are available on annual rings, it would seem that the people living on the dune had at their disposal wood of fully-grown low trees and shrubs and did not always gather their wood from the same grove.

21.3.2 Comparison with Wateringen 4

At the nearby contemporary, very comparable, but much smaller site of Wateringen 4 the zone in which waste was dumped extended only a short way into the surrounding marsh. There, wood had survived only in a few pits and in some postholes of structures, among which was a small house. 77 pieces of wood were analysed, including 15 pointed posts, and 65 pieces of charcoal were identified (Raemaekers *et al*. 1997, 159; Hänninen/Vermeeren 1995). The results agree largely with those of Schipluiden: alder, juniper, Pomoidea and *Prunus* are the dominant species and various shrubs were identified which also played a minor role at Schipluiden. Alder and juniper were used for posts for the structures, which is comparable with the use of wood for the fences at Schipluiden. *Prunus* and Pomoideae were evidently considered satisfactory for fences, but not for house construction. A conspicuous difference is however the occurrence of maple (*Acer*), among both the worked (4×) and the unworked (likewise 4×) wood, and oak (*Quercus*), three times among the unworked wood, once as a post and among the charcoal. All but one of the pieces of maple were found within a few metres from one another, along with a plank-shaped artefact measuring approx. 12 × 7 × 1.5 cm that had been meticulously chopped on two sides. The absence of *Acer* at Schipluiden suggests that this piece of wood was imported from elsewhere and was partly or entirely carved at the site.

21.3.3 The Bell Beaker structure

Many centuries after the dune had been abandoned as an occupation area and it had gradually been covered with peat, the site was once more visited by people, who hammered posts into the wet peaty ground, down to the hard sandy subsoil (sections 3.8.7 and 11.6). Twenty-four of those posts were examined. Sixteen were found to be of willow wood and eight of alder. Only in the case of alder had two thick trunks been carved into posts. The other posts were branches or thin posts. In addition, five pieces of unworked wood from Unit 2 were examined, plus a trunk of an oak (*Quercus*) with a diameter of 30 cm and some branches of alder and spindle (*Euonymus europaeus*). As this wood was of a much later date it will not be discussed here.

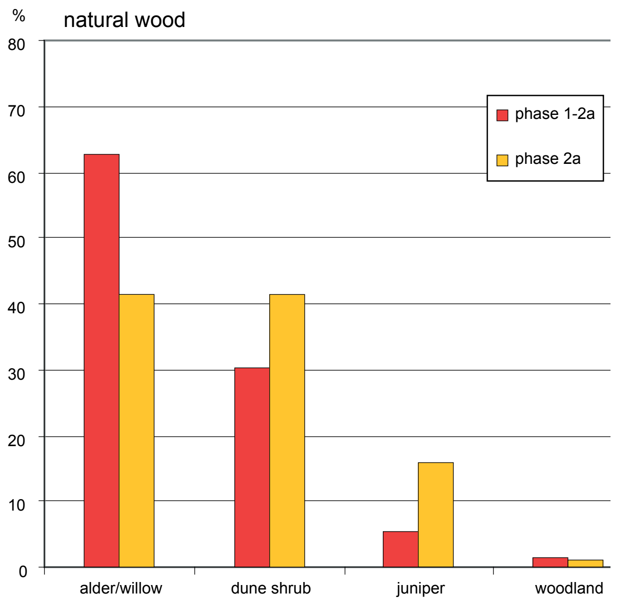

Figure 21.4 Natural wood; main vegetation types represented per phase, *cf* table 21.1.

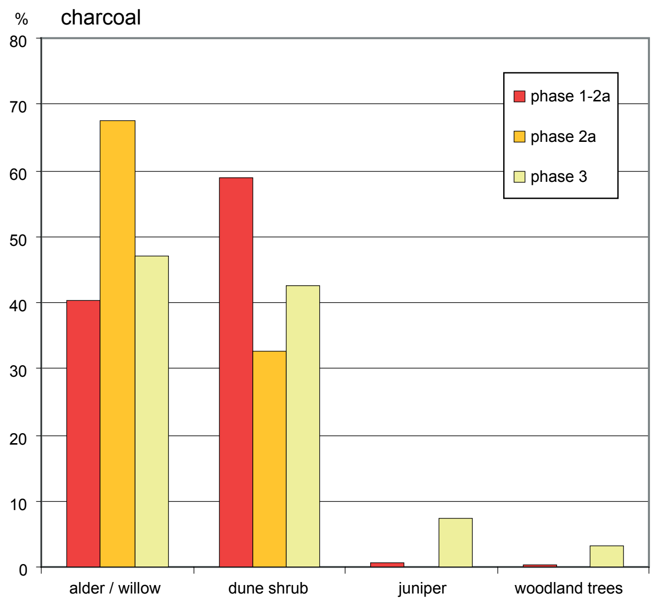

Figure 21.5 Charcoal; main vegetation types represented per phase, *cf* table 21.3.

	dune shrubs	alder carr
Alnus	–	●
Cornus (sanguinea)	●	–
Corylus avellana	●	–
Euonymus europaeus	●	–
Fraxinus excelsior	○	○
Juniperus communis	(●)	–
Ligustrum	●	–
Lonicera	●	○
Pomoideae (*)	●	–
Prunus (spinosa)	●	–
Quercus	○	○
Rhamnus cathartica	●	–
Rosa	●	–
Salix (excl. S. repens)	–	●
Taxus baccata	–	–
Ulmus	○	–
Viburnum opulus	●	○

● dominant
(●) disappeared
○ present
– absent

Table 21.5 Wood species attested at Schipluiden and their occurrence in different types of vegetation.
* = *Crataegus monogyna* and *Malus sylvestris*.

21.4 Conclusion

21.4.1 Woody vegetations (figs. 21.4-5)

In phase 1 the dune formed part of a coastal plain along with other dunes in its wider surroundings (chapter 14). Salt marshes and tidal channels to the northwest and south of the dune dominated the landscape (see fig. 14.7). In phase 2a reed pools began to develop at some distance from the dune (and reed peat began to grow in them), although there were still salt marshes elsewhere. In phase 2 the reed peat continued to grow and the lower parts of the dunes, including that of Schipluiden, disappeared beneath the expanding peat. This process continued in phase 3, until eventually the entire plain had evolved into a reed swamp in which subsequently – in some parts at least – sedge peat began to grow. By the time of the Bell Beaker culture all the dunes in this area had disappeared beneath the peat.

These landscape-genetic data suggest two types of vegetation for the origins of the tree and shrub wood: first of all the *Rhamno-Prunetea* scrub vegetations on the dunes, and secondly the *Alnetea glutinosae* alder carrs on eutrophic and mesotrophic peat. In table 21.5 the identified wood species have been classified according to these two types of vegetation. Only yew grew in neither type. The few pieces of yew wood that were found on the dune may have been imported from elsewhere. It is not inconceivable that efforts were made to obtain yew, because in the Mesolithic and Neolithic it was known that yew wood was particularly

Figure 21.6 Dune shrubs *(Rhamno-Prunetea)* on a low dune ridge in the present-day Kennemer Duinen nature reserve near The Hague as a reference for those in Neolithic Delfland, except for the absence of *Juniperus*.

suitable for the manufacture of bows. Ash, elm and oak are wood species that were used for many purposes. They were however almost totally absent from Schipluiden. Although these species can in principle grow in dune shrubs, and ash and oak also in alder carrs, it is assumed that they were extremely scarce, or even absent in the surroundings of Schipluiden. It would seem that conditions for alder carrs in particular were not optimal in any of the phases. At first the area was regularly flooded by salt water; later on conditions became fresh, but still very wet. The environmental conditions were more favourable for the *Rhamno-Prunetea* on the higher dune tops. This type of vegetation will probably have been affected by the occupants' use of wood, and the rising water will gradually have caused it to decrease in size.

Rhamno-Prunetea (fig. 21.6)
Many of the wood species listed in table 21.5 nowadays form part of the *Rhamno-Prunetea* that occurs on calcareous sand in dune areas (Haveman *et al*. 1999, 121-130). Representatives of dune shrubs are often the first woody species to grow in a saline environment. As the coastline came to lie further away and the landscape became less dynamic, the *Rhamno-Prunetea* changed in composition. The pioneers of the *Rhamno-Prunetea* in the coastal area are sea-buckthorn (*Hippophaë rhamnoides*) and elder (*Sambucus nigra*). The former has often been identified in pollen diagrams of the Dutch coastal area (see for example Jelgersma *et al*. 1970; De Jong/Zagwijn 1983), but at Schipluiden it was only encountered in one of the coprolites, incidentally in

Figure 21.7 Alder carr *(Alnetea glutinosae)* a nature reserve in the Dutch rivers district as a reference for the wooded fenland to the east of the Schipluiden site.

combination with elder (see section 18.4). The almost complete absence of sea-buckthorn confirms that the coastline lay far from the dune at the time when the site was occupied, and that a scrub vegetation typical of mid- and interior dune slopes characterised by a wider ranger of species had by then developed on the dune of Schipluiden and nearby dunes.

Juniper (*Juniperus communis*) is almost completely absent from present-day dune shrubs, except for the odd specimen in the dunes to the south of Katwijk (Zeiler/Kooistra 2002, 10). Things were different in the past. In his book on the island of Texel written at the end of the nineteenth century, the naturalist Jac. P. Thijsse for example speaks of junipers in the Fonteinsnol dunes (Thijsse 1927). The best evidence of junipers in the dunes was however obtained in palynological research. Those data show that juniper was a common species in the dunes until in the Middle Ages. After that time this evergreen species disappeared, probably as a result of the drifting sand that accompanied the formation of the Younger Dunes (Zagwijn 1997, 101-106). The composition of the range of trees and shrubs encountered at Schipluiden suggests that juniper grew in the scrub on the slopes of dunes at a certain distance from the sea, which comprised a broader range of species.

The shrubs of the *Rhamno-Prunetea* were the tallest elements of the vegetation in the dune area, which was otherwise covered with grassland vegetations or consisted of bare sand. The proportion of shrubs in a dune vegetation may vary substantially. It is assumed that representatives of dune shrubs grew here and there on the Schipluiden dune and on nearby dunes. Nowadays dune shrubs are green only in the summer. The presence of the evergreen junipers will undoubtedly have made the Neolithic dune shrubs look quite different from present-day shrubs.

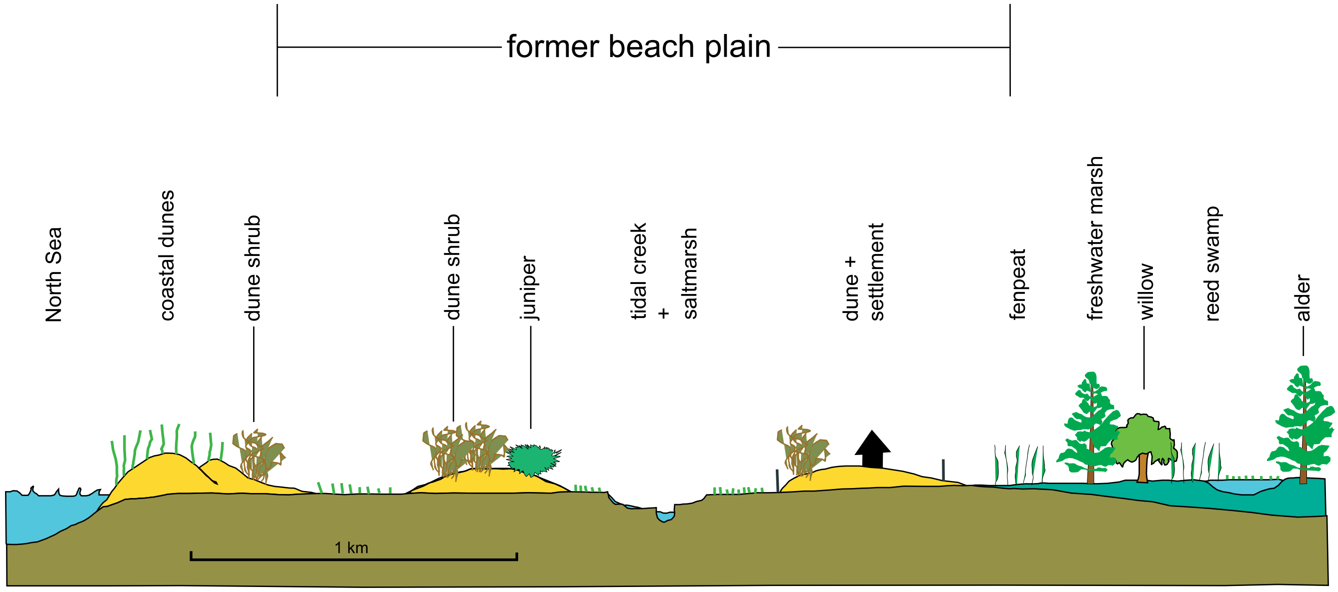

Figure 21.8 Schematic section across the Delfland microregion, *c*. 3500 cal BC, from the coast on the left to the peat fens on the right showing the different types of wood vegetation.

Alnetea glutinosae (fig. 21.7)
Alder, the wood species encountered most frequently at Schipluiden, is the principal representative of alder carrs, followed at some distance by willow (Stortelder *et al.* 1999, 189-193). Both taxa are absent from *Rhamno-Prunetea* dune shrubs.

If the groundwater level remains unchanged, the accumulation of eutrophic and mesotrophic peat will end in the formation of an alder carr. The Schipluiden dune was from phase 2a onwards surrounded by reed and sedge peat (see section 14.7). The dominance of alder and the occurrence of willow make it likely that alder carrs were to be found in this peatland. Unlike those in dune shrubs, the trunks of trees in alder carrs may acquire substantial diameters. It is hence not surprising that at Schipluiden the wood of alders often had the largest diameter.

21.4.2 Woody vegetations in a spatial and chronological context (fig. 21.8)

One of the results of the wood analyses is that the wood supply remained unchanged throughout the entire occupation period. The analyses furthermore showed that the composition of the wood species in the four distinguished categories (artefacts, fence posts, 'partly worked wood' and charcoal) is more or less the same. A third conclusion is that the greater part of the wood consists of thin trunks, branches and twigs. Only in the case of alder, Pomoideae and one ash tree were parts of thicker trunks found. It should however be added that of course only the surviving wood was analysed, and we have no information on the wood that originally stood in the thousands of postholes. The diameters indicate that those postholes held the trunks of fairly large trees.

The species composition implies that the dune shrubs lay some distance from the sea. As far as their situation relative to the coastline is concerned, the Schipluiden dune and the surrounding dunes were suitable areas for these woody vegetations. Alder carrs could theoretically have evolved in parts of the reed and sedge peatland surrounding Schipluiden where the groundwater lay at or below surface level, but the low alder values obtained in the pollen analyses make it unlikely that this was the case. The alders and willows most probably grew a little further east, at the transition of the estuarine zone to the large Holland peat swamp.

Although the wood found on the dune consists predominantly of remains of branches and thin trunks it is not likely that the occupants obtained their wood from sources more than a few kilometres away, because within that distance the landscape – and hence the woody vegetations – began to change. What is surprising is that people continued to gather wood from dune shrubs in phase 3, too, in spite of the advancing peat. Evidently there were still sufficient dunes with tops projecting fairly far above the peat. The many finds of remains of sloes and apples make it likely that some trees or shrubs of these species grew on the dune itself.

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22 Mammals

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The dune occupants met their meat demand via both stock farming and the hunting of wild mammals. The main focus of their stock-farming activities was cattle, while their hunting efforts concentrated on wild boar and red deer. They also kept pigs and supplemented their diet via the more incidental hunting of a broad range of fur animals and marine mammals. Although the proportion of cattle decreased with time, cattle farming remained the main source of animal protein until the end of the period of occupation.

The species spectrum shows that the occupants exploited different ecozones throughout the entire period of occupation: the swamps to the east of the dune, the beach plain and other nearby dunes, the coastal zone and the estuary of the former Meuse.

22.1 Research questions

The numerous, mostly well-preserved animal bones that were found at the Schipluiden-Harnaschpolder site play an important part in the study of the site's Neolithic occupation. This chapter covers the remains of large mammals (domestic animals and hunted wild animals); small mammal remains (rodents and insectivores) will be dealt with in chapter 24. In the context of the main research questions (chapter 1) the data can be used in answering the following questions:

– how important were stock farming and hunting, and how were the different populations of domestic and wild animals exploited?
– what information do the bones provide with respect to the question whether the site was occupied on a seasonal or a permanent basis?
– what information do the mammal remains provide on the former landscape and on the exploited ecozones?
– did any changes take place in the aforementioned aspects throughout the period of occupation?

The answers to these questions may lead to further insight into issues such as permanence versus mobility, site function and the community's position in the neolithisation process.

22.2 Methods

The bones were collected according to the general excavation routine (chapter 1). Different recovery techniques were used with the aim of obtaining a well-controlled group of remains: the entire manually collected fraction of >2 cm and a sample of the 'fine' fractions from the 4-mm sieve and the 'ecosieves' (mesh widths of 1 and 2 mm). The extent to which this aim was realised has been discussed in chapter 4.

The standard procedure was not followed in the analysis of the mammal remains as it would have been impossible to study the vast quantity of remains in that manner within the overall project limits. In view of the large size of the assemblage it was decided to inspect all the remains, but to select only readily identifiable fragments for further analysis. The categories commonly employed in archaeozoological research – 'indeterminate mammal', 'small mammal', 'medium-sized mammal' and 'large mammal' – were not distinguished. This procedure did however yield all data on seasonality, butchering methods and the ages at which the animals were slaughtered, the carving of bone and antler and the spatial distributions of specific categories (including human remains).

So a selection of readily identifiable fragments was made from all the manually collected remains and all the remains recovered from the 4-mm sieve fraction. The same procedure was followed for the remains recovered from the ecosieve residues (1 and 2 mm). The identifiable remains were selected from 138 of the total of 300 samples. In this way more than a quarter of the total number of around 80,000 manually collected remains (of mammals, birds and fish) were selected for identification and just under 10% of the approximately 61,000 remains recovered from the 4-mm sieve fraction. The total number of remains recovered from the ecosieve samples was not counted, but the fraction of identifiable bones among those remains will of course have been smaller than that among the 4-mm sieve residues.

The great majority of the identified mammal remains (approx. 92%) were collected by hand. A little under 8% came from the 4-mm sieve residues and less than 1% from the 1-2-mm sieves. Contrary to what was observed in the case of the bird remains (chapter 23), sieving of the excavated soil through a 4-mm sieve did not prove particularly productive.

The identifications to species/genus/family level were conducted with the aid of the reference collection of present-day bones of the Archaeological Institute of Groningen

University. After the identifications, the fragments were counted and weighed. The identifications and numbers and weights per species yields information on the proportions of the different species in the overall faunal spectrum, and hence on the importance of animal husbandry and hunting in the subsistence system. The species spectrum also provides information on seasonal activities and on the landscape in the site's surroundings.

Noteworthy characteristics (traces of burning, butchering and gnawing) were recorded in order to obtain an impression of taphonomic processes. Pathologies (skeletal deviations caused by sickness, ageing, *etc*.) were also recorded where observed.

Information on the ages at which the animals were slaughtered was obtained via analysis of the fusion stages of the postcranial ('non-skull') bones and of the eruption patterns of teeth and molars. In these analyses use was made of the data published by Habermehl (1975, 1985), Iregren/Stenflo (1982), Iregren *et al*. (2001), Mariezkurrena (1983) and Zeiler (1988).[1]

Information on butchering methods was obtained from the ratios of skeletal elements per species and from the positions of traces of butchering on the bones. Data on the ages at which animals were slaughtered and the employed butchering methods can show how and for what purposes (meat, skins, *etc*.) the different species were exploited. The ages at the time of slaughtering can also yield information on seasonal activities. The criteria formulated by Uerpmann (1973) were used to obtain an impression of the importance of the various skeletal elements in the consumption of meat.

Finally, the method developed by Von den Driesch (1976) was used to measure remains of a limited number of species (dog, wolf, cattle, aurochs, pig and boar) to obtain an impression of the animals' sizes and to distinguish the domestic from the wild species. In some cases the animals' withers height could be calculated on the basis of the measurements. This was done using Harcourt's data for dog (1974), Matolcsi's cattle data (1970) and Teichert's pig and wild boar data (1969). Cattle and aurochs were distinguished on the basis of the data of Degerbøl/Fredskild (1970), and pig and wild boar on the basis of (partly unpublished) data, which were made available by Umberto Albarella (University of Sheffield, UK). The following procedure was followed. First of all, all pig remains were grouped under the heading of 'pig or wild boar'. Then domestic pig remains were distinguished from wild boar remains on the basis of metric data relating to Mesolithic boars from Western and Central Europe (Albarella *et al*. forthcoming). The measurements related to 42 skeletal elements (humerus, astragalus, calcaneus and mandibula), four of which could not be unambiguously attributed to one of the two forms. Of the other 38 measurements, 14 were assigned to pig and 24 to wild boar.[2] To these were added three associated (fitting) elements: one of domestic pig and two of wild boar. The domestic:wild ratio of around 1:1.7 thus obtained was then extrapolated to the 'pig or wild boar' category.

The same procedure was followed for the skeletal fragments that could not be indisputably attributed to cattle or aurochs. As the number of indisputable identifications of cattle greatly outnumbered those of aurochs, all cattle/aurochs remains were categorised as cattle remains.

22.3 Materials

22.3.1 Contexts

The bones were recovered from different contexts. They were first of all the aquatic deposits and the colluvium on

	N=							W=						
phase	1	1-2a	2a	2b	3	1-3	totals	1	1-2a	2a	2b	3	1-3	totals
collected by hand														
Units	185	329	3768	1539	1495	939	8255	7.498	8.094	72.993	13.704	11.797	4.585	118.671
features	5	–	110	–	–	484	599	145	–	5.837	–	–	15.300	21.282
Totals	*190*	*329*	*3878*	*1539*	*1495*	*1423*	*8854*	*7.644*	*8.094*	*78.830*	*13.704*	*11.797*	*19.885*	*139.953*
4-mm sieve														
Units	–	39	4	270	106	321	740	–	16	1	383	50	145	594
features	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals	–	*39*	*4*	*270*	*106*	*321*	*740*	–	*16*	*1*	*383*	*50*	*145*	*594*
1- and 2-mm sieve														
Units	6	1	37	7	6	8	65	57	2	173	5	9	7	252
features	–	–	2	–	–	6	8	–	–	1	–	–	351	352
Totals	*6*	*1*	*39*	*7*	*6*	*14*	*73*	*57*	*2*	*174*	*5*	*9*	*358*	*605*

Table 22.1 Identified mammal remains excluding microfaunal remains, arranged according to recovery technique, context and phase. Weights in grams.

the southeastern and northwestern flanks of the dune. They can be regarded as two variants of the same context, notably the swampy zone at the foot of the dune (chapter 2). The great majority of the identified mammal remains came from these layers (table 22.1) – *i.e.* 93% of the manually collected remains and 89% of the remains recovered from the 1-2-mm sieved samples. All the identified remains from the 4-mm sieve fraction came from these deposits.

The other remains were recovered from features – postholes, ditches and hearth pits, but above all pits and wells. The latter two contexts together accounted for almost 75% of the total number of remains and approximately 87% of the overall weight of the remains manually collected from features. The relatively small numbers of bones found in features indicate that features were relatively rarely used for discarding refuse. Wells were evidently incidentally used for that purpose after they had lost their original function, for example having become saline following a storm flood (see also chapters 25 and 26).

The remains recovered from the aquatic deposits and the colluvium accumulated there over a period of many years, during a long series of depositions, and they therefore

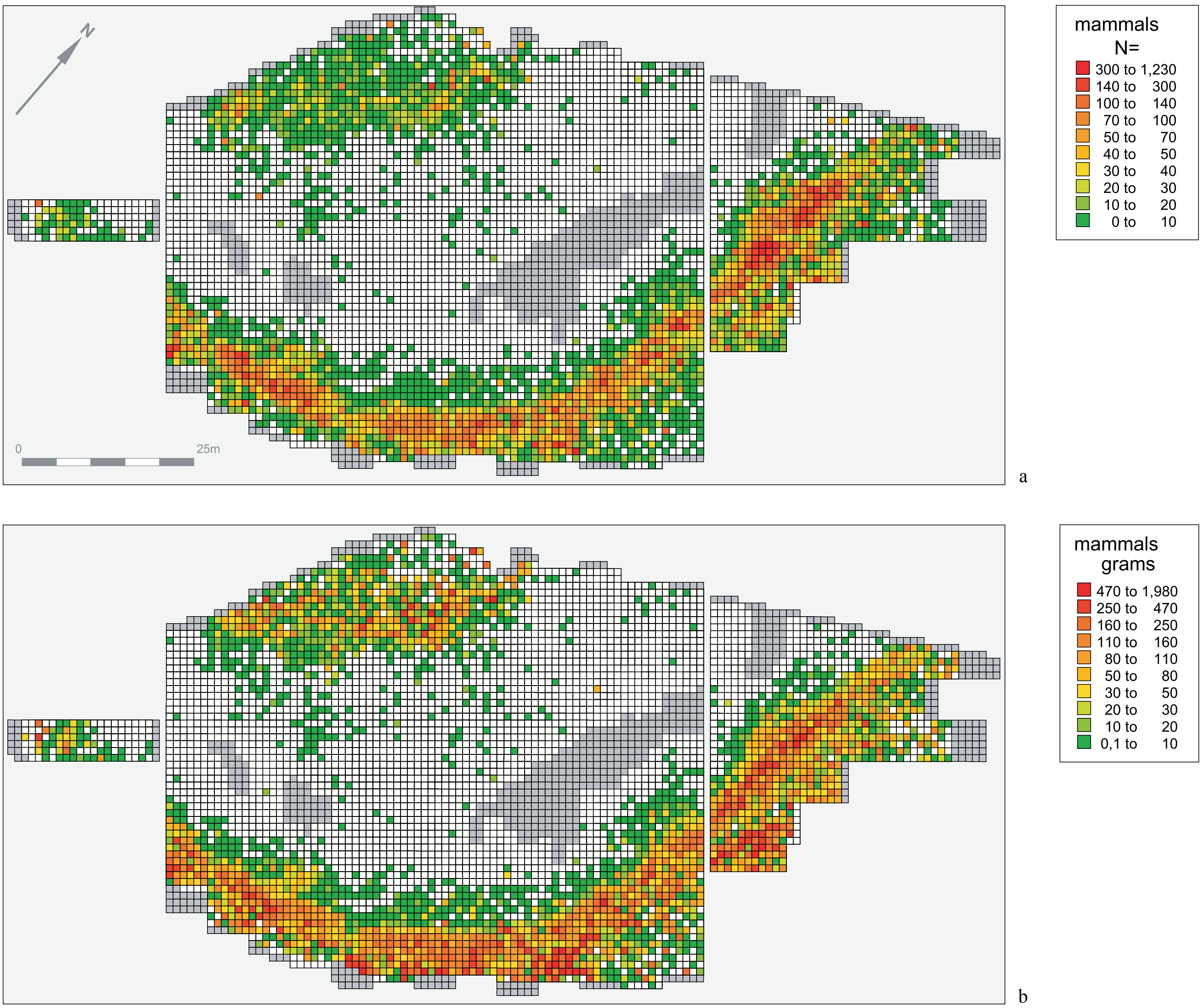

Figure 22.1 Distribution patterns of manually collected mammal remains per square metre.
a number of identified bones
b bone weight

			N=							%						
		phase	1	1-2a	2a	2b	3	1-3	totals	1	1-2a	2a	2b	3	1-3	totals
livestock																
cattle	*Bos taurus*		94	135	1386	486	319	859	3279	54.0	41.8	38.5	36.3	33.3	63.3	42.3
pig	*Sus domesticus*		18	42	493	182	109	89	933	10.3	13.0	13.7	13.6	11.4	6.6	12.0
		Subtotal	*112*	*177*	*1879*	*668*	*428*	*948*	*4212*	*64.4*	*54.8*	*52.2*	*49.9*	*44.7*	*69.8*	*54.3*
dog	*Canis familiaris*		5	44	414	126	187	121	897	2.9	13.6	11.5	9.4	19.5	8.9	11.6
wild ungulates																
aurochs	*Bos primigenius*		2	–	8	–	–	4	14	1.2	–	0.2	–	–	0.3	0.2
red deer	*Cervus elaphus*		25	20	311	121	108	91	676	14.4	6.2	8.6	9.0	11.3	6.7	8.7
roe deer	*Capreolus capreolus*		–	–	1	–	–	–	1	–	–	+	–	–	–	+
wild boar	*Sus scrofa*		28	71	838	304	191	156	1588	16.1	22.0	23.3	22.7	20.0	11.5	20.5
		Subtotal	*55*	*91*	*1158*	*425*	*299*	*251*	*2279*	*31.6*	*28.2*	*32.2*	*31.8*	*31.2*	*18.5*	*29.4*
fur animals																
beaver	*Castor fiber*		2	1	59	38	19	10	129	1.2	0.3	1.6	2.8	2.0	0.7	1.7
otter	*Lutra lutra*		–	5	59	63	17	19	163	–	1.5	1.6	4.7	1.8	1.4	2.1
marten	*Martes sp.*		–	–	1	1	–	–	2	–	–	+	0.1	–	–	+
polecat	*Putorius putorius*		–	3	2	5	1	–	11	–	0.9	0.1	0.4	0.1	–	0.1
fox	*Vulpes vulpes*		–	–	–	–	2	–	2	–	–	–	–	0.2	–	+
wolf	*Canis lupus*		–	–	3	1	–	–	4	–	–	0.1	0.1	–	–	0.1
brown bear	*Ursus arctos*		–	–	9	1	–	–	10	–	–	0.3	0.1	–	–	0.1
wildcat	*Felis silvestris*		–	–	9	9	2	2	22	–	–	0.3	0.7	0.2	0.1	0.3
lynx	*Lynx lynx*		–	–	2	–	–	1	3	–	–	0.1	–	–	0.1	+
		Subtotal	*2*	*9*	*144*	*118*	*41*	*32*	*346*	*1.2*	*2.8*	*4.0*	*8.8*	*4.3*	*2.4*	*4.5*
sea mammals																
common seal	*Phoca vitulina*		–	–	4	–	–	–	4	–	–	0.1	–	–	–	0.1
grey seal	*Halichoerus grypus*		–	2	–	1	–	1	4	–	0.6	–	0.1	–	0.1	0.1
bottle-nosed dolphin	*Tursiops truncatus*		–	–	1	–	1	5	7	–	–	+	–	0.1	0.4	0.1
whale sp.	*Cetaceae*		–	–	–	–	1	–	1	–	–	–	–	0.1	–	+
		Subtotal	*–*	*2*	*5*	*1*	*2*	*6*	*16*	*–*	*0.6*	*0.1*	*0.1*	*0.2*	*0.4*	*0.2*
		Totals	*174*	*323*	*3600*	*1338*	*957*	*1358*	*7750*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
red deer, antler			16	6	278	201	538	65	1104							

Table 22.2 Manually collected mammal remains, numbers of identifications per phase.

present an impression of the overall range of activities in the fields of the butchering, consumption and processing of mammals. Individual disposal activities, in particular of dog remains, were here and there archaeologically visible in the form of concentrations of bones. The remains recovered from pits may have made their way into those pits from surrounding areas or they may have deliberately been discarded there, in which case the pits' contents may reflect short-term specific activities. During the research, efforts were made to identify special deposition patterns. The data relating to the features were however also combined with those obtained for the deposits. In view of their relatively small sizes (6.8% in terms of numbers and 15% in terms of weight), the feature assemblages have fairly little influence on the overall picture.

22.3.2 Spatial distribution

The spatial distribution of the bones shows two concentration zones along the flanks of the dune. There are two explanations for this: the (wet) preservation conditions were most favourable in those parts, and the find situation shows that this peripheral zone of the settlement was used as a waste-disposal area (fig. 21.1). The largest concentrations were in the south and southeast, where 76% of the identified manually collected mammal remains were found. A smaller cluster was observed in the northwestern part. Virtually no animal bones were found higher up the dune. This is largely attributable to the unfavourable preservation conditions in that area. The occupants may moreover have kept their settlement (fairly) clean (see also section 3.4).

22.3.3 Phasing

More than half (52.2%) of the stratified mammal remains date from phase 2a, but a large sample is also available for phases 2b and 3. Only from phase 1 do we have few remains, but nevertheless sufficient for analysis (table 22.1). Insofar as the remains could be dated to a specific phase, phases 2b

		W=							%						
	phase	1	1-2a	2a	2b	3	1-3	totals	1	1-2a	2a	2b	3	1-3	totals
livestock															
cattle	*Bos taurus*	4.908	5.472	46.440	6.632	4.148	14.098	81.697	67.3	67.9	61.5	52.2	42.0	73.7	61.6
pig	*Sus domesticus*	459	363	4.919	1.197	559	949	8.446	6.3	4.5	6.5	9.4	5.7	5.0	6.4
	Subtotal	*5.367*	*5.835*	*51.358*	*7.828*	*4.708*	*15.047*	*90.144*	*73.6*	*72.4*	*68.1*	*61.6*	*47.7*	*78.6*	*68.0*
dog	*Canis familiaris*	144	400	2.751	579	749	565	5.188	2.0	5.0	3.6	4.6	7.6	3.0	3.9
wild ungulates															
aurochs	*Bos primigenius*	120	–	855	–	–	113	1.088	1.6	–	1.1	–	–	0.6	0.8
red deer	*Cervus elaphus*	1.061	761	10.900	1.979	2.983	1.934	19.618	14.6	9.4	14.4	15.6	30.2	10.1	14.8
roe deer	*Capreolus capreolus*	–	–	1	–	–	–	1	–	–	0.0	–	–	–	0.0
wild boar	*Sus scrofa*	545	1.037	8.709	1.967	1.169	1.312	14.738	7.5	12.9	11.5	15.5	11.8	6.9	11.1
	Subtotal	*1.726*	*1.797*	*20.466*	*3.946*	*4.152*	*3.359*	*35.445*	*23.7*	*22.3*	*27.1*	*31.1*	*42.0*	*17.6*	*26.7*
fur animals															
beaver	*Castor fiber*	51	7	462	217	51	60	847	0.7	0.1	0.6	1.7	0.5	0.3	0.6
otter	*Lutra lutra*	–	16	115	100	38	25	294	–	0.2	0.2	0.8	0.4	0.1	0.2
marten	*Martes sp.*	–	–	1	+	–	–	1	–	–	+	+	–	–	+
polecat	*Putorius putorius*	–	1	2	3	1	–	7	–	+	+	+	+	–	+
fox	*Vulpes vulpes*	–	–	–	–	10	–	10	–	–	–	–	0.1	–	+
wolf	*Canis lupus*	–	–	60	9	–	–	69	–	–	0.1	0.1	–	–	0.1
brown bear	*Ursus arctos*	–	–	131	3	0	–	134	–	–	0.2	+	–	–	0.1
wildcat	*Felis silvestris*	–	–	19	18	4	3	44	–	–	+	0.1	+	+	+
lynx	*Lynx lynx*	–	–	1	–	–	1	1	–	–	+	–	–	+	+
	Subtotal	*51*	*24*	*791*	*349*	*102*	*88*	*1.406*	*0.7*	*0.3*	*1.1*	*2.8*	*1.0*	*0.5*	*1.1*
sea mammals															
common seal	*Phoca vitulina*	–	–	8	–	–	–	8	–	–	+	–	–	–	+
grey seal	*Halichoerus grypus*	–	8	–	2	–	42	53	–	0.1	–	+	–	0.2	+
bottle-nosed dolphin	*Tursiops truncatus*	–	–	85	-	17	32	134	–	–	0.1	–	0.2	0.2	0.1
whale sp.	*Cetaceae*	–	–	–	–	148	–	148	–	–	–	–	1.5	–	0.1
	Subtotal	–	*8*	*93*	*2*	*165*	*75*	*343*	–	*0.1*	*0.1*	+	*1.7*	*0.4*	*0.3*
	Totals	*7.288*	*8.065*	*75.459*	*12.705*	*9.875*	*19.133*	*132.525*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
red deer, antler		356	29	3.372	999	1.922	752	7.429							

Table 22.3 Manually collected mammal remains, bone weights in grams per phase.

and 3 were best represented in the 4-mm sieve fraction. This is due to the fact that the clay soils of Units 19 and 18 were not, or virtually not sieved on a large scale. More than half of the identified remains recovered from the 1- and 2-mm sieve fractions, finally, date from phase 2a while only a small number of remains date from the other phases. This unbalanced distribution of the remains from the sieve fractions is attributable to an unequal distribution of samples from the different occupation phases. The same was observed in the case of the bird remains (chapter 23) and the background fauna (chapter 24).

22.3.4 Species spectra

In total, almost 10,000 mammal remains were identified.[3] The identifications of the manually collected bones and the bones recovered from the various sieve fractions are summarised in tables 22.2-6. As already mentioned above, the majority of the identified bones are manually collected remains. On the one hand, these remains show a great diversity, representing twenty species in total, and on the other they are strongly dominated by five species: three domestic species (cattle, pig and dog) and two wild species (red deer and wild boar). They together account for 95% of the identifications. The numbers and weights of pig and wild boar remains are based on the ratio of the two species as inferred from the metric data (see section 22.4.1). The remains recovered from the 4-mm sieve fraction represent eleven species. The diversity of the remains from the 1- and 2-mm sieve samples is the smallest, comprising six species.

These species ratios agree well with those of the nearby contemporary sites of Wateringen 4 (Raemaekers *et al.* 1997) and Ypenburg (De Vries 2004). The more limited species spectra of the latter two sites must be attributable to the fact that the assemblages of those sites are much smaller than that

		N=						%					
	phase	1-2a	2a	2b	3	1-3	totals	1-2a	2a	2b	3	1-3	totals
livestock													
cattle	*Bos taurus*	11	–	72	30	154	267	28	–	27	29	54	38
pig	*Sus domesticus*	5	–	43	16	42	106	13	–	16	16	15	15
	Subtotal	*16*	–	*115*	*46*	*196*	*373*	*41*	–	*43*	*45*	*68*	*53*
dog	*Canis familiaris*	10	1	32	22	7	72	26	–	12	21	2	10
wild ungulates													
red deer	*Cervus elaphus*	–	–	9	–	2	11	–	–	3	–	1	2
wild boar	*Sus scrofa*	9	1	73	28	72	183	23	–	28	27	25	26
	Subtotal	*9*	*1*	*82*	*28*	*74*	*194*	*23*	–	*31*	*27*	*26*	*28*
fur animals													
beaver	*Castor fiber*	–	1	–	–	1	2	–	–	–	–	+	+
otter	*Lutra lutra*	2	1	24	4	4	35	5	–	9	4	1	5
marten	*Martes sp.*	2	–	–	–	–	2	5	–	–	–	–	+
polecat	*Putorius putorius*	–	–	1	–	3	4	–	–	+	–	1	1
weasel	*Mustela nivalis*	–	–	1	–	–	1	–	–	+	–	–	+
brown bear	*Ursus arctos*	–	–	–	–	1	1	–	–	–	–	+	+
wildcat	*Felis silvestris*	–	–	10	3	2	15	–	–	4	3	1	2
	Subtotal	*4*	*2*	*36*	*7*	*11*	*60*	*10*	–	*14*	*7*	*4*	*9*
	Totals	*39*	*4*	*265*	*103*	*288*	*699*	*100*	–	*100*	*100*	*100*	*100*
red deer, antler		–	–	5	3	33	41						

Table 22.4 Mammal remains from the 4-mm sieve residues, numbers of identifications per phase.

of Schipluiden. A comparably broad species spectrum is incidentally characteristic of many Neolithic sites in the Dutch delta area, such as Vlaardingen (Clason 1967), Hekelingen III (Prummel 1987) and Hardinxveld-Giessendam De Bruin (Oversteegen *et al*. 2001).

It should be borne in mind that the tables give only the numbers and weights of the identified remains, and that they provide a biased, indirect picture of meat consumption. The meat of certain species, such as dog, will not have been consumed (section 22.5). Antler was classed as a separate category and antler remains were not included in the totals. The remains in question may after all represent collected shed antler and have nothing to do with meat consumption (section 22.8). Had we counted the (readily identifiable) antler fragments, the score ultimately obtained for deer would moreover have been proportionally much higher than the scores of the other animals.

Another separate class, finally, consists of a few human remains and carved bone and antler fragments, which were all found predominantly among the manually collected remains.[4] They have already been discussed in chapters 5 and 10, respectively.

22.3.5 Differences in identifications between the differently collected remains

The numbers of species identifications of the manually collected remains differ from those of the remains recovered from the sieve fractions (tables 22.2-6; fig. 22.2). In the first place, in terms of percentages, the remains from the 4-mm sieve fraction comprise more than twice as many identified remains of fur animals as the manually collected remains (9% and 4%, respectively). Secondly, the average weight of the remains from the 1-2-mm sieve fractions is much higher than that of the remains from the 4-mm sieve fraction: 8.5 g as opposed to 0.8 g. This is attributable to the difference in sampling method: the sieving (through a 4-mm mesh width) of soil that had already been searched as opposed to the sieving of freshly dug 5-litre samples. This explains why 21 (comparatively) large bone fragments of cattle, pig, wild boar, dog and red deer with a total weight of 588 g. were found among the remains recovered from the 1-2-mm sieve fraction. These fragments are not representative of the fine sieve fractions. Without this component of larger remains the average weight of the remains from the 1-2-mm sieve fraction is 0.3 g.

The low average weight of the remains from the 4-mm sieve fraction is largely due to the large number of fragments of teeth and molars (approximately two-thirds of the total number of identified remains). This high proportion is attributable to the fact that dental elements can be relatively easily identified, even when they are quite small.

An interesting question is how the collection method influenced the ratios of the various species. It goes without

		W=						%					
	phase	1-2a	2a	2b	3	1-3	totals	1-2a	2a	2b	3	1-3	totals
livestock													
cattle	*Bos taurus*	4	–	215	19	101	338	.	.	58	42	73	59
pig	*Sus domesticus*	3	–	36	5	11	55	.	.	10	11	8	10
	Subtotal	*6*	–	*251*	*24*	*112*	*393*	.	.	*68*	*53*	*81*	*69*
dog	*Canis familiaris*	5	+	22	10	2	39	.	.	6	22	2	7
wild ungulates													
red deer	*Cervus elaphus*	–	–	24	–	2	26	.	.	7		2	5
wild boar	*Sus scrofa*	4	+	61	9	19	93	.	.	17	19	14	16
	Subtotal	*4*	+	*85*	*9*	*21*	*119*	.	.	*23*	*19*	*15*	*21*
fur animals													
beaver	*Castor fiber*	–	+	–	–	+	1	.	.	–	–	–	+
otter	*Lutra lutra*	1	–	11	2	1	14	.	.	3	3	1	2
marten	*Martes sp.*	+	–	–	–	–	+	.	.	–	–	–	–
polecat	*Putorius putorius*	–	–	+	–	1	1	.	.	–	–	1	+
weasel	*Mustela nivalis*	–	–	+	–	–	+	.	.	–	–	–	–
brown bear	*Ursus arctos*	–	–	–	–	1	1	.	.	–	–	1	+
wildcat	*Felis silvestris*	–	–	2	1	+	3	.	.	+	2	–	+
	Subtotal	*1*	+	*13*	*2*	*3*	*19*	.	.	*3*	*5*	*3*	*3*
	Totals	*16*	*1*	*370*	*45*	*139*	*570*	.	.	*100*	*100*	*100*	*100*
red deer, antler		–	–	13	5	6	24						

Table 22.5 Mammal remains from the 4-mm sieve residues, bone weights in grams per phase.

saying and is quite understandable that sieving leads to a bias in remains of smaller species, in particular fur animals. It is however not possible to make a direct comparison of the remains collected according to the different methods because the remains recovered from the sieve fractions, coming from a volume of 8% – or 1/12 – of the total volume of soil, were intended to *supplement* the manually collected remains. What the ratios would have been if *all the* soil had been sieved we see if we add the data relating to the sieve residues, multiplied by 12, to those relating to the manually collected remains. Then, all the soil has actually been 'virtually sieved'. The result is presented in table 22.7. Comparison of the outcome of this calculation with that obtained for the manually collected remains reveals only slight differences. The numbers of identifications show a decrease in red deer and increases in pig and wild boar. The fur animals viewed as a group rise from 4.4% to 6.6%, but that is not a dramatic difference either. The weights understandably show virtually no differences: the small bones recovered from the sieve fractions have hardly any influence on the totals. The conclusion is that the collection method does have some influence on the number ratios of the various species, but very little or no influence on the weight ratios. This is something that should be borne in mind in comparing the Schipluiden assemblage with other assemblages, and in comparing sites where remains were exclusively recovered from sieve fractions (Hardinxveld for example) or were exclusively collected by hand (Vlaardingen, Hekelingen).

The remains from the 1-2-mm sieve fraction represent an even smaller sample of the remains originally present (less than 0.1% of the soil volume of the manually collected remains). Small fur animals are surprisingly not as amply represented in the 1- and 2-mm fractions as we would expect (table 22.6). The relatively high weight proportion of cattle, pig, wild boar and red deer is as already mentioned attributable to a number of (comparatively) large bone fragments that are not representative of these fine sieve fractions. All in all the 1- and 2-mm sieve samples yielded little extra qualitative and quantitative information on the large mammals on top of that provided by the manually collected remains and the remains from the 4-mm sieve fractions. So the zoological importance of sieving concerns predominantly birds, the microfauna and fish (chapters 23, 24 and 25).

22.3.6 Differences in identifications between remains recovered from different contexts

There are differences in terms of the composition of the manually collected remains between those from the deposits (units) and those from pit fills. The latter remains for example represent a much narrower range of species than the former (9 as opposed to 20), which will be attributable to

	N=							W=						
phase	1	1-2a	2a	2b	3	1-3	totals	1	1-2a	2a	2b	3	1-3	totals
livestock														
cattle (*Bos taurus*)	–	–	3	1	1	2	7	–	–	14	3	8	327	351
pig (*Sus domesticus*)	2	–	9	2	2	2	17	21	–	3	1	+	2	27
Subtotal	*2*	–	*12*	*3*	*3*	*4*	*24*	*21*	–	*17*	*3*	*8*	*329*	*378*
dog (*Canis familiaris*)	–	–	1	–	–	1	2	–	–	3	–	–	6	9
wild ungulates														
red deer (*Cervus elaphus*)	–	–	8	–	–	1	9	–	–	149	–	–	20	169
wild boar (*Sus scrofa*)	4	–	16	4	3	6	33	36	–	5	1	+	3	46
Subtotal	*4*	–	*24*	*4*	*3*	*7*	*42*	*36*	–	*154*	*1*	+	*23*	*215*
fur animals														
otter (*Lutra lutra*)	–	–	1	–	–	–	1	–	–	+	–	–	–	+
wildcat (*Felis silvestris*)	–	–	–	–	–	2	2	–	–	–	–	–	+	+
Subtotal	–	–	*1*	–	–	*2*	*3*	–	–	+	–	–	+	*1*
Totals	*6*	–	*38*	*7*	*6*	*14*	*71*	*57*	–	*174*	*5*	*9*	*358*	*603*
red deer, antler	–	1	1	–	–	–	2	–	2	1	–	–	–	2

Table 22.6 Mammals remains from the 1- and 2-mm sieve residues, numbers of identifications and bone weights in grams per phase.

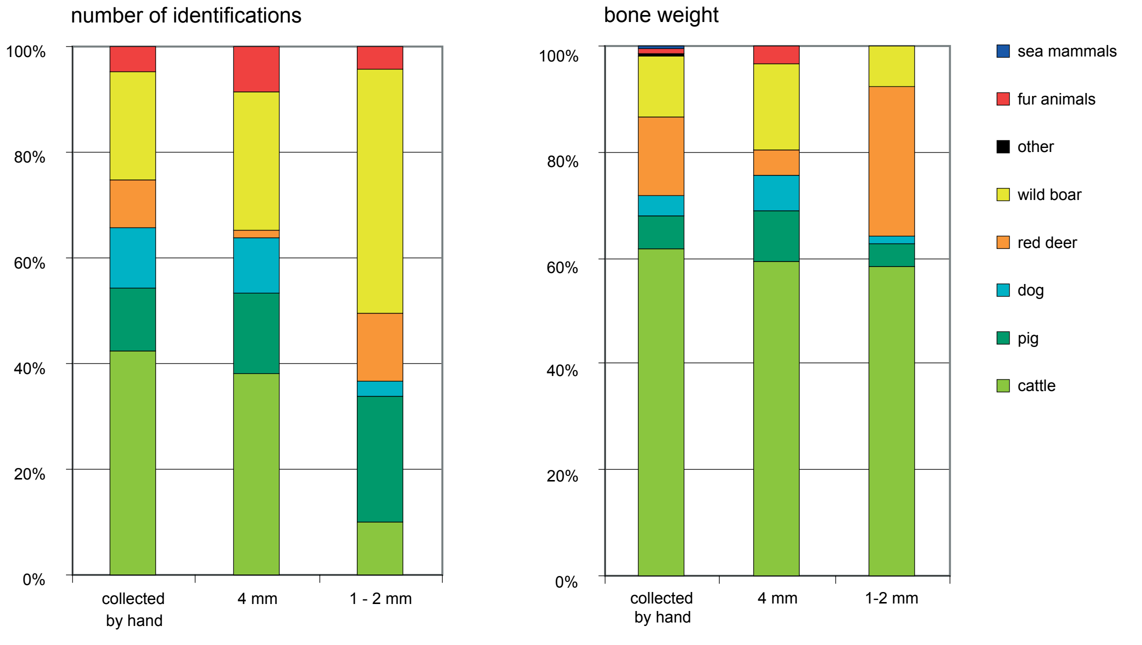

Figure 22.2 Ratios of the most important species and groups of mammals expressed as numbers of identifications and as bone weight, presented according to recovery procedure; all manually collected remains, excluding antler.

the smaller size of the assemblage from pit fills (6.8% in numbers of identifications). Secondly, the average weight of the remains from the pit fills is almost 2.5 times as high as that of the remains from the units (35.5 g as opposed to 14.4 g). An obvious explanation for this is a difference in taphonomy: the remains from the pits will have become incorporated in the soil much sooner, and will have been much less affected by trampling. What will however also be influential factors are differences in the species ranges (fig. 22.3). Remains of smaller mammal species (fur animals)

		N=			%			W=			%		
	phase	hand-coll.	4mm corr. (×12)	totals	hand-coll.	4mm corr. (×12)	totals	hand-coll.	4mm corr. (×12)	totals	hand-coll.	4mm corr. (×12)	totals
livestock													
cattle	*Bos taurus*	3279	3204	6483	42.3	38.2	40.2	81,697	4,055	85,752	61.6	59.2	61.6
pig	*Sus domesticus*	933	1272	2205	12	15.2	13.7	8,446	656	9,103	6.4	9.6	6.5
	Subtotal	*4212*	*4476*	*8688*	*54.3*	*53.4*	*53.9*	*90,144*	*4,711*	*94,855*	*67.4*	*68.8*	*67.5*
dog	*Canis familiaris*	897	864	1761	11.6	10.3	10.9	5,188	469	5,657	3.9	6.9	4.1
wild ungulates													
aurochs	*Bos primigenius*	14	–	14	0.2	–	0.1	1,088	–	1,088	0.8	–	0.8
red deer	*Cervus elaphus*	676	132	808	8.7	1.6	5	19,618	316	19,933	14.8	4.6	14.3
roe deer	*Capreolus capreolus*	1	–	1	–	–	–	1	–	1	–	–	–
wild boar	*Sus scrofa*	1588	2196	3785	20.5	26.2	23.4	14,738	1,116	15,854	11.1	16.3	11.4
	Subtotal	2279	2328	4607	29.4	27.8	28.5	35,445	1,432	36,876	26.7	20.9	26.5
fur animals													
beaver	*Castor fiber*	129	24	153	1.7	0.3	0.9	847	8	855	0.6	0.1	0.6
otter	*Lutra lutra*	163	420	583	2.1	5	3.6	294	164	458	0.2	2.4	0.3
marten	*Martes sp.*	2	24	26	–	0.3	0.2	1	2	4	–	–	–
polecat	*Putorius putorius*	11	48	59	0.1	0.6	0.4	7	12	19	–	0.2	–
weasel	*Mustela nivalis*	–	12	12	–	0.1	0.1	–	1	1	–	–	–
fox	*Vulpes vulpes*	2	–	2	–	–	–	10	–	10	–	–	–
wolf	*Canis lupus*	4	–	4	0.1	–	–	69	–	69	0.1	–	–
brown bear	*Ursus arctos*	10	12	22	0.1	0.1	0.1	134	11	144	0.1	0.2	0.1
wildcat	*Felis silvestris*	22	180	202	0.3	2.2	1.3	44	32	77	–	0.5	0.1
lynx	*Lynx lynx*	3	–	3	–	–	–	1	–	1	–	–	–
	Subtotal	*346*	*720*	*1066*	*4.4*	*8.6*	*6.6*	*1,306*	*232*	*1,638*	*1*	*3.4*	*1.2*
sea mammals													
common seal	*Phoca vitulina*	4	–	4	0.1	–	–	8	–	8	–	–	–
grey seal	*Halichoerus grypus*	4	–	4	0.1	–	–	53	–	53	0.1	–	–
bottle-nosed dolphin	*Tursiops truncatus*	7	–	7	0.1	–	–	134	–	134	0.1	–	0.1
whale sp.	Cetaceae	1	–	1	–	–	–	148	–	148	0.1	–	0.1
	Subtotal	*16*	–	*16*	*0.3*	–	*0.1*	*343*	–	*343*	*0*	–	*0.2*
	Totals	*7750*	*8388*	*16138*				*132,525*	*6,844*	*139,368*			
red deer, antler		1104	492	1596	–	–		7,429	286	7,714	–	–	–

Table 22.7 Mammal remains, total number of remains >4 mm calculated by adding volume-corrected data of the 4-mm fraction to the remains collected by hand.

are conspicuously absent from the pit assemblages (mice and the like are not considered here). Remains of European wildcat constitute approximately 2.5% of the overall assemblage from the units, whereas the remains from the features comprise only two wildcat remains, corresponding to 0.4%. Amounting to around 68%, the proportion of cattle bones among the remains from the features is moreover substantially higher than that among the remains from the units, which amounts to 40%. The proportion of cattle bones from the features is higher in terms of weight, too: approx. 78% as opposed to 62%; all percentages are excluding antler. There is also a difference between the remains from the units and those from the features as regards the ratios of the cattle skeletal elements. This will be discussed further in section 22.3.7.

Within the features, five assemblages with more than 25 identified bones were distinguished. In most of those assemblages, cattle is the dominant species in terms of both numbers and weight, for example in the deposition pit that will be discussed below (feature 12-48). Exceptions are feature 10-140 (a well), which yielded exclusively remains of dog, and feature 21-477 (disturbed by plant growth), in which remains of red deer predominated in quantitative terms. The remains in question are however mainly parts of antler; here, too, cattle is the dominant species in terms of weight. The concentration of dog bones found in feature 10-140 will be discussed further in section 22.5.

22.3.7 Deposition pit 12-48

A remarkable context is a small, deep, low-lying pit dating from phases 1-2a, which is on the basis of a number of exceptional characteristics assumed to have been used for deliberate deposition (feature 12-48, see section 3.5.3). It

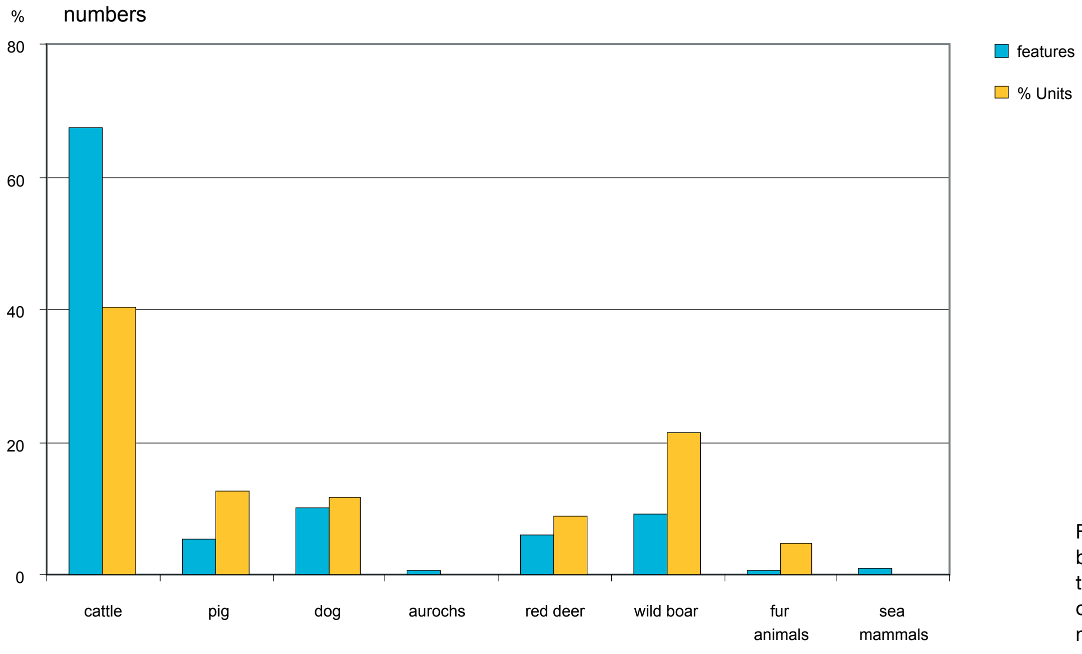

Figure 22.3 Compositions of bone assemblages from features compared with those of assemblages from units; manually collected remains.

may even be associated with the nearby cemetery. It is certainly an unusual archaeological feature that contained a high density of artefacts plus – at a lower level – a large quantity of sloes (section 19.5.1). It would seem that the fruits were the first objects to have been deliberately deposited in the pit, followed shortly after by the bones described here. The contents of the pit seem to reflect a special activity, whose nature is not yet clear.

Besides some remains of flatfish (section 25.5.3), the pit yielded 60 mammal remains. The bones lay so close together as to suggest that they were all simultaneously deposited here. The majority of the remains are cattle bones. The other bones are two pig or wild boar sesamoid bones, one red deer tarsal bone and – interestingly – the skull of a dog. If we assume that the boar and red deer bones ended up in the pit through chance, we are left with a conspicuous combination of exclusively cattle bones and one dog skull, and there is something unusual about both.

In the first place it is evident from the dog skull that the animal concerned was deliberately killed by a hard blow to the left eye socket (fig. 22.9). A dog skull showing similar evidence was found among the remains from Unit 18 on the southeastern side of the dune (see section 22.5).

Equally remarkable is the composition of the 56 cattle skeletal elements (table 22.8). They derive from all parts of the body – the head (including three isolated molars),

	N =			%		
	feature 12-48	other features	total	feature 12-48	other features	total
cranial elements	24	62	86	45.3	32.6	35.4
vertebrae and sacrum	19	8	27	35.8	4.2	11.1
ribs	–	6	6	–	3.2	2.5
scapulae	–	5	5	–	2.6	2
forelegs (humerus, radius, ulna)	2	34	36	3.8	17.9	14.8
pelvis	3	5	8	5.7	2.6	3.3
hind legs (femur, tibia)	1	25	26	1.9	13.2	10.7
lower legs (metapodia, carpalia, tarsalia, phalanges)	4	45	49	7.5	23.7	20.2
Totals	*53*	*190*	*243*	*100.0*	*100.0*	*100.0*

Table 22.8 Skeletal parts of cattle (excluding three isolated teeth) from 'deposition pit' feature 12-48 compared with those from all features.

spine, long bones, pelvis and phalanges – and from at least three individuals, two of which were more than two years old and one younger than 15-18 months (as determined on the basis of the teeth). A pelvis fragment of an animal aged less than 7-10 months may derive from the latter individual. The composition of the remains differs from the general composition of the assemblage from the features in several respects. The proportion of cranial elements may be more or less the same in both cases, but spinal elements were represented in much greater numbers in the deposition pit. Elements from the legs, also the lower legs (butchering remains), are on the contrary conspicuously scarce; the great majority of the bones are to be classed as consumption waste. The assemblage appears to represent the remains of an event during which three heads of cattle were slaughtered, after which most of the parts not containing meat were deposited elsewhere and the bones that did originally contain meat were deliberately deposited in this small pit, along with the skull of a killed dog. This suggests some (extensive) special meal and – in view of the association with the killing of a dog – a certain ritual significance. So the archaeozoological evidence supports the assumption of special deposition inferred from archaeological evidence.

22.3.8 *Taphonomy* (fig. 22.4)

Between the time of an animal's death and the time of the excavation of its remains, various taphonomic processes take places, which all leave specific signs on the bones. The first of those processes are slaughtering (including skinning), consumption and carving of the meat from the bones, which will be visible as cut marks and other traces of butchering. The (discarded) remains will subsequently have been subject to gnawing by animals such as dogs, trampling, burning and weathering. In some cases traces of burning may be associated with consumption, but on the whole, burning will be a secondary process.

Generally speaking, the identified remains are in a reasonable to good state of preservation, in spite of their fairly fragmented condition. In many cases the surface of the bones was found to have suffered no or only very little weathering, and the majority of the dental elements are intact. The percentage of bones showing traces of burning is lowest among the manually collected remains and highest among the remains from the finest sieve fractions. Burning has a strong fragmenting effect, and precisely the smallest fragments are better represented in the finest sieve fractions. On the whole, the percentage of burnt bone is however low, implying that burning played only a modest role in the taphonomic processes. Gnawing marks were found only on manually collected bones; the same holds for traces of butchering, with one exception (table 22.9).

The percentage of bones showing traces of butchering is higher in the case of the bones from the features than in the case of the bones from the units. A possible explanation for this could be that the bones contained in those sealed contexts were less affected by taphonomic processes and hence survived in better condition. Traces of butchering, in particular cut marks, can be more easily identified on bones

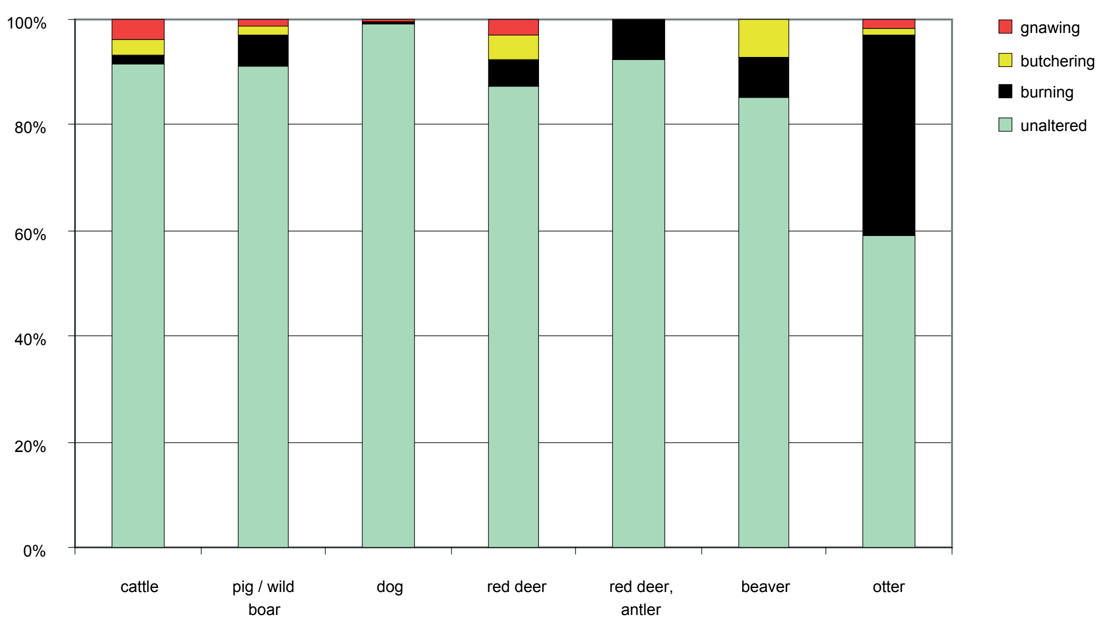

Figure 22.4 Proportions of traces of gnawing, butchering and burning on remains of various mammal species.

	N%		
	burning	butchering	gnawing
hand-collected	4.4	2.1	2.1
4 mm sieve	9	–	–
1 and 2 mm sieve	15.4	0.8	–

	N%		
	burning	butchering	gnawing
Units	4.5	1.9	2.0
features	3.1	4.8	3.6

Table 22.9 Percentages of mammal bones showing traces of burning, butchering or gnawing, presented according to recovery technique and context.

with less weathered surfaces. Secondly, gnawing marks were observed both on the bones from the features and on those from the units; the percentage is even slightly higher in the case of the bones from the features. This means that part, at least, of the butchering and consumption waste did not become buried immediately, but remained within reach of dogs for some length of time.

There are also differences – sometimes quite substantial – between the various animal species (table 22.10). They are partly attributable to the small number of identified remains of some species (aurochs, fox, brown bear, European wildcat and common seal).

Interestingly, hardly any of the dog remains show traces of burning, butchering or gnawing. This means that the carcasses of dogs were treated differently from those of the other species. This will be discussed further in section 22.5. The proportions of bones with traces of burning are in the same order of magnitude in the case of pig/wild boar, red deer and beaver, but the proportion is lower in the case of cattle and remarkably higher in the case of otter. Evidently, the different species were differently processed, and their remains were discarded in different ways. With the exception of that of dog, the percentages of remains showing gnawing marks are in the same order of magnitude.

The traces of burning, butchering and gnawing will be discussed in greater detail in the sections on the individual species (sections 22.4-6).

22.3.9 Pathologies

Pathologies are rare. For a proper understanding, they will be presented together here. Pathologies were observed almost exclusively on bones of domestic animals (cattle and dog). One of the exceptions concerns a thoracic vertebra of a wolf with uncontrolled bone growth along the edges. This phenomenon, which is known as 'lipping', is associated with strain or age. In this case it can be interpreted as an affliction of old age. In addition, a cattle or aurochs phalanx II shows uncontrolled bone growth just under the proximal epiphysis. This may likewise be an affliction of old age, but if the bone concerned derives from a domestic animal, it may also be attributable to strain.

Seven skeletal fragments of cattle (all mature individuals) show pathologies. Three lumbar vertebrae from the same animal show abnormal growth along the edges of the articular facets. The same phenomenon is also observable on a fourth lumbar vertebra. All four vertebrae were found in the same trench (27), but in different layers (16 and 11, respectively), so it is not certain whether they all derive from the same animal. In both cases the cause may have been

	N=				%		
	total	burning	butchering	gnawing	burning	butchering	gnawing
cattle	3279	57	96	123	1.7	2.9	3.7
pig / wild boar	2521	145	38	36	5.8	1.5	1.4
dog	897	1	3	3	0.1	0.3	0.3
aurochs	14	–	1	4	–	–	–
red deer	676	34	32	20	5	4.7	3
red deer, antler	1104	74	–	–	7.4	–	–
beaver	129	10	9	–	7.8	7	–
otter	163	62	2	3	38	1.2	1.8
fox	2	1	2	–	–	–	–
brown bear	10	–	–	1	–	–	–
wildcat	22	1	–	–	–	–	–
common seal	4	3	–	–	–	–	–
Totals	*8821*	*388*	*183*	*190*	*4.4*	*2.1*	*2.2*

Table 22.10 Mammal bones showing traces of burning, butchering or gnawing, presented according to animal species.

Figure 22.5 Pathology on a bovine pelvis. The socket of the femur joint (acetabulum) is badly worn; its surface shows a pronounced gloss; excessive bone growth is visible especially along its rim (scale 1:1).

strain and/or old age. Another abnormality is observable in two lower jaws, from which P1 and P2 are respectively absent. In both cases the associated sockets are absent, too. Whether the animals concerned lost the molars prematurely, after which the cavities became obliterated, or whether they never had the elements in question is not clear. Part of a cattle pelvis, finally, shows a remarkable abnormality. The cavity is very badly worn; part of the surface shows a high gloss and substantial abnormal growth is observable along the edges in particular (fig. 22.5). This animal may have fractured its left hind leg and have borne too much weight on its right leg for quite some time. Such a strain may have caused the aforementioned traumatic phenomena in the cavity of the right half of the pelvis.

None of the observed abnormalities can incidentally be interpreted as a direct cause of death. The pathologies on the vertebrae will have caused some inconvenience, in particular stiffness. The animal with the deformed pelvis must have suffered quite badly and was undoubtedly lame. It is indeed remarkable that the animal evidently continued to live with this defect for a fairly long time.

Pathologies were observed on four skeletal elements of dog. Two lumbar vertebrae had fused and showed abnormal growth along the edges of the articular facets. This will be due to old age. Two lower jaws also show a deformity. In the case of one, P1 is absent and the associated socket is not/no longer visible. The animal may never have had the tooth in question or it may have lost it prematurely after which the cavity became obliterated. A tooth is missing from the other lower jaw, too – in this case M1. The fact that the associated socket is still open and moreover shows some abnormal growth makes it most likely that the animal lost the molar prematurely. In none of the cases will the pathologies have been a direct cause of death, but they will definitely have caused inconvenience or pain.

22.4 Domestic animals: livestock

22.4.1 Introduction

Two livestock species are represented among the Schipluiden mammal remains: cattle and pig. Their remains date from all the occupation phases. Remains of sheep and goat are absent.

Domesticated animals are usually distinguished from their wild relatives on the basis of metric data. That's not always simple when dealing with Neolithic remains due to a certain amount of overlap. This does incidentally not imply a continuous development of measurements without interruptions. In the case of domestic cattle and aurochs, for example, the data published by Degerbøl/Fredskild (1970) show that only the measurements of the largest domesticated bulls and those of the smallest aurochs cows overlap.

The overlap in measurements, which is also observable in (Neolithic) pigs and wild boars, may imply a certain degree of interbreeding between the domesticated and the wild species. Although this is known from the (recent) past in the Netherlands and is still known elsewhere today (Albarella *et al.* in press 1) it cannot be proved for the Neolithic. What seems to have been far more influential – certainly as far as pig and wild boar are concerned – is that in the Neolithic the domestic form was not yet all that different from the wild one. This is further supported by the results of recent research into mitochondrial DNA, which show that wild boars were domesticated in different parts of Europe and at different times (Larson *et al.* 2005).

The amount of overlap between pig and wild boar tends to differ, but it can make it difficult to distinguish between the two. This holds for both Early and Middle Neolithic sites in different parts of Europe (Albarella *et al.* in press 2). It should incidentally be added that the amount of (metric) overlap between the wild and the domestic forms in the various publications is partly dependent on the criteria employed by the researchers concerned (see also Prummel 1987). This is in part associated with the variation in size between the domestic and wild populations in different areas, but also with more subjective aspects. Prummel (1987), for example, employed a much narrower overlap range in distinguishing between domestic and wild pigs at Hekelingen III than, say, Clason (1967) did at Hekelingen I and Vlaardingen.

In the case of Schipluiden the overlap seems to be small, though it should be borne in mind that the measurements relate to only a small number of skeletal elements. As already mentioned in section 22.2, the remains that were initially categorised under the heading of 'pig/wild boar' were divided into domestic and wild boar bones in a ratio of 1:1.7 on the basis of the measurements of 38 bones of adult animals. The same division cannot be applied – excluding the bones that can be identified as deriving from a domestic or a wild animal on the basis of measurements – where the ages at which the animals were slaughtered are concerned or noteworthy characteristics observed on the bones. We are after all not dealing with 'neutral' values such as numbers and weights, but with individual bones, each with their own specific characteristics. For this reason the specific character-istics and data relating to the ages at which the animals were slaughtered will in section 22.4.3 be discussed in relation to the undivided category of pig/wild boar, with all the limitations this implies.

The majority of the cattle and aurochs bones could be easily distinguished. In only a few cases did this prove impossible.

22.4.2 Cattle

With a total of 3279 manually collected bones, cattle is the most prominently represented mammal in the faunal spectrum. This species' remains are not only dominant in terms of number, but above all also in terms of weight. Of nine of the bones it is not certain whether they derive from cattle or from aurochs (Appendix 22.2). The measurements of two skeletal elements (a humerus and a metacarpus) fall in the overlap range between domestic bulls and aurochs cows. The other fragments do differ in size relative to the remains of domestic cattle, but it is not clear whether they derive from aurochs or domestic cattle.

More than half of the total weight of the remains recovered from the 4-mm sieve fraction can be assigned to cattle.

Remains from all the phases derive from all parts of the body (Appendices 22.1a-c), implying that they represent both butchering and consumption remains. There is in this respect however a conspicuous difference between the (manually collected) remains of cattle from the units and those from the pits. The proportion of consumption remains among the bones from the latter context is around 20% higher, the difference concerning mainly skeletal parts containing little meat, and the percentage of butchering remains (horn sheaths and lower legs) is half of that obtained for the bones from the Units (table 22.11; fig. 22.6).

There are ten associations (skeletal parts fitting or belonging together grouped under the same find number) of cattle bones. Seven concern fitting fragments deriving from the same skeletal parts (radius, metacarpus, skull, two mandibulae and two horn sheaths) that were fractured in antiquity. The fracturing will have been postdepositional. The other three associations concern a number of skeletal parts that belong together, indicating that the remains concerned were discarded there immediately after butchering or consumption ('primary deposition'), and did not end up there via secondary processes

	%	
	Units N = 1430	features N = 244
category A, rich in meat	23.2	27.0
category B, poor in meat	36.6	52.5
consumption waste	*59.8*	*79.5*
category C, poor in meat	40.1	20.5
butchery waste	*40.1*	*20.5*

Table 22.11 Remains of cattle (excluding stray teeth N=1605), divided into main processing categories (after Uerpmann 1973).
category A: vertebrae, scapula, humerus, pelvis, femur
category B: head (excl. horn core), ribs, radius, ulna, tibia
category C: horn core, metapodia, carpalia, tarsalia, phalanges

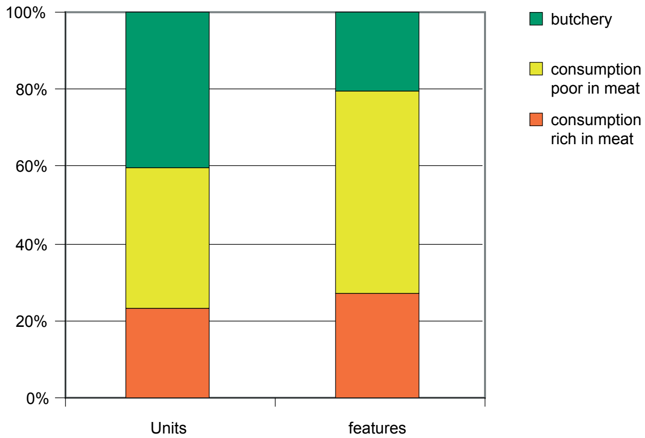

Figure 22.6 Ratios of consumption and butchering waste from units and features.

such as colluviation. Two of these associations come from Unit 18 (phase 2a) on the southeastern side of the dune. They comprise part of the left and right lower legs (metacarpus, metatarsus and carpal) and a fitting radius and ulna. The other association, likewise comprising a radius and an ulna, comes from a well dating from phase 2a (feature 18-8). The most important association is however that from the deposition pit, 12-48.

Withers height and body size
73 postcranial skeletal elements were measured (Appendix 22.2). The measurements are in the same order of magnitude as those obtained for Vlaardingen (Clason 1967), site P14 (Gehasse 1995), Swifterbant S3, Hazendonk and Kolhorn (Zeiler 1997). In two cases the withers height could be inferred from the greatest length of the metatarsus: 117.8 and 129.4 cm. The latter individual was of the same size as an animal at Kolhorn and one at Vlaardingen (129.0 and 130.0 cm, respectively); the other animal was distinctly smaller.

Traces of butchering, burning and gnawing
Traces of butchering, burning and gnawing were observed only on manually collected bones. Just under 60 skeletal remains were carbonised or calcined. All but one (a skull fragment) of the remains concerned are front or hind leg elements. The number of bones showing gnawing marks by dogs is more than twice as high (127); the bones in question are likewise mostly elements from front and hind legs (including the scapula and pelvis). Exceptions are four lower jaw parts and a piece of skull showing a dog's teeth impressions. The number of leg parts (including the scapula and pelvis) may be around 2.5 times higher (Appendix 22.1a), but that does not explain the substantial differences in bones showing signs of burning and gnawing. It would seem that the skull bones – unlike the postcranial elements – were generally discarded out of reach of fire or dogs immediately after butchering, whereas the leg bones were left around on the farmyard for some time.

96 skeletal fragments show different types of butchering marks, from which different activities can be inferred. About half of the marks are cut marks produced in carving the meat from the bones. They were observed for example in the central parts of long bones (humerus, radius, ulna, femur and tibia), but also on some jaws and fragments of shoulder blades. A quarter of the butchering marks are cut marks on elements from the lower legs: metacarpus, metatarsus, astragalus and calcaneus. Like the cut marks observed on a skull fragment – around the base of a horn sheath – they will have been produced in skinning the animals. The other quarter are marks formed in cutting and chopping at and near articular facets of long bones, mandibulae, scapulae, pelvis and vertebrae. These marks were formed in dividing the carcasses into smaller parts. A case apart are the butchering marks observed on a scapula (find number 4546) from phase 2a. The bone shows not only cut marks around the neck (collum), which will have been formed in dividing the carcass into parts, but also an artificially produced hole near the top of the flat part. The latter could imply that the shoulder blade was suspended from a hook, for the purpose of for example smoking the meat over a fire or keeping it out of reach of dogs.

Ages at the time of death
The age determinations were based primarily on the fact that the growth zones of different leg bones of an animal fuse at different ages. Each type of bone hence yields a 'reference age': if the bone has fused, the animal lived beyond that age and if the bone has not yet fused, it was killed before it reached that age. This information provides an impression

of the ages at which the animals were killed, and how the livestock was exploited (table 22.12). Thanks to the large size of the Schipluiden bone assemblage, these calculations could be carried out on such a large scale for the first time for the Dutch Neolithic.

The information on the ages at which the animals were killed shows that animals of all possible maturity classes were slaughtered, from a foetus, represented by part of a lower jaw, to adult individuals of more than 3½-4 years old (Habermehl 1975). Being so numerous, the remains from phase 2a in particular, and to a lesser extent also those from phase 2b, provide a lot of useful information for a reconstruction of the kill-off patterns (table 22.13). Less information is available for phases 1, 1-2a and 3, and all that can be concluded from it is that it supports the general conclusion that animals of all maturity classes were slaughtered. This conclusion is incidentally strongly influenced by the fact that 70% of the data on which it is based concern phase 2a. Interestingly, the assemblage includes not a single unfused bone datable to phase 3. This could mean that in this phase only (relatively) old animals were slaughtered, but the limited amount of information may also play a role here.

In phase 2a a quarter of the cattle were slaughtered in their first year and another quarter in their third year. Only a small proportion (5%) of the animals belonging to the age class from one to two years were slaughtered. A substantial proportion of the cattle population (40%) lived beyond 3-4 years of age. So although animals of all age classes were slaughtered, the proportions of the various categories vary.

Clear differences are observable between phase 2b and phase 2a, but they are probably all attributable to the fact that only little information is available for phase 2b. The absence of evidence of the killing of animals of less than one year of age in phase 2b is insignificant as it is based on only 4 cases. In phase 2b, 15% and 35% of the animals were killed when they were two and three years old, respectively. The proportion of the cattle population that lived beyond the age of 3-4 (43%) is on the contrary comparable with that in phase 2a.

Information on the ages at which the animals were killed based on the eruption patterns of teeth and molars is more limited and less detailed (table 22.14). According to the dental data, the proportion of animals that were slaughtered before the end of their second year in phase 2a was not 42%, as based on bone fusion, but approximately 60%. This discrepancy illustrates the margin that should be considered in such calculations and the method's restrictions. The data available for the other phases are too limited to allow any conclusions to be drawn from them.

The kill-off patterns indicate that the cattle were kept both for their meat and for other purposes. The most obvious interpretation is that some older animals were kept for breeding (IJzereef 1981). Older animals may also have been kept for traction. Although recent research in France and England has shown that milk was being produced already at various (Early) Neolithic sites (Balasse/Tresset. 2002; Copley *et al*. 2003), there is no evidence to prove it at Schipluiden.

The aforementioned part of a lower jaw of a foetus (from phase 2a) has not been included in the tables showing the ages at the time of death. It is unlikely that a down-calving heifer was slaughtered. The bone may derive from a calf that was born prematurely and died shortly after birth. This would mean that pregnant cows, and hence probably also cows with young calves, were kept on or near the dune.

A remarkable example of an older animal concerns part of a pelvis that had fused to the sacrum; this occurs only in (fairly) old animals. It is unfortunately not possible to quote an exact age for the animal in question as this phenomenon is not described in the literature.

fused at age:	phase 1		phase 1-2a		phase 2a		phase 2b		phase 3	
(in months)	fused	unfused	fused	unfused	fused	unfused	fused	unfused	fused	unfused
7-10	4	1	2	–	19	6	4	–	3	–
12-15	2	–	2	–	14	2	1	–	–	–
15-20	2	1	7	1	26	10	10	1	2	–
20-24	3	–	1	3	15	11	6	2	1	–
24-30	3	1	1	1	33	39	4	4	5	–
36	–	–	–	1	3	8	–	4	–	–
42	–	–	–	1	5	7	1	–	–	–
42-48	2	3	1	2	12	15	2	–	1	–
Totals	*16*	*6*	*14*	*9*	*127*	*98*	*28*	*11*	*12*	–

Table 22.12 Age class determinations of cattle based on the stages of fusion of postcranial bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

22.4.3 Pig

In the category of (agricultural) domestic animals pig comes second, with proportions of 12% of the number of manually collected remains and 6.5% of the overall weight. The proportion in terms of numbers varies from around 10 to 14% for the different occupation phases while the proportion in terms of the total weight varies from around 4 to 10% (tables 22.3, 22.5). Once again, it should be added that the distinctions between domestic pig and wild boar are based largely on extrapolation (section 22.2). The remains that can on the basis of measurements be said to indisputably derive from domestic pig show that the species was kept at the site in all the phases. The remains concerned derive both from the head and from the postcranial skeleton, implying that the animals were killed at the site.

	N=		%		
age in months	fused	unfused	% killed after age	% killed before age	% killed between two ages
phase 2a					
7-10	33	8	81	20	–
12-20	26	10	72	28	8
20-24	15	11	58	42	14
24-30	33	39	46	54	12
36-48	20	30	40	60	6
phase 2b					
7-10	4	–	100	0	–
12-20	11	1	92	8	7
20-24	6	2	75	25	17
24-30	4	4	50	50	25
36-42	3	4	43	57	7

Table 22.13 Age classes and culling rates of cattle in phases 2a and 2b based on the fusion of postcranial long bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

age in months	phase					
	1	1-2a	2a	2b	3	totals
5-6	–	–	1	1	–	2
< 15-18	–	1	1	–	–	2
15-18	1	1	1	–	–	3
> 15-18	–	–	–	1	–	1
18-24	–	–	5	–	–	5
< 24	1	3	17	4	–	25
c. 24	–	–	–	–	1	1
> 24	–	4	15	1	1	21
Totals	*2*	*9*	*40*	*7*	*2*	*60*

Table 22.14 Age class determinations of cattle based on dental elements, excluding foetal elements.

Withers height and body size

In five cases the size of the pigs could be assessed by calculating the withers height on the basis of the greatest lateral length (GLL) of the astragalus. The remains in question were all identified as domestic pig bones on the basis of dimensional data. The smallest pig had a withers height of 66 cm; the largest two were both 72.3 cm high. The other measurements are 71.1 and 71.7 cm.

Traces of butchering, burning and gnawing

The only domestic pig remains showing marks of any kind are two astragali on which traces of gnawing by a dog were observed. The other bones showing traces of butchering, burning and gnawing all belong to the pig/wild boar category. Around 200 remains show traces of burning; about a quarter of those bones were recovered from the sieve fractions. The number of remains showing butchering marks is even smaller (less than 40); with the exception of one bone from the 1- and 2-mm sieve fraction the remains in question are all manually collected bones. Almost all the traces of butchering are cut marks that were formed in dividing the carcass into portions and/or cutting the meat from the bones. They were observed on parts of long bones, scapula, pelvis, atlas and mandibula. Cut marks on two tarsalia show that the animals were skinned. Traces of gnawing by a dog were observed on 34 bones.

As in the case of cattle, the proportion of cranial remains showing traces of burning and gnawing is very small, although the proportion of cranial elements deriving from pig/wild boar is greater than in the case of cattle (39% as opposed to 26%). This must again be attributable to a difference in deposition between cranial and postcranial bones rather than to a numerical difference between the two categories.

Ages at the time of death

The distribution of the ages shows that animals of all maturity classes were slaughtered, from foetal or newborn piglets, represented by five skeletal remains, to adult individuals aged more than 3-3½ years (Habermehl 1975). The data relating to the ages at which the animals were killed are summarised in tables 22.15-17. The remains of the foetal or newborn piglets (three from phase 2a and two from phase 2b) have not been included in the tables. Unlike the foetal cattle remains, they are difficult to explain. If they are domestic pig remains, they may derive from stillborn piglets or piglets that died shortly after birth. If so, they imply that pregnant sows and sows with piglets were kept on or near the dune. But it is also possible that young piglets were occasionally slaughtered or – in the case of wild boar – shot. This will be discussed further in section 22.7.

It should be borne in mind that the data relating to the ages at which the animals were killed concern a mixture of domestic and wild pigs – except for a small number of data that relate to remains of adult individuals that may on the basis of their dimensions be positively identified as deriving from either domestic pig or wild boar (table 22.15).

The numerous remains from phases 2a and 2b offer the best possibilities for a reconstruction of the kill-off patterns in the case of pig, too (table 22.16). In both phases high, more or less equal proportions of the pig population were killed in the animals' first year (35-37%). The same holds for animals that were killed when they were more than three years old (21-22%). The proportion of animals of the intermediate age groups that were killed in phase 2b however differs remarkably from that of phase 2a. On the whole, animals of all age groups were slaughtered. As in the case of cattle, the data available for phases 1, 1-2a and 3 are limited, and provide little more than a confirmation of the aforementioned conclusions.

The data relating to the ages at which the animals were killed based on the eruption patterns of teeth and molars likewise show a high proportion of young animals in phase 2a: 42% of the remains derive from individuals of at most 16 months old (table 22.17). The percentage obtained for phase 2b is lower (26%). This reveals a shift towards the slaughtering or hunting of older animals, though this may to some extent be influenced by the fact that we have fewer data for phase 2b than for phase 2a.

As already mentioned, our understanding of the slaughter patterns is not clear as they relate to a mixture of domestic and wild pigs. The difference in slaughter patterns between domestic cattle (a relatively high proportion of young animals) and wild animals (almost exclusively adult individuals) makes it likely that the young(er) animals are mainly domestic pigs while the category of old(er) animals also includes wild boars. The occupants of for example Hardinxveld on the contrary randomly hunted wild boars, whereas – like the Schipluiden occupants – they did spare young individuals in hunting red deer (Van Wijngaarden-Bakker *et al*. 2001, 231).

22.5 Other domestic animals: dog

In total, 970 dog remains were identified, mainly among the bones collected by hand from the units bordering the dune. The bones derive from all parts of the body. Their spatial distribution largely coincides with that of all the other mammal remains. The total number is rather high because in the case of fractured skulls the number of fragments was counted (insofar as those fragments couldn't be refitted) and in a few places skeletal parts of a single individual were found together.

22.5.1 Deposition of dogs – heads and other body parts

In the field, compact concentrations of dog bones were found in three places, and also a relatively large number of skulls and complete lower jaws. This suggested a special treatment and deviating deposition of dogs, possibly the disposal of entire bodies and heads. To check this hypothesis we needed more information on the spatial distribution of the dog remains and on any clustering of those remains. The dog remains were therefore all recorded in detail and differentiated according to location, phase, skeletal part and degree of fragmentation, with special attention to associations and clusters. The majority of the dog bones were found to be in accordance with the general bone distribution patterns. In the end, four depositions of incomplete carcasses were identified (fig. 22.7). They were found to comprise secondarily buried dog remains or discarded body parts – both entire bones and fragments. In addition, seven more or less complete heads (skull-lower jaw combinations) were discarded, plus various individual body parts.

The dog depositions are documented in Appendix 22.3 and figure 22.8, and will be described below.

fused at age:	phase 1		phase 1-2a		phase 2a		phase 2b		phase 3	
(in months)	fused	unfused	fused	unfused	fused	unfused	fused	unfused	fused	unfused
12	4	2	1	1	44	26	13	7	14	3
24	1	–	3	1	21	27	17	11	3	5
24-30	–	–	–	–	4	6	–	2	–	2
36	–	1	–	–	–	2	–	1	–	1
36-42	–	–	–	–	–	7	–	–	–	–
42	–	2	1	–	6	14	2	6	–	1
Totals	*5*	*5*	*5*	*2*	*75*	*82*	*32*	*27*	*17*	*12*

Table 22.15 Age class determinations of pig/wild boar based on the stages of fusion of postcranial bones, excluding foetal and neonate bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

Dog 1 (d1)

Well 10-140 contained the incomplete and partly fractured remains of a dog (d1). The bones lay fairly close together in the highest part of the secondary fill, suggesting that they were deliberately buried there. They certainly didn't end up there via natural processes, as we would then expect to find a scattered pattern. This well was initially dated to an early part of the occupation period on the basis of its position – fairly low down the dune and in line with fence stretch 1 that must have intersected its fill. On the other hand, the soil of the fill was anthropogenic in nature, indicating that the well was by this time no longer surrounded by sterile soil. The well therefore most probably dates from phase 2a or 2b and the dog remains from phase 2b.

The following remains were found in the well: the entire lower jaw, the atlas and axis and a few other vertebrae, a few ribs, a shoulder blade and parts of the forelegs, in particular the lower legs, and of both hind legs. Large parts were absent, including the skull, the pelvis and most of the long leg bones. The lower leg bones are intact, but all the other bones are fractured and have survived in part only. Some bones found in Unit 18 next to the well need not necessarily derive from the same dog, as suggested by a second lower right jaw.

The find context is more indicative of the deliberate burial of (some) remains of a dog than of natural fragmentation and disintegration.

	N=		%		
age in months	fused	unfused	% killed after age	% killed before age	% killed between two ages
phase 2a					
12	44	26	63	37	–
24-30	25	33	43	57	20
36-42	6	23	21	79	24
phase 2b					
12	13	7	65	35	–
24-30	17	13	57	43	8
36-42	2	7	22	78	39

Table 22.16 Age classes and culling rates of pig/wild boar in phases 2a and 2b based on the fusion of postcranial long bones, excluding foetal and neonate bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

age in months	phase					
	1	1-2a	2a	2b	3	totals
c. 8	–	–	–	2	–	2
> 8	–	1	9	2	1	13
8-13	–	–	10	2	–	12
8-16	–	–	13	–	1	14
12-13	–	1	5	2	–	8
12-16	–	1	3	–	–	4
> 12	1	2	10	3	2	18
< 16	–	3	22	3	3	31
> 16	1	1	11	16	2	31
13-20	–	–	1	–	–	1
> 18	–	–	5	–	–	5
18-20	–	1	12	–	–	13
> 20	2	3	25	5	3	38
Totals	*4*	*13*	*126*	*35*	*12*	*190*

Table 22.17 Age class determinations of pig/wild boar based on dental elements, excluding foetal elements.

Dog 2 (d2)

Remains of a second dog (d2) were found in Unit 18, in the middle of the southeastern side of the dune (trench 19). The remains were clustered within an area of one m^2 and are more complete than those of dog 1. All body parts are represented, including the complete skull, but many of the long bones have survived in part only and some smaller leg bones are missing. The find context suggests that the remains were buried in a shallow pit, which the excavators failed to identify as such. If the bones had been discarded on the ground they would have ended up scattered further apart. In the immediate surroundings of these remains the excavators did incidentally find some skeletal elements that were absent from the concentration and could derive from the same dog, but also the remains of three (other) dog skulls, including a complete head (h4). The find context closely resembles that of the remains of dog 1, the main difference being that the entire head of dog 2 was found. The combination of a sharply defined concentration with the degree of fragmentation and missing body parts makes it more likely that these remains were discarded (buried) than that they represent a complete cadaver. This could also explain why the vulnerable skull has survived almost intact. The remains must hence have been buried after phase 2a.

Dog 3 (d3)

Remains of a third dog were found on the northwestern side, in Unit 10 (phase 3), within an area of 2 m^2. The findspot lies relatively far (around 15 m) from the former periphery of the dune, in what was then peatland, outside the general distribution of settlement refuse and probably also outside the area covered in daily expeditions. This could explain why parts of this deposition have survived. The stratigraphic position places the remains in phase 3.

This skeleton is also very incomplete, comprising, besides large parts of the left hind leg, fragments of the right hind leg, the pelvis, vertebrae and both humeri. Some of the long

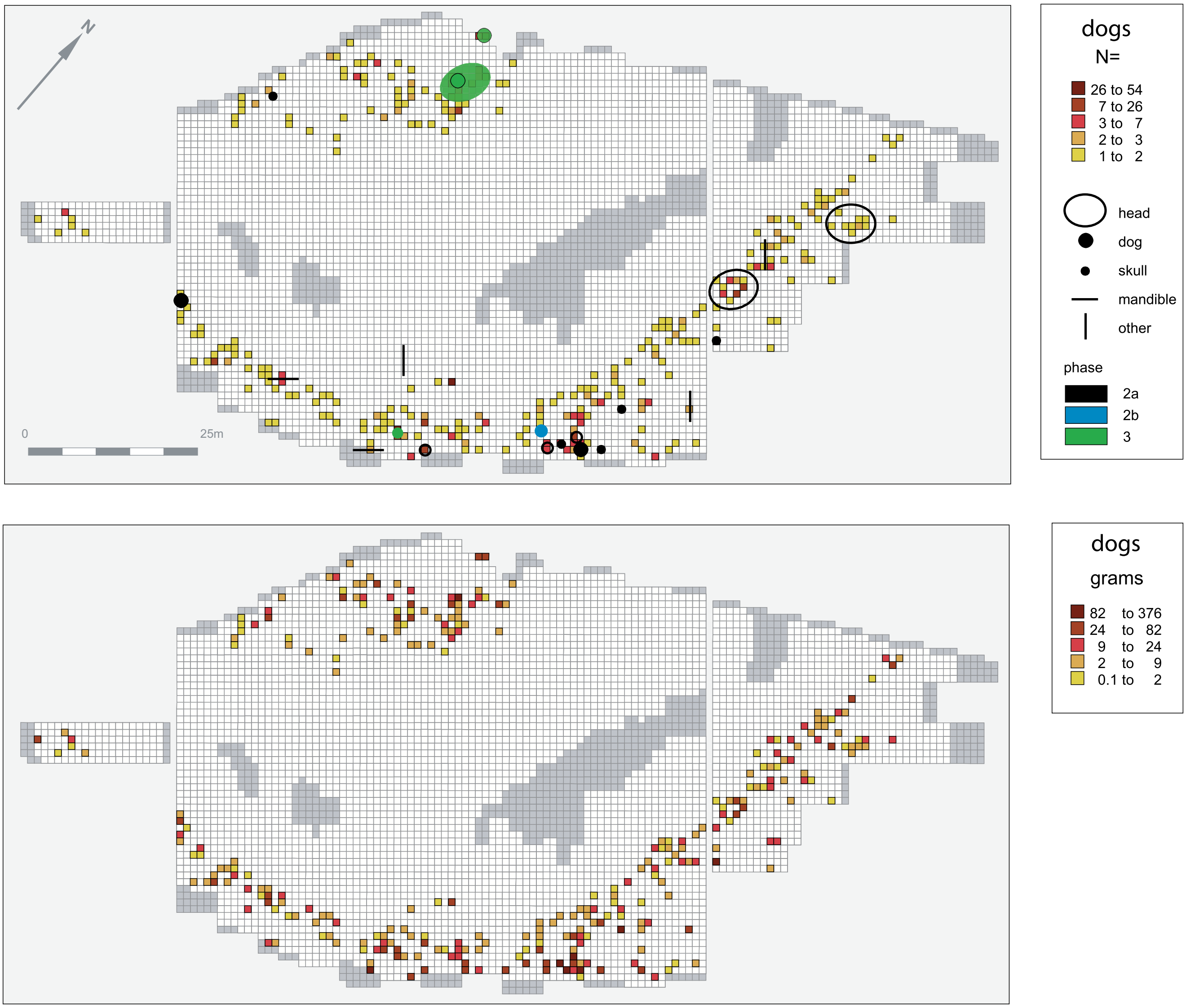

Figure 22.7 Distribution patterns of all dog bones per square metre.
a number of bones with the findspots of the depositions
b bone weight

bones are not fractured and (almost) intact. No other dog remains were found within a radius of 4 m. This find likewise more probably represents discarded remains than a carcass.

Dog 4 (d4)

Remains of a fourth dog were identified in a cluster of skeletal parts covering an area of around 4 m^2, also on the northwestern side, in Units 10/11, only 7 m away from those of dog 3 at the edge of the dump zone. These remains comprise exclusively bones from the head (skull, lower jaw, atlas) and the two forelegs, some of the long bones of which were intact. The presence of (corresponding parts of) two humeri among the remains of dogs 3 and 4 implies that the bones represent two different individuals. A fairly large number of skeletal parts of several dogs were found in older deposits (19N, 15) in the immediate vicinity of this concentration, but the

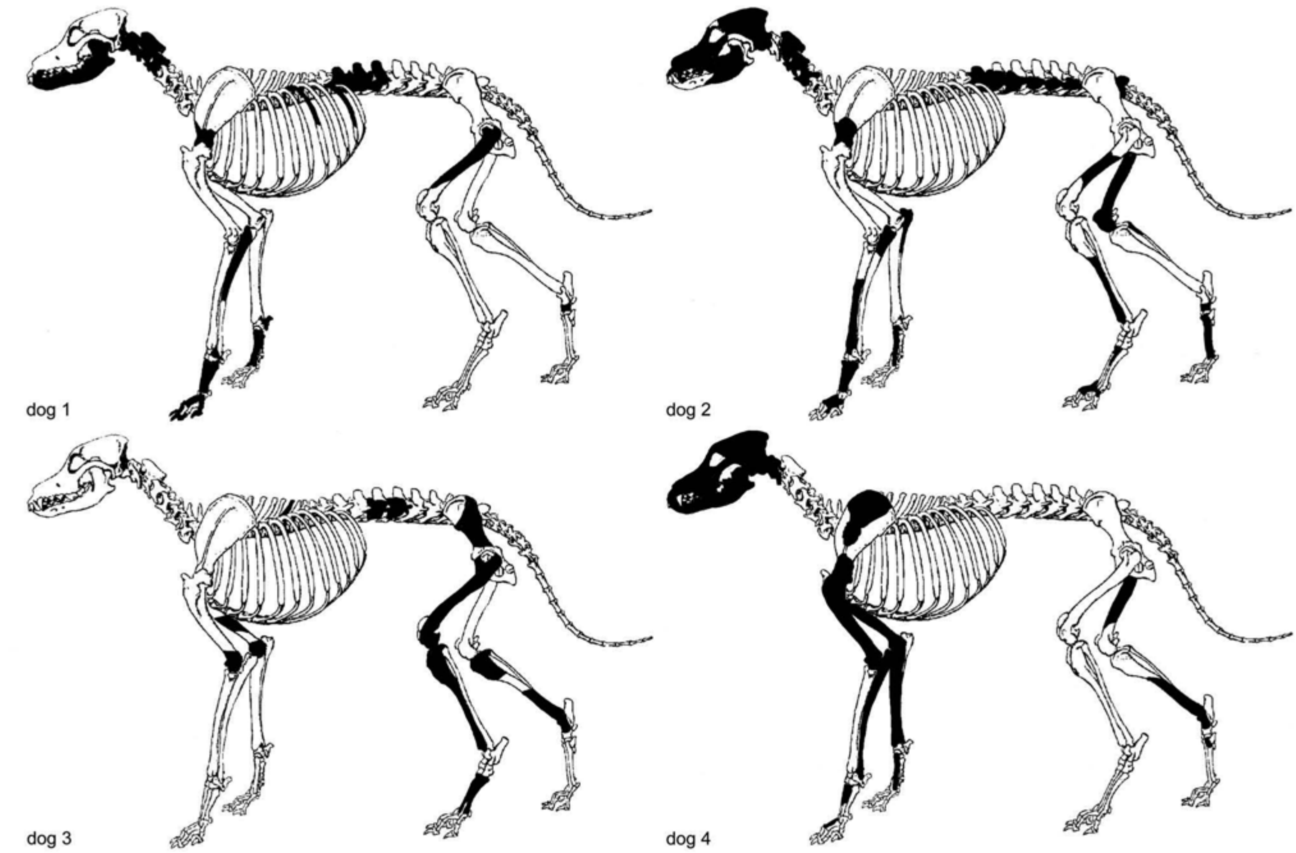

Figure 22.8 Preserved skeletal parts in dog depositions 1-4.

majority can't derive from dog 4. This does not hold for remains of a right hind leg and a right scapula that were found 3 to 4 m further east in the same unit (10/11): the shoulder blade fragment could be fitted to the humerus of dog 4. The leg partly duplicated that of dog 3, showing that it derived from a different animal. This is the only find involving remains that were distributed further than a few m^2 apart, but – as with dog 3 – intact leg bones contrast with the absence of other bones, and again the deposition of certain body parts – as opposed to an entire carcass – seems the most likely explanation.

Heads

On top of this there were also seven isolated finds comprising remains of entire dog heads, including the lower jaws and – in four cases – the atlas and/or axis. They were all found on the southeastern side of the dune (trenches 15-29, western end); five date from phase 2a, one from phase 2b and one from phase 3. Most of these remains lay concentrated within an area of 1 to 2 m^2. In one case the lower jaw lay 4 m from the other skull parts, making their association uncertain. In two cases, both in the northern part of the dump zone, the head remains were scattered across an area with a diameter of several metres. The bones in question were clearly post-depositionally disturbed. The skulls are all incomplete, having fractured in the past and/or during excavation. The robust lower jaws have survived largely intact, or even in their entirety, including the atlas and axis. One assemblage of small fragments of the skull and lower jaw (h2) for example includes an almost intact atlas and axis. No concentrations of other (connected) body parts were found around these heads from phases 2a, 2b and 3 within the long band of (fragments of) dog bones on the southeastern side, so the conclusion must be that these bones indeed represent the deposited remains of individual (chopped-off) heads.

Other body parts

The dog remains also include a relatively large number of lower jaw halves. In two cases the two halves were found lying together. Other noteworthy finds are five skulls with the associated upper jaws and dental elements, but without the lower jaws, one of these from the fill of deposition pit no. 12-48 (fig. 22.9). These finds we however don't consider exceptional; we regard them as part of the general refuse, though they may of course be the last remaining relics of head depositions. Two complete lower jaws – found without any skull remains in their vicinity –, an almost complete pelvis and remains of a right foreleg (from the ulna and radius) can also be regarded as 'normal' waste, and need not necessarily be associated with any significant deposition. The scapula and right hind leg of dog no. 4 are more in line with the deposition pattern.

Conclusion

This unusual form of deposition is not randomly distributed in spatial and chronological terms. Its focus is in phase 2a, with depositions along the entire central and northern parts of the southeastern periphery of the dune, and a concentration in the middle. There, we also found remains of a head deposited in phase 2b and another in phase 3. In those phases dog remains were dumped in two places on the other side of the dune, too (fig. 22.7). In two cases we found evidence showing that the dog was killed by a blow to the side of its head. One of the skulls concerned was found in the deposition pit 12-48 as one of the few non-cattle remains (fig. 22.9). The other skulls were too fragmented to allow such a conclusion. Dogs evidently had a special meaning for the dune occupants and played some role in rituals whose purpose eludes us. Dogs were killed, their heads were chopped off and discarded separately. Other remains were collected and secondarily buried (2× in phase 2a) or dumped, partly still in an articulated condition (2× in phase 3). No evidence of such an unusual treatment and meaning of dogs has so far been found for the Swifterbant culture. Such a treatment and meaning are in line with the special role of dogs in general in late hunter-gatherer societies, in particular in the Mesolithic, but contrast with the careful burial known from for example Hardinxveld-Polderweg.

Withers height and body size

26 cranial and postcranial skeletal elements were measured (Appendix 22.2). The measurements are in the same order of magnitude as those obtained for other Neolithic sites in the western Netherlands, in particular Ypenburg (De Vries 2004), Vlaardingen (Clason 1967), site P14 (layer D; Gehasse 1995), Hazendonk (Hazendonk-3 phase; Zeiler 1997) and Kolhorn (Zeiler 1997). In two cases the withers height could be determined: 42.4 and 47.8 cm. The former is an average of three measurements obtained for bones deriving from the same individual (greatest length of the left and right humerus and right radius), the latter is based on the greatest length of a (left) tibia. The withers height of the smallest individual is comparable with the heights of dogs whose remains were found at Ypenburg, Vlaardingen, Hazendonk and Kolhorn, which range from 43.0 to 44.9 cm. Both dogs were however a lot smaller than the Mesolithic dogs of Hardinxveld-Giessendam Polderweg (Van Wijngaarden-Bakker 2001 *et al.*), which had withers heights ranging from 49 to 59 cm (average of 54.5 cm). A dog at site P14 was also bigger than the Schipluiden dogs, having a withers height of 50.6 cm.

Traces of butchering, burning and gnawing

Only a few of the dog remains showed marks of any kind. Six parts of dog skeletons showed evidence of burning while three bones showed traces of gnawing by other dogs. Intriguing are the two skulls, mentioned before, showing that the dogs in question were deliberately killed, by a hard blow to the head close to the left eye socket (fig. 22.9).

Also intriguing is part of the shaft of a tibia showing fairly deep, short transverse cut marks. Cut marks in this particular part of the bone may have been produced in cutting away meat, but the marks formed in such an action are usually shallower and longer. Precisely what happened to this bone will have to remain a mystery for the time being. All that can so far be said with certainty is that, as in the case of the two battered skulls, there is no (clear) connection with consumption.

Ages at the time of death

Almost all the dog skeletal elements that can be used to determine the ages at which the animals died derive from adult (fully-grown) animals. The jaws all contain permanent teeth and molars, indicating an age of at least 6-7 months. The information provided by the postcranial bones agrees with this (Habermehl 1975). The only exceptions are a tibia of a not yet fully grown animal (younger than 1½ years) and two parts of the pelvises of young dogs in which the individual bones had not yet fused. In the latter case the exact age cannot be determined due to the absence of literature data.

22.6 WILD MAMMALS

The wild mammals can be divided into three categories: ungulates, fur animals and marine mammals. The ungulates comprise aurochs, red deer, roe deer and wild boar. The fur animals are beaver, fox, wolf, marten, polecat, weasel, otter, brown bear, European wildcat and lynx and the marine mammals are common and grey seal, bottle-nosed dolphin and a cetacean.

22.6.1 Ungulates

Aurochs

Fourteen of the manually collected bones were identified as deriving from aurochs, three on the basis of dimensional data (Appendix 22.2). Comparison with the data published by

Figure 22.9 Skull of a dog from deposition pit 12-48 (no. 6441) showing evidence of a blow (scale approx. 1:1).

Degerbøl and Fredskild (1970) shows that the greatest length (GL) of a phalanx I (GL = 75.5 mm) and a phalanx II (GL = 51.3 mm) fall within the range of aurochs bulls (fig. 22.10). A phalanx I with a distal width (BD) of 34.4 mm can be assigned to an aurochs cow. The other identifications are based on (immeasurable) remarkable differences in size relative to the remains of domestic cattle. All the remains derive from adult individuals. With the exception of two cervical vertebrae and a fragment of ulna and pelvis, the bones are parts of the lower legs: phalanges and carpal and tarsal bones. This implies that some of the animals were not butchered on site. The lower leg elements may have been brought to the site incorporated in skins. The aurochs bones seem to date from phases 1 and 2a only. There are remains from both these phases and phase 2b that cannot be unambiguously identified as deriving from domestic cattle or aurochs.

Red deer

Red deer is one of the two dominant wild mammals, represented by 676 remains (excluding antler). Remains have survived from all the phases, amounting to approx. 6-15% of the total number of manually collected remains and approx. 7-16% of the total weight (tables 22.3, 22.5). The remains derive from the head, front and hind legs (including scapula and pelvis) and the body (vertebral spine) and therefore comprise both butchering and consumption waste (Appendices 22.1a-c). The remains show that entire animals were brought to the site and processed there.

Nine associations were distinguished, four of which comprise fitting fragments of a single skeletal part (scapula, tibia and two fragments of mandibula). The fragmentation of these skeletal elements will be postdepositional. The other associations are the result of the direct deposition of elements belonging together – parts of the right hind leg (tibia and astragalus, and calcaneus and astragalus) and twice a fitting radius and ulna.

Antler

Constituting 62% of the total number of manually collected red deer remains, antler fragments are remarkably numerous. The weight proportion of the antler is much smaller at around 27%, but still quite substantial. The main cause of this overrepresentation will be that even small

Figure 22.10 Phalanx II of an aurochs bull (1299) compared with a phalanx II of domestic cattle (6441) (scale 1:1).

antler fragments can be easily identified. The difference between numbers and weights is due to the facts that antler is lighter than bone and the fragments are on average fairly small. The occupants of the dune also collected shed antler. Of the thirteen antler bases (not counting artefacts), nine derive from shed beams. The other four include attached parts of the skull, implying that they come from hunted animals. The shed antler is unequally distributed among the occupation phases (fig. 22.17), but in view of the small numbers concerned no great significance should be attached to this. Nevertheless remarkable is that antler with attached parts of the skull is completely absent from phases 2b and 3.

The large proportion of antler is also observable in the percentages of burnt red deer remains. 6% of the manually collected remains is burnt and the majority of those burnt remains (approx. 68%) are antler fragments. The percentage of burnt red deer remains in the 4-mm sieve fraction is even higher: approx. 77%. An even greater proportion than in the case of the manually collected remains consists of antler, constituting 95% of the number of burnt remains. These high percentages are again due to the fact that antler can be fairly easily identified, even in small, burnt fragments – much more easily than, say, fragments of long bones.

Traces of butchering, burning and gnawing

Excluding antler fragments, traces of burning were observed exclusively on postcranial elements. The same holds for gnawing marks, excluding one mandibula fragment. More so than in the case of cattle and pig/wild boar, this seems to be attributable to the relatively small proportion of cranial elements (approx. 8%). A difference in deposition may however have played a role, too.

The manually collected remains include 34 bones with traces of burning, 20 skeletal parts with gnawing marks and 32 remains showing marks produced in butchering (table 22.10). The butchering marks can be divided into four types, each representing a different activity. The saw marks observed on two skull parts, for example, point to the removal of the antler beams. Cut marks on seven lower leg elements (astragalus, metacarpus and metatarsus) indicate that the animals were skinned. Cut marks on or near articular facets (long bones, mandibula, scapula and pelvis) constitute the largest category (63%) and represent the division of the carcasses. The butchering marks of the fourth and last type, observed on the central part of three radius fragments, were in all probability produced in cutting the meat from the bones.

Ages at the time of death

The animals killed in hunting were almost exclusively (fairly) old. The great majority of the postcranial bones from which the age at the time of death can be inferred derive from individuals of more than 20 months old (Mariezkurrena 1983; Habermehl 1985; table 22.18). This is confirmed by the eruption and wear patterns of the molars. Only two of the 25 lower jaw fragments derive from animals that had not yet reached maturity: the presence of milk premolars indicates an age of less than 32 months. The other jaw fragments come from individuals in which M3 had erupted and/or the milk premolars had been replaced by permanent ones, implying that they were more than 32 months old. In the case of eleven of these individuals the age at the time of death could be more precisely determined on the basis of the wear patterns of the molars (table 22.19). The youngest animal was killed when it was around 3 years old, the oldest at an age of 12-13 years.

Roe deer

Only one bone fragment of roe deer was found, among the manually collected remains (phase 2a). It is part of a metapodium from an adult animal aged more than 1½ year (Habermehl 1985). The fragment shows no noteworthy characteristics.

Wild boar

Wild boar is the second most important wild species after red deer (tables 22.2-3; fig. 22.15). The (extrapolated) number percentages of the manually collected remains vary from around 16% to 23% for the various phases; the weight percentages vary from 7.5% to 15.5%.

From the remains that can on the basis of measurements be positively identified as wild boar it can be concluded that the species was hunted in all phases. The remains concerned derive both from the head and from the postcranial skeleton.

Two bones show traces of butchering. Cut marks on a mandibula imply that the meat was cut from the bones; cut marks just above the distal epiphysis of humerus are evidence of the division of the carcass.

In four cases the animals' withers height could be inferred from the greatest lateral length (GLL) of the astragalus: 88.9, 88.4, 86.0 and 80.9 cm. These values are in the same order of magnitude as those obtained for Hardinxveld-De Bruin (87.0 and 99.0 cm) and Polderweg (79.6, 80.4, 82.6, 86.9 and 87.0 cm). For present-day (European) wild boars Lange *et al.* (1994) quote a range of 60-110 cm; Van den Brink (1978) cites heights of 70-115 cm.

2.6.2 Fur animals

A great variety of fur animals was found at Schipluiden, including as the most spectacular species the lynx. This we owe primarily to the exceptionally large number of identifications because, except for beaver and otter, the various species are each represented by only a very small number of remains. Correction for the 4-mm sieve fraction (table 22.7) enhances the evidence very little.

Besides for their skins, some fur animals (beaver, otter and fox) were also hunted for their meat. The hunt for fur animals, which was incidentally of minor economic importance, was selective, focusing almost exclusively on adult individuals.

The proportion of fur animals shows an increase from phase 2a to phase 2b, followed by a drop in phase 3 (tables 22.2-3, fig. 22.15). The increase most probably reflects a change in environmental conditions. The continuing shift towards freshwater conditions will have been favourable for beavers and otters, although the latter are also to be found in brackish environments and even along seacoasts. The drop in phase 3 is more difficult to explain. Environmental changes (decrease in the area of open water) may have played a role, but another possibility is that the site's function changed slightly.

age in months	fused	unfused
8-20	41	–
20	58	2
20-32	28	2
32	50	2
Totals	*177*	*6*

Table 22.18 Age class determinations of red deer based on the fusion of postcranial long bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

age in years	N =
3	1
5	1
7	1
8	1
9	1
9-10	1
10	1
11	3
12-13	1
Totals	*11*

Table 22.19 Age class determinations of red deer based on wear patterns of teeth in mandibles.

Beaver

The assemblage includes beaver remains from all phases, if in low frequencies. The numerical proportion is at most approx. 3%, the maximum weight proportion approx. 1.5%. Correction on the basis of the 4-mm sieve fraction (table 22.7) leads to a substantial decrease in these percentages as virtually no beaver remains were found during the sieving. So hunting for beavers was of minor importance.

Just over 40% of the skeletal remains are cranial elements; the other bones are parts of the front and hind legs (including clavicula, scapula and pelvis; approx. 48%) and the vertebral spine (11.5%). Particularly well represented in the latter category are caudal vertebrae.

Cut marks were observed on nine skeletal remains. In most cases (clavicula, pelvis, femur, tibia and lumbar vertebra) they indicate the division of the carcass and/or the cutting of meat from the bones. Cut marks on the bottom side of a lower jaw fragment show that the animal concerned was skinned. Ten remains were burnt – six of the ten were calcined, the other four carbonised.

Ages at the time of death were determined only on the basis of postcranial bones (Iregren/Stenflo 1982). The age distribution shows a pronounced dominance of adult individuals. Of the 34 bones for which the age at the time of slaughtering could be determined, 30 derive from animals that were more than two years old, 16 of which were more than 3 years old. Only four remains come from individuals that were less than three years old at the time of their death (table 22.20).

Unlike at sites in other ecozones of the delta, the beaver was at Schipluiden evidently of only complementary importance. In all the phases the occupants selectively hunted almost exclusively adult animals, for both their skin and their meat. This means that if the animals were hunted with traps, the occupants set free young animals. The same form of exploitation was observed at Swifterbant and Hazendonk (Zeiler 1997). At Hardinxveld-Giessendam De Bruin on the contrary, a much larger proportion of young animals were killed (Oversteegen *et al.* 2001).

Otter

Represented by 163 skeletal fragments (2.1%), the otter was the most commonly hunted fur animal. Due to the relatively large number of identifications in the 4-mm sieve residue, correction causes the proportion of otter to increase to on average 3.5% (table 22.7). There are no otter remains from phase 1 and the proportion increases to 4.7 % for phase 2b, followed by a decrease. The weight percentage never exceeds 1%.

Besides elements from the head (approx. 32%) and the front and hind legs (including scapula and pelvis; approx. 66%), two caudal vertebrae and a penis bone were found. Three fragments show traces of gnawing by dogs. Two remains show cut marks: a proximal part of a femur and part of the shaft of a humerus. The positions of the cut marks in both cases point to consumption: the division of the carcass (femur) and cutting of meat from the bones (humerus). This means that the otters were consumed, but they will certainly also have been hunted for their fur.

A remarkably high percentage of the otter bones show evidence of burning: 31% of the remains from the 4-mm sieve fraction and 38% of the manually collected remains are carbonised or calcined (fig. 22.4). The otter remains evidently came into contact with fire more often than the bones of other species, implying that they were processed in a different way.

In the case of 64 postcranial bones the age at the time of death could be roughly estimated on the basis of the fusion of the epiphyses (table 22.21; see Zeiler 1988). In 11 cases this could be done on the basis of the wear patterns of molars (table 22.22). The results show that the occupants hunted otters in a very selective manner, focusing almost exclusively on adult individuals, as was also observed at the much older site of Hardinxveld, and for example also for all the occupation phases of the Hazendonk site.

Fox

Fox is represented by two remains dating from phase 3. The remains in question are part of a lower jaw and a fragment of a humerus. The lower jaw is burnt (calcined) and shows cut marks that were produced in skinning the animal. The humerus shows cut marks implying consumption.

Wolf

Four bones were identified as deriving from wolves: a thoracic vertebra, two skull fragments and an ulna (fig. 22.11). The first three were identified on the basis of their remarkable size in comparison with the dog remains. The ulna – deriving from an adult individual of more than 2½ years old – was likewise identified on the basis of measurements (Appendix 22.2). The Schipluiden bone is larger than an ulna of a (male) wolf in the reference collection of the GIA.[5]

Marten, polecat and weasel

The manually collected remains include a few remains of small predators – 13 in total, representing less than 0.1% of the overall bone assemblage. More remains were recovered from the 4-mm sieve residue, bringing the percentage of marten species to 0.7% after correction (table 22.7).

	N=		%		
age in months	fused	unfused	% killed before age	% killed after age	% killed between two ages
24	14	–	100	0	–
36	16	4	80	20	20

Table 22.20 Age class determinations of beavers based on the fusion of postcranial long bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

	N=		%		
age in months	fused	unfused	% killed after age	% killed before age	% killed between two ages
12	29	–	0	100	–
24	34	1	3	97	3

Table 22.21 Age class determinations of otters based on the fusion of postcranial long bones.
(epiphysis) fused = younger than indicated age
(epiphysis) unfused = older than indicated age

	N=	C	P2	P3	P4	M1	estimated age in years
mandible							
	1	+	+	–	+	+	> 1
	1	–	+	+	–	+	> 1
	1	–	+	•	•	•	> 1
	1	–	+	+	–	–	> 1
	1	–	–	+	+	+	> 1
	1	–	–	–	+	+	> 1
	2	–	–	•	•	•	< 1
	1	–	–	–	•	•	< 1
maxilla							
	1	–	+	•	–	–	> 1
	1	–	–	–	+	+	> 2

• no dentine visible
\+ dentine visible
– no data

Table 22.22 Age class determinations of otters based on wear patterns of teeth.

Marten
The four marten remains are two molars, a phalanx I and a tibia. The remains cannot be identified to species (pine or stone marten) level.

Polecat
With 11 manually collected remains, polecat is the best represented of the marten species. The remains date from all the phases except phase 1. The 4-mm sieve fraction yielded only a few extra remains. The remains are predominantly cranial elements plus three postcranial bones (pelvis, femur, tibia) of adult individuals.

Weasel
A single weasel bone was identified thanks to the sieving programme: a right lower jaw of an adult individual that was at least 3-4 months old (fig. 22.12).

Brown bear
Of the 11 skeletal fragments of brown bear nine derive from the skull (fig. 22.12), the other two are phalanges. Most of the remains date from phase 2b and were found in two small associations lying far apart: no. 1302/2345, trench 14: parts of a left and a right upper jaw and a left incisor; no. 10,387/10,507, trench 27: two fragments of a right lower jaw and a left M2 from the lower jaw.

The jaw fragments can on the basis of the surviving permanent molars be assigned to one or more adult animals. According to Dittrich (1960, quoted in Iregren *et al.* 2001) the replacement of dental elements is in brown bears complete by the age of 1-2 years. The phalanges also derive from at least one adult individual.

The fact that the brown bear remains comprise only cranial remains and phalanges implies that the killed animals were not brought back to the site in their entirety; only their skins, with attached phalanges and skull (with lower jaw), were brought home from the hunt. It is not certain, but very likely that this bear (or bears) was shot in the occupants' own territory. From both archaeozoological and historical data it is known that brown bear was a native species in the Low Countries. Brown bear remains have also been identified at various sites of the Vlaardingen group (Vlaardingen, Hekelingen 1 and 3, Voorschoten, Hazendonk). More than half of the remains found at prehistoric sites are cranial elements (including isolated teeth and molars). Any postcranial bones encountered are usually parts of the lower legs, such as phalanges and metapodia. In only a few cases have other bones been found (lumbar vertebra, humerus, tibia, femur and patella). This suggests that most of the remains, including those of Schipluiden, are remnants of skins with attached heads and lower legs (Zeiler, in press). With a few exceptions, bears were evidently skinned at the spot where they were shot and their meat was not consumed.

Figure 22.11 Left ulna of a wolf (7173) compared with a left ulna of a dog (843) (scale 1:1). The withers height of the dog was calculated to be 42.4 cm.

European wildcat
Represented by 22 skeletal parts in the manually collected remains and 15 in the 4-mm sieve residues, the European wildcat is the most frequently encountered predator after

Figure 22.12 Skeletal remains of fur animals.
1302 right maxilla of a brown bear with M2 (scale 1:1)
9262 lower right canine tooth of a brown bear (scale 1:1)
9185 right half of a wildcat mandible (magnification 2×)
4437 right half of a weasel mandible (magnification 5×)

the otter. This is supported by the results obtained after correction of the 4-mm sieve sample (table 22.10).
Both elements from the head (fig. 22.12) and from the postcranial skeleton (front and hind legs) are represented. In all 15 cases in which the age at the time of death could be determined the remains were found to derive from adult individuals (older than 8½-11½ months; Habermehl 1975). No wildcat remains dating from the earliest phases (1 and 1-2a) were found. This could be due to the open salt-marsh landscape that surrounded the dune in those days – by no means an ideal biotope for this species. The relatively small number of identifications may however also play a role here.

Lynx
The lynx is definitely the most spectacular species in the represented faunal range. Along with a skull found at the Roman *castellum* of Valkenburg (Van Bree/Clason 1971) and an as yet undated (and unpublished) lower jaw from the IJsselmeer polders, this is the third archaeological find of this species in the Netherlands, and officially the first dating from Dutch prehistory. The species is represented by three molars, one right one and two left ones from the lower jaw, all M1. Two date from phase 2a. The third was found in Unit 20 (fig. 22.13). That means that they derive from at least two individuals. As in the case of brown bear, the nature of the remains suggests that they are remnants of skins with attached

skulls, including the lower jaws. The same interpretation was suggested for the skull that was found at the Roman Valkenburg site. It is impossible to say whether the animals were killed in the site's own territory or whether their skins were imported from elsewhere. The latter option is the most likely in view of the fact that – unlike in the case of brown bear – we have no archaeological and/or historical sources indicating that the lynx was indigenous in the Low Countries.

22.6.3 Marine mammals

Considering its location close to the coast and the environment of the Schipluiden site, remains of marine mammals are remarkably scarce. A few remains have survived from all phases except phase 1. They derive from common seal, grey seal, bottle-nosed dolphin and a cetacean.

Common seal is represented by four skeletal remains: three cervical vertebrae and a phalanx I from the front leg. The vertebrae – which have the same find number and hence most probably derive from the same individual – were all three burnt (calcined).

In addition, four grey seal remains were identified: two tarsals, one phalanx I from the front leg and a thoracic vertebra (fig. 22.14).

The seven fragments that were identified as deriving from bottle-nosed dolphin are all caudal vertebrae (fig. 22.14). Four of them were found in one of the wells (feature 12-314), the others come from (different) deposits.

One vertebra is too large for a bottle-nosed dolphin, so it must come from a (fairly) large, indeterminate cetacean.

22.7 Subsistence

Most of the identified species will have been consumed. This is in the first place evident from cut marks on the bones of frequently encountered species, in particular cattle, pig, wild boar, red deer, otter and beaver, plus the bones of fox. In combination with the distribution of the skeletal elements (Appendices 22.1a-c), the traces of butchering indicate that the domestic animals were slaughtered and consumed at the site, and that – in some cases at least – the hunted animals were in their entirety (or in parts) brought back to the site to be processed there. This holds for both small species such as otter and beaver and for the larger ungulates (red deer, wild boar).

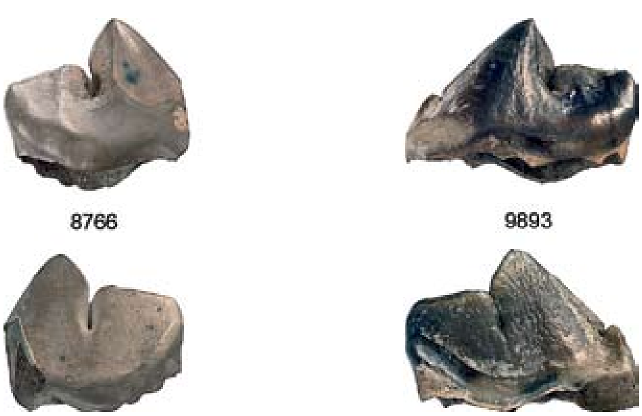

Figure 22.13 molars of a lynx (magnification 2×).
8766 M1 from a right mandible
9893 M1 from a left mandible

Stock farming was more important for the meat supply than hunting (fig. 22.15). Cattle was the principal stock, followed by pigs. Hunting large wild animals (red deer, wild boar) was however also very important. Insofar as they were (also) hunted for their meat, fur animals were in this respect of less importance, as were marine mammals. Considering the local landscape and the site's location it is surprising that so few marine mammal remains were found. This was however also the case at all Mesolithic and Neolithic sites in the Rhine/Meuse delta, but most of those sites lay further inland, in the freshwater zone. The same was indeed also observed at most of the Late Neolithic sites in the former tidal area of West-Friesland. The only exception in that area is the Mienakker site (Schnitger 1991). Hunting for seals and other marine mammals was evidently in all periods and almost everywhere in the western Netherlands of minor importance. This is not easy to explain. Perhaps hunting at sea was more cumbersome than hunting on land.

Although the picture outlined above in broad lines applies to the entire period of occupation, some changes did take place in the course of time (fig. 22.15). After phase 1 cattle gradually became less important; this is particularly evident from the weights of the bones, more so than from their numbers. Cattle farming nevertheless remained the main source of animal protein throughout the entire period of occupation.

No trends are observable in pig and wild boar, but they do show fluctuations, of around 6 weight percent in the case of pig and 13 weight percent in the case of wild boar. The values obtained for red deer (excluding antler) are for all phases around 10% in numbers of identifications and around 15% in terms of weight. In phase 3 the weight percentage however rises to more than 30%, at an only slightly rising number percentage, implying that (relatively) large bones were deposited.

The latter is an intriguing observation that calls for an explanation. This effect was observed only among red deer remains, and not among the cattle bones. The fact that the average weights of the cattle bones from phases 2b and 3 are more or less the same tells us that the bones from the two phases underwent the same formation processes. The bones of both red deer and cattle from phase 2a are larger (heavier) than those from phases 2b and 3, but this is attributable to

Figure 22.14 Skeletal remains of sea mammals (scale 1:1). 10,185 thoracic vertebra of grey seal
8032 caudal vertebra of bottle-nosed dolphin

a difference in taphonomy: the layer containing the remains from phase 2b is a colluvium, whereas that containing those from phase 2a consists of trampled clay.

So the greater weight of the red deer bones from phase 3 relative to that of the bones from phase 2b can't be attributed to differences in postdepositional processes, because such processes are not species-specific. Are all the bones larger or is the difference caused by a limited number of large bones, and, if so, were they deposited in a special way? In an attempt to find an answer to this question the frequencies, numbers, weights and average weights of red deer bones from phases 2b and 3 on the different sides of the dune were compared. The bones from both phases were found to be substantially larger on the northwestern side than on the other sides, which can be explained by better preservation conditions. The weight proportions of the bones from the two phases are almost the same on that side (34 and 36%), so this factor does not explain the differences in the general average values.

The difference lies in the bones on the southeastern side, those from phase 3 being larger (heavier) than those from phase 2b – notably 25 grams on average as opposed to 11 grams. This difference is largely caused by eleven large parts of long bones – five humeri, four radii, one ulna and one metacarpus – found in the southern part of this side, in trenches 10-16. Without these large bones the average weight on this side would decrease from 25 to 14 grams. Interestingly, the bones in question all derive from forelegs, and in the overall identifications long bones from forelegs are also strongly dominant among the remains from phase 3, in terms of both number and dimensions. This is not the case with the bones from phase 2b.

So the greater weight of red deer bones from phase 3 is entirely due to the deposition of the long bones of forelegs, which underwent only little fragmentation, along a restricted stretch of the periphery of the dune. Such a deviating, localised deposition suggests some special activity whose remains cannot be stratigraphically distinguished from those of phase 3. One possibility is that the abandoned settlement site was later used as a hunting base. The large size of the bones could then be attributed to the absence of trampling by cattle. Evidently a red deer foreleg was from time to time consumed at the hunting base and the rest of the animal (hind legs, body, skin) was taken along to the new settlement.

22.8 Other purposes for which parts of mammals were used

Besides meat, the various species also yielded other products. The occupants of the dune used red deer antler and cattle and pig bones to make tools (chapter 10). They also used skins of both domestic and wild animals. Although only a (small) number of skeletal remains of cattle, pig, red deer, beaver and fox show cut marks indicating that the animals were skinned, it may be assumed that the skins of other (fur) species were used, too. A different indication of skinning is the exclusive or dominant occurrence of bones of the lower legs and/or the head of an

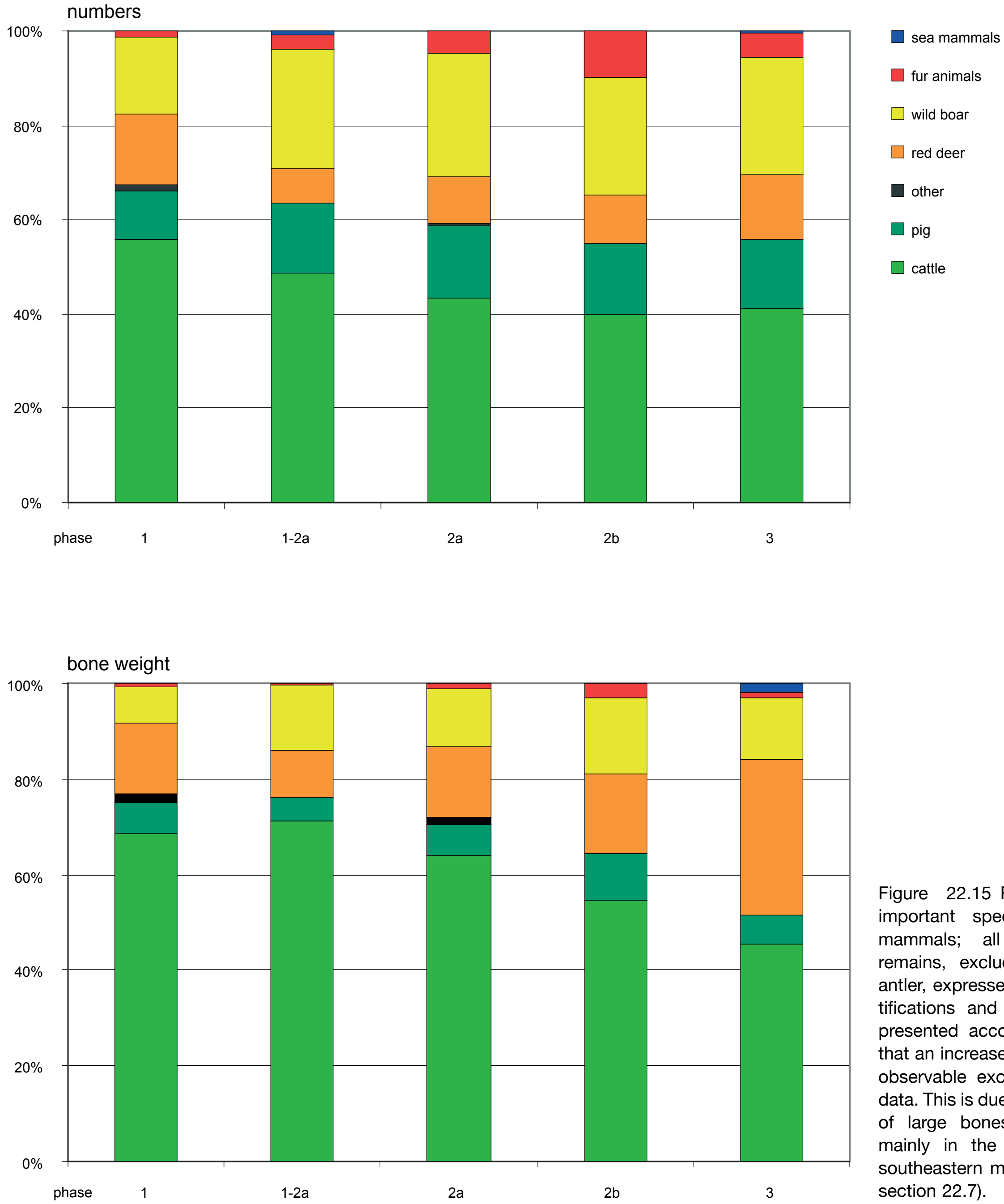

Figure 22.15 Ratios of the most important species and groups of mammals; all manually collected remains, excluding dog bones and antler, expressed as numbers of identifications and as bone weight and presented according to phase. Note that an increase in red deer remains is observable exclusively in the weight data. This is due to a restricted number of large bones, which were found mainly in the western part of the southeastern margin of the dune (see section 22.7).

animal, which implies that the animal was killed off-site and its fresh skin was brought back to the settlement for further processing. This holds for aurochs, brown bear and lynx. In the use-wear analysis of the flint tools evidence of the scraping of fresh and dried skins was frequently observed (chapter 7).

22.9 Seasonal evidence

Information on human activities in specific seasons was inferred from evidence provided by shed red deer antler and antler with parts of the skull attached, fur animals and marine mammals and the ages at which pig/wild boar and cattle were killed (figs. 22.16-17).

Red deer males shed their antler in late winter and early spring; the new antler is fully grown in the summer (July). As antler decomposes fairly quickly, shed antler will have been collected in February-April, too. Antlers with parts of the skull attached on the contrary point to active hunting in the period of August-January. Of the twenty collected antler bases 12 are from collected antlers and eight from shot animals. Both stages are fairly unequally distributed among the occupation phases – 14 antler bases from phase 2a are equally divided over both categories, the five bases from phases 2b and 3 are all from shed antlers.[6]

As far as fur animals are concerned, the quality of the fur is best in (late) winter. An exception is the fur of the otter; this animal sheds its hair gradually throughout the year, so its fur is of a constant quality. Although the occupants of Schipluiden also consumed the meat of some species (beaver, otter, fox), an important objective of their hunting strategies will generally have been to obtain fur. So we may safely assume that fur animals – excluding the otter – will have been most intensively hunted from late autumn until early spring (November-March).

As for the seals – the common seal may have been hunted in the dune's surroundings at any time of the year. This species tends to move around fairly little, unlike the grey seal, which leaves the coast in winter, going in search of deeper water. So the incidental occurrence of remains of this species indicates hunting in the period from spring until (late) autumn (April-October).

On the basis of the eruption of molars in lower and upper jaws of pig/wild boar and cattle, the ages at the time of death can in some cases be coupled to the month or season in which the animal must have been killed (table 22.23). In these calculations the average dates of birth of calves and piglets were set at 1 and 15 April, respectively. Both cattle and pig/wild boar were slaughtered in both the summer and the winter half of the year (fig. 22.16). The data relating to phase 2a in particular show that the greatest proportion of animals were killed between autumn and (early) spring (October-May). Extra information is provided by six foetal and/or neonatal skeletal remains – five of pig and one of a bovine animal. These animals must all have died in early spring.

The above data are summarised in fig. 22.17. Although the number of data varies substantially from one phase to another, there is evidence for human activities in all seasons in all the occupation phases. This is not to say that these data imply that the site was occupied on a year-round basis. Along with the results of the other studies they do however constitute a supportive argument in favour of permanent human presence and occupation of the dune.

22.10 Exploited ecozones

The results of the physical-geographical and palaeobotanical studies reveal an open landscape initially characterised by a salt-marsh vegetation that later gave way to a swamp vegetation. The brackish conditions of phase 1 were in the course of the occupation period replaced by freshwater conditions, which development was associated with the growth of reed and sedge peat. So we know what the landscape was like in general terms. Our understanding of small-scale landscape elements is however much poorer, and precisely these elements may have been important for the macrofauna.

The landscape reconstructions constitute the context for the assessment of the faunal data. Thanks to their preference for specific biotopes, the wild mammals provide supplementary information on the landscape. The species show us

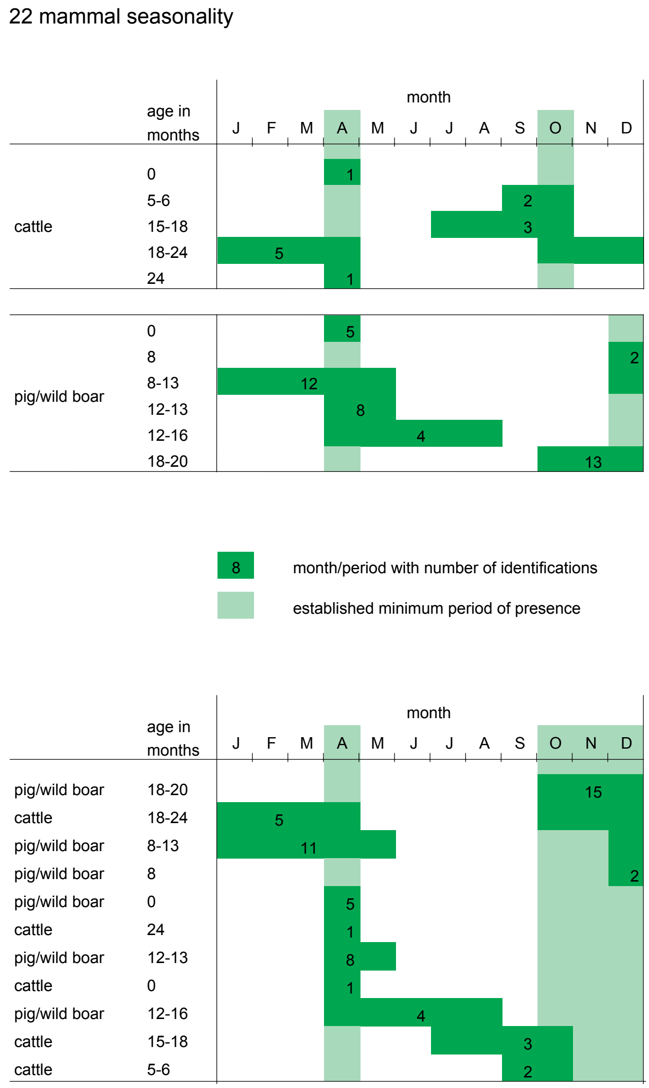

Figure 22.16 Seasonal indications based on culling ages of cattle and pig inferred from dental evidence.

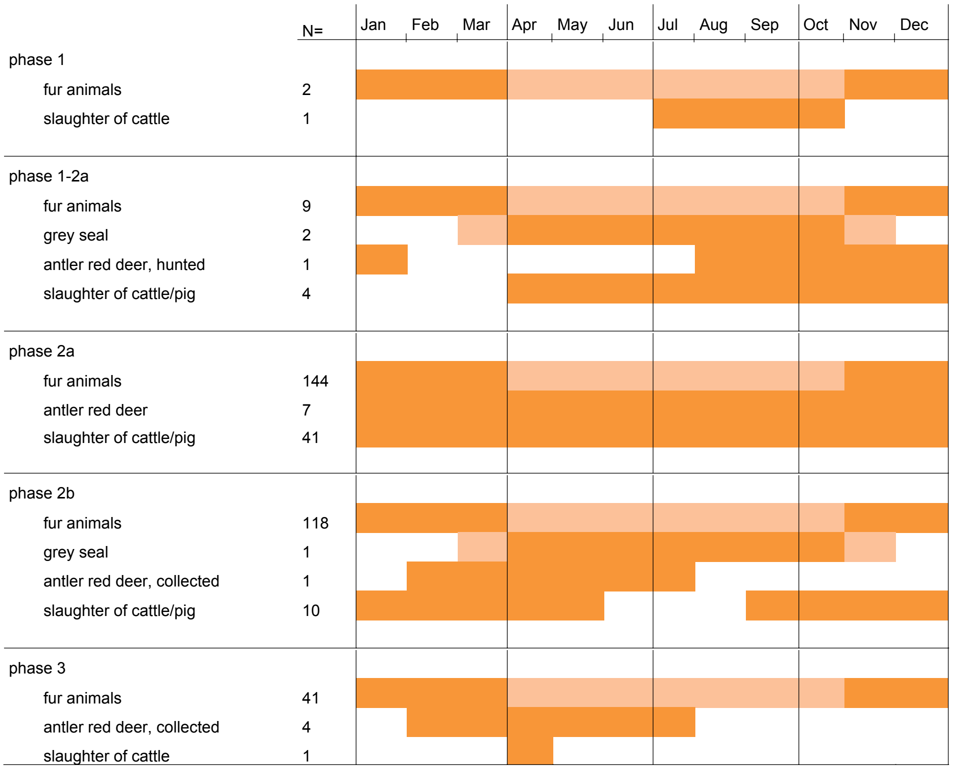

Figure 22.17 Seasonal indicators among the mammal bone remains, presented according to phase.

which ecozones were exploited within the occupants' daily action radius, which we may assume extended no further than 5 to 10 km from the dune.

The landscape must initially have been very suitable for cattle farming; this will indeed have been an important factor in the site's selection. The cattle will have been pastured in the dune's immediate surroundings, in particular on the (former) salt marshes and the beach plain. The presence of alder pollen in cattle coprolites (chapter 17) however indicates that cattle were also pastured in the swampy areas

age in months	month/period	phase					
		1	1-2a	2a	2b	3	totals
cattle							
0	April	–	–	1	–	–	1
5-6	September - October	–	–	1	1	–	2
15-18	July - October	1	1	1	–	–	3
18-24	October - April	–	–	5	–	–	5
24	April	–	–	–	–	1	1
	Totals	*1*	*1*	*8*	*1*	*1*	*12*
pig/wild boar							
0	April	–	–	3	2	–	5
8	December	–	–	–	2	–	2
8-13	December - May	–	–	10	2	–	12
12-13	April - May	–	1	5	2	–	8
12-16	April - August	–	1	3	–	–	4
18-20	October - December	–	1	12	–	–	13
	Totals	–	*3*	*33*	*8*	–	*44*

Table 22.23 Seasonal indications based on culling ages of cattle and pig as inferred from dental evidence, presented according to phase.

to the east of the dune. The decreasing proportion of cattle in the species spectrum after phase 1 may be associated with the changes that took place in the landscape, in particular the increasing growth of peat in the course of the occupation period, which will have led to a decrease in the area of pastureland.

The (open) landscape of the earliest phases was probably far less suitable for pigs and wild boars. There were for example no forests with an abundance of acorns (although they are of course available for only a limited part of the year). Wild boars moreover prefer semi-open areas in which they can find sufficient shelter. Nowadays the highest wild boar densities are found in flat areas abounding in water with deciduous forests and farmland. The landscape was probably not particularly suitable for red deer either. This species likewise prefers a semi-open landscape with mixed forests alternating with open plains. The landscape nevertheless afforded sufficient nutrients and shelter for red deer throughout the entire period of occupation. They were probably to be found in the brushwood behind the coastline, small woods on the scattered dunes and the carrs in the eastern part of the surrounding area. Red deer (fig. 22.18) may have been attracted by the lush pastures, too. Rather surprising in this context is that roe deer, which show a comparable biotope preference, were very scarce, or were perhaps not hunted. All in all, red deer and wild boar may have been hunted anywhere in the dune's surroundings, in different places and different biotopes.

Sheep and goat remains are conspicuously absent. Remains of sheep, and sometimes goats too, have been found at most Neolithic sites (if always in small quantities), even in environments, which at first sight seem to have been entirely unsuitable for these species. An example is Swifterbant, which also yielded evidence of liver fluke, which is lethal for sheep and goats (De Roever-Bonnet *et al.* 1979). Conditions at Schipluiden will certainly have been more favourable, comparatively speaking.

The bones of beavers are evidence of hunting in the swampy area to the east of the dune (fig.22.19). The beaver biotope must contain flowing or stagnant water with a depth of at least 50 cm and nutrients in the form of herbs, water plants and woody shrubs such as willows. Beavers show a strong preference for freshwater conditions, unlike otters, which are to be found in both freshwater and brackish environments and even along seacoasts. So otters may have been hunted in the swamp, but also in the brackish and saline ecozones, such as the estuary. Remarkable in this context is the absence of otter remains from phase 1, whereas beaver remains have survived from all the occupation phases in almost the same frequencies, and the numbers of beaver and otter remains surviving from the other phases don't differ that much.

The other wild mammal species were represented by (far) fewer remains. From those remains we can at least conclude that the species concerned were to be found in the dune's surroundings, but were for example less intensively hunted. This may hold for example for the polecat. Polecats are not restricted to a specific biotope, but they do like the proximity of water (Broekhuizen *et al.* 1992).

In some cases the absence of a suitable biotope for a specific species however plays an important part in interpretation. A case in point concerns the lynx, a species typical of large uninterrupted forested areas (Lange *et al.* 1994). It is highly unlikely that the lynx roamed the dune's surroundings; the represented remains most probably derive from skins that were imported via the occupants' far-reaching contacts with areas further south. The brown bear remains and some of the aurochs bones are also remnants of skins. Contrary to the lynx, these two species may however have been hunted in the dune's surroundings. From archaeological finds we know that both species were indigenous in these parts. So, although the brown bear, being a typical mixed forest occupant, is not really a species we would immediately associate with this landscape, it is quite possible that (roaming) individuals were from time to time to be found in the area.

Much less is known about the aurochs' biotope. Van Vuure (2003) writes: "Finds of bones and ancient sources suggest that there was a close affinity between the aurochs and swamps and swamp forests … for example river valleys, river deltas, salt marshes and other types of swamps". He (quite rightly) adds that the favourable preservation conditions in wet soils may have led to a strong bias in the species' distribution. In his opinion the many finds from wet areas nevertheless suggest that: "… such biotopes constituted at least an important part of the aurochs' local distribution". So whether this was indeed the case is questionable. Two thousand years earlier there were no aurochs to be found in the swamps surrounding Hardinxveld-Giessendam. The aurochs bones that were found there are imported tools.

Another species that we would not immediately expect to find in such a landscape is the European wildcat. It is nevertheless represented by a few dozen remains. Nowadays, the European wildcat is found only in higher parts, but in the past it roamed in lowlands, too (Lange *et al.* 1994). Remains of this animal have been found at most Mesolithic and Neolithic lowland sites. The landscape of the Schipluiden area evidently afforded sufficient shelter for this species in the form of brushwood and shrubs.

The other wild mammal species – wolf, fox and weasel – may have lived in the landscape, but they are not typical of it. No conclusions concerning the landscape can be drawn from the marten remains as those remains cannot be identified to species level (pine or stone marten).

Figure 22.18 Red deer in the lowlands in the present-day Oostvaardersplassen nature reserve in the IJsselmeerpolders. The animals were deliberately introduced there and are doing very well in this environment. Red deer disappeared from the lowlands in late prehistoric/early historical times due to reclamation and agrarian use of the land.

The remains of marine mammals from almost all the occupation phases indicate that the marine ecozone (coast and estuary) constantly formed part of the occupants' action radius, but was exploited to a limited extent only. Seals and bottle-nosed dolphins may have been actively hunted if they happened to come close to the coast or in the adjacent estuary. Bottle-nosed dolphins occur mainly in shallow coastal waters and sometimes swim up (large) rivers. Common and grey seals usually live close to or at the coast and in deltas (fig. 22.20); sometimes seals, especially common seals, swim up rivers (Lange *et al*. 1994). It is not certain whether the Schipluiden occupants actively hunted bottle-nosed dolphins and seals at the beach or on the water, or whether the represented remains derive from animals that got caught in nets or fish weirs. The cetacean vertebra most probably derives from an animal that was washed up on the shore.

22.11 Conclusions

Stock keeping and hunting game were important in the subsistence of the occupants of the dune. Cattle were by far the most important stock, followed by pigs. Sheep and goats were absent. The two main hunted species in terms of meat yield were red deer and wild boar. Throughout the entire period of occupation the occupants also – often incidentally – hunted a broad range of mammal species, including around ten fur animals and a few marine mammals. In a few cases they will have benefited from the availability of dead animals, such as a cetacean washed up on the beach. In all phases the occupants exploited several ecozones: the swamps to the east of the dune, the beach plain, other nearby dunes and the coastal zone with the estuaries it contained. The species spectrum is comparable with that of sites such as Ypenburg (De Vries 2004) and Hardinxveld-Giessendam De Bruin (Oversteegen *et al*. 2001). The results of the study of

Figure 22.19 Beavers were originally to be found in the Dutch wetlands in large numbers but they became extinct in the early 19th century. Reintroduction of beavers in nature reserves such as this one in the Oostvaardersplassen region has had varying results.

the mammal remains, along with those of the analyses of bird (chapter 23) and fish (chapter 25) remains, point to a highly diverse subsistence system.

In the course of time the importance of hunting increased at the expense of that of stock (cattle) keeping, possibly due to changes in the landscape: the growth of reed and sedge peat will have led to a decrease in the area of pastureland. Even so, cattle farming remained the most important source of animal protein throughout the entire period of occupation. Interesting is the substantial increase in the weight proportion of red deer remains from phase 3. This increase is entirely attributable to a deviating deposition of long bones of the forelegs along a limited stretch of the periphery of the dune. This could mean that the abandoned settlement site was later used as a hunting base.

As far as the exploitation of different types of mammals is concerned, there is a remarkable difference between the kill-off patterns of the cattle and those of hunted wild animals. The latter focused specifically on relatively old, adult individuals. Younger animals were killed only incidentally. This holds for both fur animals (otter and beaver) and red deer. Judging from the available data, a fairly large proportion of the cattle population was on the contrary slaughtered already before the end of the animals' second year. The exploitation patterns of domestic pigs and wild boars are much less clear because their remains could not be distinguished, as a result of which the ages at the time of death relate to a mixture of a domestic and a wild population. What can be inferred from the remains is that, as with the cattle, a large proportion derive from young animals. If the wild boars were hunted in the same manner as the other wild mammals, this would mean that the remains of young individuals derive mainly from domestic pigs and those of older animals partly from wild boars.

A question that arises in this context is whether the pigs were herded and kept largely separate from their wild relatives or whether they were allowed to roam unsupervised by humans (and dogs) – perhaps more often than the cattle. Albarella *et al.* (in press 2) have recently discussed a scenario involving extensive exploitation of a semi-wild population of pigs. In an ethnographic study they describe traditional pig-farming methods in Sardinia and Corsica. In spite of a substantial degree of variation, one of the most important characteristics of the farming system concerned is that the pigs roam either entirely freely within a range of at most 50 ha or in enclosed areas measuring 1 to 30 ha. The herds are relatively small (at most 50 animals). Interbreeding with wild boars occurs, but has no influence on the animals' body size as both the wild and the domestic species are dwarf types. The animals are caught by luring them with food or by driving them into an enclosure; sometimes they are shot. Very few animals are lost, both in the free-range herds and in the herds kept in the enclosures.

Sardinia and Corsica of course have specific climatic, natural and cultural conditions. So their extensive form of pig farming cannot simply be used as a model anywhere else, as the authors themselves indeed emphasise. At Schipluiden there were for example no forests where pigs could have foraged for acorns on a large scale. And the small number of animals lost in Corsica and Sardinia is without doubt (partly) attributable to the absence of large predators such as the wolf and the brown bear. The ethnographic study is however of value in that it warns us not to concentrate too much on distinguishing between the management of domestic and wild sources of food. The authors incidentally add that in cases in which the wild and domestic forms cannot be readily distinguished on metric grounds, the problem is not solved "...by introducing the possible existence of a third biological status placed somewhere between the wild boar and the domestic pig ...". They add that "...the emphasis in our explanations must be on *management* rather than *biological status*, as the second is by and large a product of the first."

It would seem that the pig-farming system described by Albarella *et al.* cannot be applied to Schipluiden. As already mentioned above, the conditions at Schipluiden differed substantially from those on the two islands in some respects. In the first place there were clear metric differences between the wild and the domestic pig populations. Secondly, the remains include bones of foetal or neonatal piglets. If we assume that they derive from domestic individuals, this means that pregnant sows and sows with piglets were kept on or near the dune itself. That is not in agreement with the above scenario based on extensive exploitation of

Figure 22.20 Grey seal and common seal on a shoal near the isle of Ameland in the Waddenzee. Both species occurred in the Meuse estuary and along the North Sea coast in prehistoric times but were hunted only incidentally throughout the Neolithic by the Schipluiden community.

a free-range semi-wild population. The problem, however, is that it is not possible to say whether the remains of such young animals derive from domestic or wild individuals. What we can ask ourselves is whether pregnant animals will at all have been hunted.

What should also be borne in mind in this context is that the remains include isolated milk premolars and teeth. They need not necessarily derive from slaughtered animals, but may also have been lost following natural replacement by permanent elements. Interestingly, the remains include far fewer of such elements from pig/wild boar than from cattle. In the case of both the manually collected remains and the remains recovered from the 4-mm sieve fraction, more than 40% of the total number of isolated cattle dental elements are milk premolars and teeth. The percentage for pig/wild boar is 2.5 to 3 times lower (13-17%). This difference cannot be attributed to a difference in kill-off patterns: in the case of both cattle and pig/wild boar a large proportion of young animals were slaughtered. A possible explanation could be that piglets, unlike calves, were only incidentally kept on the dune itself. This would mean that the pigs – including the sows with piglets – usually roamed freely, which would agree with the scenario based on extensive exploitation of a semi-wild population. A more obvious explanation however lies in the fact that, as with most of the other remains, it is not possible to say whether the milk molars and teeth of pig/wild boar derive from domestic or wild animals. The teeth of young wild boars were replaced off-site. So some of these elements are not represented in the overall assemblage of domestic and/or wild mammal remains, and their proportion is consequently much lower than that of cattle.

So, on the basis of the currently available evidence, there is no reason to assume extensive free-range pig farming at Schipluiden. The data clearly point to a domestic and a wild population, which will have been exploited in different ways: the former herded, the latter hunted. This does incidentally not necessarily mean that the two populations were kept strictly apart. Certainly if the pigs were allowed to forage unsupervised in the dune's surroundings they will have been in contact with their wild relatives, and that may well have involved some interbreeding.

notes

1 No literature data are available for age determinations of polecat, marten, European wildcat and common and grey seal. The data available for domestic cats were used – as a guideline – for the European wildcat (Habermehl 1975).

2 No wild/domestic distinction has been made in the measurements of the other skeletal elements; they are for this reason given under "pig/wild boar" in Appendix 22.2.

3 This number includes the fragments that were stuck together and fitting or associated fragments that were counted as a single fragment in the database. If they were to be counted individually, the total number of identified mammal remains would be around 14,000.

4 Of the 17 human remains, 14 were found among the manually collected remains and three in the 4-mm sieve fraction. These figures are 37 and two, respectively, for the 39 pieces of carved bone and antler.

5 The DPA and SDO of the ulna in the GIA reference collection are 34.2 and 28.2 mm; the measurements of the specimen from Schipluiden are 36.5 and 32.5 mm, respectively.

6 In these numbers are six worked antlers bases (chapter 10) included.

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Appendices

22.1A Mammal remains collected by hand: species versus skeletal element, numbers of identifications.

	cattle	pig	dog	cattle/ aurochs	aurochs	red deer	roe deer	wild boar	pig/ wild boar	beaver	otter	marten	polecat	fox	wolf	brown bear	wildcat	lynx	common seal	grey seal	bottle–nosed dolphin	whale
antler	–	–	–	–	–	1104	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
horn core	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
cranium	135	–	241	–	–	15	–	–	63	5	1	–	–	–	2	–	–	–	–	–	–	–
mandibula	220	8	58	2	–	35	–	17	424	7	40	–	7	1	–	3	5	–	–	–	–	–
maxilla	26	–	51	–	–	3	–	–	118	–	3	–	1	–	–	2	1	–	–	–	–	–
teeth	670	–	–	–	–	9	–	–	267	10	–	–	–	–	–	–	–	–	–	–	–	–
upper teeth	589	–	91	–	–	78	–	–	214	19	7	–	2	–	–	2	1	–	–	–	–	–
lower teeth	346	–	56	–	–	25	–	–	493	10	2	–	–	–	–	2	1	3	–	–	–	–
hyoid	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
vertebra	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
atlas	9	–	3	1	1	5	–	–	13	–	–	–	–	–	–	–	–	–	–	–	–	–
axis	3	–	19	–	–	4	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–
cervical vertebra	10	–	75	1	1	–	–	–	3	3	–	–	–	–	–	–	–	–	2	–	–	–
thoracic vertebra	20	–	6	1	–	1	–	–	14	–	–	–	–	–	1	–	–	–	–	1	–	–
lumbar vertebra	10	–	28	–	–	3	–	–	7	2	–	–	–	–	–	–	–	–	–	–	–	–
caudal vertebra	–	–	1	–	–	–	–	–	–	10	2	–	–	–	–	–	–	–	–	–	7	–
sacrum	8	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
rib	14	–	4	–	–	–	–	–	11	–	–	–	–	–	–	–	–	–	–	–	–	–
clavicula	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
scapula	77	–	6	–	–	24	–	–	55	4	2	–	–	–	–	–	1	–	–	–	–	–
humerus	120	2	17	1	–	34	–	5	97	4	26	–	–	1	–	–	3	–	–	–	–	–
radius	99	–	18	–	–	45	–	–	40	2	10	–	–	–	–	–	1	–	–	–	–	–
ulna	43	–	20	1	1	14	–	–	57	6	6	–	–	–	1	–	2	–	–	–	–	–
carpalia	45	–	16	–	3	49	–	–	47	–	–	–	–	–	–	–	–	–	–	–	–	–
metacarpus	143	–	–	1	–	11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
metacarpus1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
metacarpus2	–	–	8	–	–	–	–	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–
metacarpus3	–	–	7	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–
metacarpus4	–	–	2	–	–	–	–	–	14	–	1	–	–	–	–	–	–	–	–	–	–	–
metacarpus5	–	–	5	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–
pelvis	40	–	23	–	1	15	–	–	25	10	3	–	–	–	–	–	–	–	–	–	–	–
femur	94	–	28	–	–	23	–	–	58	10	18	–	1	–	–	–	–	–	–	–	–	–
patella	3	–	–	–	–	2	–	–	10	–	–	–	–	–	–	–	–	–	–	–	–	–
tibia	112	–	24	–	–	57	–	–	78	10	15	1	–	–	–	–	4	–	–	–	–	–
fibula	–	–	2	–	–	–	–	–	13	–	1	–	–	–	–	–	–	–	–	–	–	–
astragalus	25	5	6	–	–	33	–	3	26	6	9	–	–	–	–	–	–	–	–	–	–	–
calcaneus	35	–	4	–	–	26	–	1	38	–	10	–	–	–	–	–	2	–	–	–	–	–
tarsalia	43	–	5	–	2	27	–	–	31	–	1	–	–	–	–	–	–	–	–	2	–	–
carpalia/tarsalia	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
metatarsus	119	–	–	–	–	34	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
metatarsus1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
metatarsus2	–	–	3	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
metatarsus3	–	–	3	–	–	–	–	–	5	1	2	–	–	–	–	–	–	–	–	–	–	–
metatarsus4	–	–	5	–	–	–	–	–	14	2	1	–	–	–	–	–	–	–	–	–	–	–

	cattle	pig	dog	cattle/ aurochs	aurochs	red deer	roe deer	wild boar	pig/ wild boar	beaver	otter	marten	polecat	fox	wolf	brown bear	wildcat	lynx	common seal	grey seal	bottle–nosed dolphin	whale
metatarsus5	–	–	3	–	–	–	–	–	2	1	–	–	–	–	–	–	1	–	–	–	–	–
metapodia	34	–	5	–	–	5	1	–	38	–	–	–	–	–	–	–	–	–	–	–	–	–
phalanx I	53	–	20	–	3	51	–	–	69	3	1	1	–	–	–	1	–	–	1	1	–	–
phalanx II	38	–	7	1	2	30	–	–	53	2	–	–	–	–	–	–	–	–	–	–	–	–
phalanx III	10	–	5	–	–	6	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–
sesamoid	16	–	1	–	–	10	–	–	36	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals	*3270*	*15*	*879*	*9*	*14*	*1780*	*1*	*26*	*2480*	*129*	*163*	*2*	*11*	*2*	*4*	*10*	*22*	*3*	*4*	*4*	*7*	*1*

22.1B MAMMAL REMAINS COLLECTED FROM 4-MM SIEVE RESIDUES: SPECIES VERSUS SKELETAL ELEMENT, NUMBERS OF IDENTIFICATIONS.

	cattle	dog	red deer	pig/ wild boar	beaver	otter	marten	polecat	weasel	brown bear	wildcat
antler	–	–	41	–	–	–	–	–	–	–	–
horn core	27	–	–	–	–	–	–	–	–	–	–
cranium	1	1	–	2	–	–	–	–	–	–	–
mandibula	–	–	–	1	–	1	–	–	1	–	–
maxilla	–	–	–	1	–	1	–	1	–	–	–
teeth	197	–	3	191	2	–	–	–	–	–	–
upper teeth	17	30	–	17	–	5	2	–	–	–	2
lower teeth	18	13	1	45	–	3	–	1	–	–	4
scapula	–	–	–	–	–	–	–	–	–	–	1
humerus	1	–	–	–	–	1	–	–	–	–	–
radius	–	1	–	–	–	–	–	–	–	–	–
ulna	1	2	–	–	–	–	–	–	–	–	–
carpalia	–	4	–	2	–	–	–	–	–	–	–
metacarpus	1	–	–	–	–	1	–	–	–	–	–
metacarpus 1	–	1	–	–	–	–	–	–	–	–	2
metacarpus 2	–	–	–	–	–	1	–	–	–	–	–
metacarpus 3	–	–	–	1	–	1	–	–	–	–	1
metacarpus 5	–	–	–	1	–	1	–	–	–	–	–
pelvis	–	–	–	–	–	–	–	1	–	–	–
femur	–	–	–	–	–	1	–	–	–	–	–
patella	–	1	–	–	–	–	–	–	–	–	–
tibia	1	–	–	–	–	1	–	1	–	–	–
astragalus	–	–	–	–	–	1	–	–	–	–	–
calcaneus	–	–	–	–	–	1	–	–	–	–	–
tarsalia	–	–	–	2	–	1	–	–	–	–	–
metatarsus	–	–	1	–	–	1	–	–	–	–	–
metatarsus2	–	–	–	1	–	–	–	–	–	–	–
metatarsus5	–	–	–	–	–	1	–	–	–	–	–
metapodia	1	3	1	2	–	2	–	–	–	–	–
phalanx I	2	4	2	13	–	7	–	–	–	–	4
phalanx II	–	7	1	6	–	3	–	–	–	1	1
phalanx III	–	5	–	3	–	–	–	–	–	–	–
sesamoid	–	–	2	1	–	–	–	–	–	–	–
baculum	–	–	–	–	–	1	–	–	–	–	–
Totals	*267*	*72*	*52*	*289*	*2*	*35*	*2*	*4*	*1*	*1*	*15*

22.1C Mammal remains collected from 1- and 2-mm sieve residues: species versus skeletal element, numbers of identifications.

	cattle	dog	red deer	pig / wild boar	otter	wildcat
antler	–	–	2	–	–	–
cranium	–	–	–	2	–	–
mandibula	1	–	–	–	–	–
teeth	2	–	–	32	–	–
upper teeth	2	–	–	3	–	–
lower teeth	1	–	–	5	–	1
atlas	–	1	–	–	–	–
humerus	1	–	–	2	–	–
radius	–	–	1	–	–	–
metacarpus	–	–	1	–	–	1
femur	–	–	2	–	–	–
tibia	–	1	1	–	–	–
astragalus	–	–	1	2	–	–
calcaneus	–	–	3	–	–	–
tarsalia	–	–	–	1	1	–
metatarsus5	–	–	–	1	–	–
phalanx II	–	–	–	1	–	–
phalanx III	–	–	–	1	–	–
Totals	*7*	*2*	*11*	*50*	*1*	*2*

22.2: Abbreviations

BD	maximum width of the distal end
BG	width of the glenoid cavity (scapula)
BM3	width of the third molar
BP	maximal width of the proximal end
BT	maximum width of the trochlea (humerus)
DPA	depth across the processus anconeus (ulna)
GL	maximum length
GLL	maximum length of the lateral half (astragalus)
GLM	maximum length of the medial half (astragalus)
GLPE	maximum length of the peripheral half (phalanx I)
HVR	height of the vertical ramus (mandible)
LG	length of the glenoid cavity (scapula)
LM3	length of the third molar
M1-M3	length along the alveoles from first molar up to and including third molar
LP1-M3	length along the alveoles from first premolar up to and including third molar
LP1-M2	length along the alveoles from first premolar up to and including second molar
SD	minimum width of the diaphysis
SDO	minimum depth of the olecranon (ulna)
SL	snout length
SLC	minimum length of the collum scapulae
TL	total length (mandible)

22.2 MAMMAL REMAINS COLLECTED BY HAND: MEASUREMENTS (IN MM) OF SKELETAL ELEMENTS. In the case of pig/wild boar only the measurements of the humerus (BT), calcaneus (GL), astragalus (GLL) and mandible (LM3) were used to make a distinction between domestic pig and wild boar.

	measurements	values	range
cattle			
scapula	GLP	63.0; 61.0; 61.0; 61.7; 69.9	61.0 - 69.9
	SLC	56.5; 50.1; 47.8; 47.3; 48.8; 45.8	47.3 - 56.5
	LG	53.4; 51.8; 54.0; 52.4; 53.0; 59.4	51.8 - 59.4
	BG	49.6; 46.0; 45.7; 46.8; 42.7; 57.2	42.7 - 57.2
humerus	BT	74.4	
radius	BP	78.7	
	SD	37.1	
metacarpus	BP	54.3; 56.5; 58.0; 56.2; 53.7; 57.8; 54.8; 50.2	50.2 - 58.0
	BD	40.7; 39.6; 51.2; 53.3; 42.9; 64.9; 53.2; 41.7; 45.8; 43.7; 42.2; 55.8; 54.9; 43.4; 55.2	40.7 - 64.9
metatarsus	BP	50.5; 50.2; 45.3; 46.2; 44.7; 45.5	45.3 - 50.5
	SD	27.2; 24.9	24.9 - 27.2
	BD	54.9; 50.2; 53.9; 57.5; 52.3; 51.0; 51.0	50.2 - 57.5
	GL	237.5; 216.1	216.1 - 237..5
tibia	BD	56.1; 55.9	55.9 - 56.1
astragalus	BD	41.8; 39.6; 39.7; 40.9; 39.7; 42.6	39.6 - 42.6
	GLL	66.5; 66.1; 68.0; 67.2; 65.5; 64.8; 70.9; 66.6; 67.6; 65.6; 69.0; 64.0	64.0 - 70.9
	GLM	61.4; 61.5; 58.8; 60.3; 66.1; 59.0; 61.9; 59.9; 63.2; 57.1; 61.5; 63.0	57.1 - 63.2
calcaneus	GL	130.8	
phalanx I	BP	29.2; 26.8; 30.2	26.8 - 30.2
	SD	23.1; 22.2	22.2 - 23.1
	BD	26.7; 26.0; 25.8; 27.0	25.8 - 27.0
	GLPE	53.7; 53.3; 58.1; 65.1; 58.2	53.3 - 65.1
phalanx II	BP	26.6; 28.7; 26.2; 25.8; 26.9; 28.7; 23.6	23.6 - 28.7
	BD	22.9; 22.0; 21.4; 21.9; 22.6; 24..1	21.4 - 24.1
	GL	40.3; 42.5; 36.3; 37.5; 38.7; 39.1	36.3 - 42.5
aurochs			
phalanx I	BD	34.4	
phalanx I	BP	38	
	GLPE	75.5	
phalanx II	BP	42.6	
	BD	36.2	
	GL	51.3	
cattle/aurochs			
humerus	BD	87.1	
metacarpus	BD	70.6	
dog			
mandibula	LP1-M3	71.3; 71.1; 73.6; 64.4; 64.5; 69.3; 68.2; 67.5; 65.5; 70.4; 72.0; 75.7; 69.8; 68.4; 68.6	64.4 - 75.7
	HVR	46.5; 56.2; 51.7	46.5 - 56.2
	TL	121.6; 141.5; 127.2; 127.4	121.6 - 141.5
maxilla	LP1-M2	64.5; 64.3; 61.0	61.0 - 64.5
cranium	SL	81.5; 86.8; 85.9	81.5 - 86.8
	TL	173.9; 167.1; 169.9; 165.2	165.2 - 173.9
humerus*	SD	10.5; 10.5	
	BD	25	
	GL	132.7; 133.4	
radius*	BP	14.6	
	SD	10.9	
	BD	19.2	

	measurements	values	range
	GL	123	
femur	BP	37.4	
tibia	GL	160.5	
metacarpus 2	GL	53.8	
wolf			
ulna	DPA	36.5	
	SDO	32.5	
pig			
mandible	P2-M3	109.1	
	LM3	33.4; 33.5; 33.4; 34.1; 35.0; 33.8; 34.7	33.4 - 35.0
	BM3	15.0; 15.4; 15.1; 15.8; 16.2; 15.7; 16.9	15.0 - 16.9
humerus	BT	27.7; 29.9	27.7 - 29.9
astragalus	GLL	38.8; 41.8; 42.2; 42.5; 42.5	38.8 - 42.5
	GLM	36.5; 38.4; 38.8; 39.4	36.5 - 39.4
	BD	24.6	
pig/wild boar			
mandible	LM3	37.3; 36.7; 36.2; 36.4	36.2 - 37.3
	BM3	16.6; 16.0; 15.8; 16.1	15.8 - 16.6
maxilla	M1-M3	69.0; 70.2	69.0 - 70.2
	LM3	31.1; 33.0; 35.1; 36.4; 38.1; 38.8; 40.4; 40.6; 40.9	31.1 - 40.9
	BM3	18.4; 19.7; 21.2; 21.4; 21.9; 22.0; 22.8; 22.8; 24.0	18.4 - 24.0
scapula	GLP	36.4; 46.8	36.4 - 46.8
	SLC	24.5; 32.5	24.5 - 32.5
ulna	DPA	46.9	
phalanx I	BP	16.5	
	BD	15.3	
	GL	38	
wild boar			
mandible	M1-M3	75.7; 82.7; 79.9	75.7 - 82.7
	LM3	38.1; 38.5; 39.1; 40.2; 40.4; 40.5; 41.4; 42.6; 43.0; 43.1; 43.4; 44.3; 46.1; 40.3; 41.8	38.1 - 46.1
	BM3	17.2; 17.1; 17.6; 18.1; 18.6; 18.8; 19.0; 19.5; 19.6; 20.2; 20.9. 21.0; 22.0; 18.9; 20.4	17.1 - 22.0
humerus	BT	35.6; 31.6; 31.8; 34.1; 38.2	31.6 - 38.2
astragalus	GLL	47.6; 50.6; 52.3	47.6 - 52.3
	GLM	43.9; 46.6; 47.2	43.9 - 47.2
calcaneus	GL	94.6	

* one individual (DOG 01)

22.3 Associations of dog remains.

code	phase	no.	trench	body parts	specification of skeletal elements
dog 1	2a	1400	10	part of head, part of spine, ribs, part of left & right fore leg, part of left & right hind leg	left & right mandible; 3 cervical vertebra (incl. atlas & axis), 3 lumbar vertebra; 2 ribs
					left scapula, left ulna, left metacarpus 1-5, left carpal;
					right metacarpus 1-5, right carpal;
					left femur; right tarsal;
					4 phalanges I, 6 phalanges II, 3 phalanges III
dog 2	2a	7804	19	head, part of spine, part of left & right fore leg, part of left & right hind leg	cranium, left & right maxilla, left & right mandible; 3 cervical vertebra (incl. atlas), 6 lumbar vertebra; left scapula, left radius, left ulna, left metacarpus 2&5, left carpal
					right ulna, right metacarpus 2, right carpal;
					left femur, left tibia, left metatarsus 2&4;
					right femur, right tibia, right fibula, right metatarsus 4&5, right tarsal
	2a	8035	19	part of head, part of spine, part of (lower) fore leg	cranium; axis; left metacarpus 3
dog 3	3	6508 / 6513	17	part of spine, pelvis, part of left fore leg, part of left & right hind leg	thoracic vertebra, 2 lumbar vertebra left half of pelvis; left humerus, left femur, left tibia, left metatarsus 1-4
					right tibia, right astragalus
dog 4	3	843	16	part of left and right fore leg	left: humerus, ulna; right: humerus, radius, ulna, metacarpus 5
	3	902	16	head and part of spine	cranium, left & right maxilla, left & right mandible; atlas
	3	1455	16	part of left (lower) fore leg	metacarpus 2&3, carpale, phalanx I
	3	6386	17	part of right hind leg	femur, tibia, metatarsus 5, astragalus
	3	6297	17	scapula	parts of right scapula
head 1	3	5672	15	part of head	cranium, left & right maxilla
		5667	15	part of head	left & right mandible with associated teeth
head 2	2b	3184	18	part of head and part of spine	cranium, left maxilla, left & right mandible; atlas, axis
head 3	2a	7801	19	part of head	cranium, left & right maxilla with associated teeth
		7492	19	part of head	left & right mandible with associated teeth
head 4	2a	7803	19	part of head	cranium, left & right maxilla, left & right mandible
		7817	19	part of spine	3 cervical vertebra
head 5	2a	6348	15	part of head	cranium, right maxilla
		1698	16	part of head	cranium, left & right maxilla
		1677	16	part of head	left & right mandible with associated teeth
head 6	2a	10393	28	part of head	cranium, left & right maxilla
		10503	28	part of head	cranium, left & right maxilla
		10320	28	part of head	right mandible with associated teeth
		10270	27	part of head	teeth
		10350	27	part of head	right maxilla
		10378	27	part of head	mandibula
		10507	27	part of head	atlas
		10352	28	part of head	teeth
		10354	28	part of head	teeth
		10393	28	part of head	cranium
head 7	2a	5761	26	part of head	left mandible
		5771	26	part of head	teeth
		5765	26	part of head	right mandible
		5749	26	part of head	teeth
		5738	26	part of head	teeth
		5747	26	part of head	right maxilla, teeth
		5719	26	part of head	teeth

code	phase	no.	trench	body parts	specification of skeletal elements
skull 1	2a	7802	19	part of head	cranium, left & right maxilla
skull 2	2a	4554	20	part of head	cranium, right maxilla, teeth of left maxilla
skull 3	2a	4577	20	part of head	cranium, right maxilla with associated teeth
skull 4	2a	10125	29	part of head	cranium, left & right maxilla with associated teeth
skull 5	1/2	6441	12	part of head	cranium, left & right maxilla with associated teeth
mand. 1	2a	2323	14	mandible	left and right mandible
mand. 2	2a	3452	12	mandible	right mandible
	2b	3451	12	mandible	left mandible
varia 1	2a	10138	27	fore leg	metapodal, phalanges, carpalia
varia 2	2a	4488	22	pelvis	left & right half of pelvis

23 Birds

Jørn Zeiler

Throughout the entire period of occupation, birds were shot on a large scale on the Schipluiden dune, in particular water fowl, more specifically ducks. The hunting of a broad range of other bird species seems to have been more incidental. Besides information on the subsistence economy, the bird remains also give us an impression of the occupants' seasonal activities. They moreover provide additional information on the landscape surrounding the dune, the ecozones exploited by the occupants and the environmental changes that took place during the period of occupation.

23.1 Research questions

The study of the bird remains focused on the following research questions:

- Which species were hunted and in what ratios? What part did fowling play in subsistence in relation to stock keeping, hunting wild mammals and fishing?
- What information do the represented (migratory) bird species provide on the seasons in which the site was occupied?
- What information do the bird species provide on the former landscape and the exploited ecozones?
- Are there any indications suggesting that birds were exploited as a source of raw materials (feathers, down) or that birds may have had a symbolic meaning?
- Did any changes take place in the aforementioned aspects throughout the period of occupation?

As in the case of the study of the mammal remains (chapter 22), the answers to these questions can contribute towards the discussion of issues such as permanent occupation versus mobility, the site's function in the settlement system and the community's place in the neolithisation process.

23.2 Methods

The bird remains were collected in the same way as the mammal bones (section 22.2), and the same criteria as used for the bones of mammals were employed in the selection and analysis of those of the birds: in view of the large numbers of remains and the limited time and means available only the (readily) identifiable fragments were studied further. This approach seems to have involved little loss of information. In this chapter, 'bird remains' and 'bird bones' are hence understood to refer exclusively to the identifiable and identified bones.

Almost two-thirds of the bird bones were collected by hand, one-third was recovered from the 4-mm sieve and just over 3% from the 1- and 2-mm sieves. So the sieving through a sieve with a mesh width of 4 mm was definitely productive.

phase		1	1–2a	2a	2b	3	1–3	totals
collected by hand		28	192	1333	1126	622	182	3483
Units features		13	–	44	–	–	197	254
	Totals	*41*	*192*	*1377*	*1126*	*622*	*305*	*3737*
4-mm sieve		–	230	77	795	202	422	1726
Units features		–	–	–	–	–	174	174
	Totals	–	*230*	*77*	*795*	*202*	*422*	*1900*
1- and 2-mm sieve		9	5	50	14	55	13	146
Units features		–	–	4	–	–	41	45
	Totals	*9*	*5*	*54*	*14*	*55*	*21*	*191*

Table 23.1 Bird remains, numbers of identifications presented according to recovery technique, context and phase.

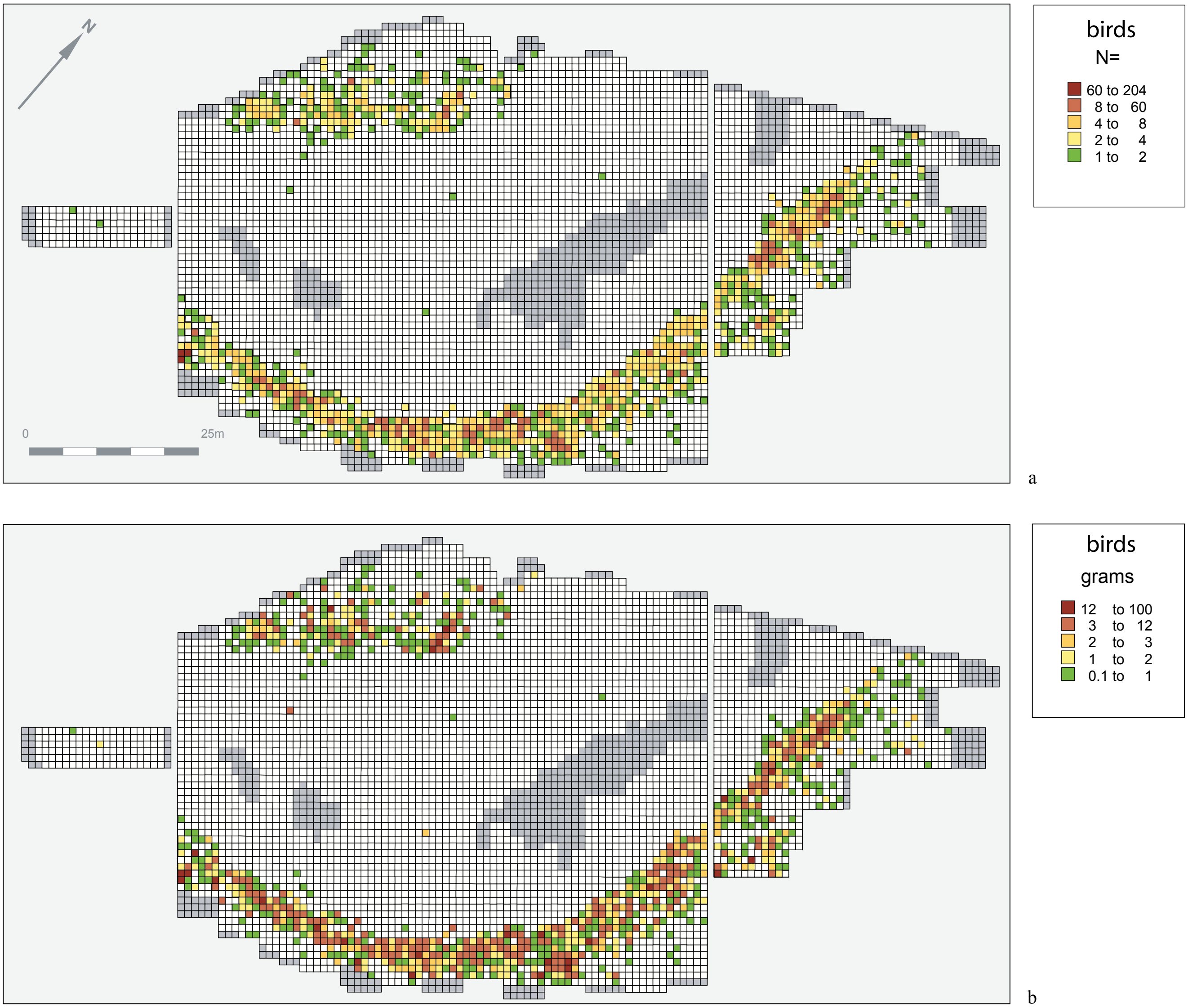


Figure 23.1 Distribution patterns of manually collected bird remains per square metre.
a numbers of identified bones
b bone weight

The bones were identified with the aid of the reference collection of the *Groninger Archeologisch Instituut* (GIA; Archaeological Institute of Groningen University). The fragments were counted and weighed in order to assess the ratios of the different species. Notable characteristics such as evidence of burning, slaughtering and gnawing were recorded to obtain an impression of the taphonomic processes. And, finally, on the basis of the traces of slaughtering on the bones and the distribution of the skeletal elements attempts were made to determine the purposes (meat, feathers, ritual) for which the different bird species were hunted.

23.3 Materials

23.3.1 Contexts

The Schipluiden assemblage of 5828 identified bird bones is by far the largest from Dutch prehistory – a good deal larger than for example those of the Late Mesolithic sites of Hardinxveld-Polderweg (N_{det} =643) and Hardinxveld-De Bruin (N_{det} = 954, Van Wijngaarden-Bakker *et al*. 2001;

no.	Unit / feature	phase	mallard	wigeon	pintail	garganey	teal/garganey	shoveler	duck	anser sp.	total ident.	totals
			N=									
285	10	3	40	19	7	–	–	5	132	–	71	132
256	10	3	15	9	–	–	–	–	54	–	24	54
294	15	2b	4	3	–	–	1	–	25	–	8	25
10.478	13-635	1-2a	2	–	–	–	7	–	14	2	9	16
10.081	11-532	1-2a	8	–	–	1	7	–	9	–	16	9
4545	18	2a	9	–	–	–	–	–	15	–	9	15
		Totals	*78*	*31*	*7*	*1*	*15*	*5*	*249*	*2*	*137*	*251*

Table 23.2 Bird remains, composition of the six largest associations.

Overstegen *et al*. 2001) and the Late Neolithic sites of Kolhorn (N_{det} =1411 and 979; Zeiler 1997) and Mienakker (N_{det} = 3594, Schnittger 1991). Sufficiently large samples (>200 identifications) are available from all the distinguished occupation phases except phase 1. Almost two-thirds (64%) of these remains could incidentally not be identified with any greater precision than as deriving from swan, goose or duck.

The majority of the identified bird bones come from the stratified deposits bordering the edges of the dune (fig. 23.1). A small proportion was recovered from features (table 23.1). This holds for both the remains that were gathered by hand and those recovered from the two sieve fractions. Two-thirds of the remains found in features came from wells, which is understandable considering their dimensions, number, depth, wet conditions and the fact that they were filled up within a short space of time. Waste was evidently primarily dumped in the wet peripheral zones of the dune, and to a much lesser extent in the wells.

We assume that the remains that were found here and there in the units represent the average outcome of long-term deposition processes, while the remains that were recovered from find concentrations within the units and in the rapidly filled wells represent brief deposition moments and single specific activities. The latter remains may tell us more about whether there was any degree of specialisation. The six largest assemblages of the hand-gathered remains, dating from different phases (table 23.2), reveal a conspicuous difference between two assemblages from wells and the other find groups. The remains from the wells comprise a relatively large number of teal bones, which are virtually absent in the other find groups. This suggests that the two groups of ducks were to some extent separately hunted. This is also suggested by the composition of the remains recovered from the 4-mm sieve fraction of a sample from one of the wells (feature 11-532): a large proportion of the remains (47%) were found to derive from teals. Find numbers 285 and 256 together comprise almost 50% of the bird bones from phase 3, so they greatly influence (distort?) our understanding of fowling in that period.

%	N=	body part head	body	wing	leg
collected by hand	3482	0.5	6.1	85.6	7.9
Units features	255	2.4	10.6	79.6	7.5
Totals	*3737*	*0.6*	*6.4*	*85.1*	*7.9*
4-mm sieve	1726	1	7.9	84.2	6.8
Units features	174	0.6	14.9	63.8	20.7
Totals	*1900*	*1*	*8.6*	*82.4*	*8.1*

Table 23.3 Bird remains, skeletal elements (body parts) versus recovery technique and general context.

%	burnt / charred	butchering marks	gnawing marks
collected by hand	4.6	0.1	0.2
4-mm sieve	10.4	–	–
1- and 2-mm sieve	11.5	–	–

Table 23.4 Bird bones with traces of burning, butchering or gnawing.

%	Units	features
collected by hand	4.9	1.6
4-mm sieve	10.8	5.7
1- and 2-mm sieve	6.2	28.9

Table 23.5 Bird bones with traces of burning per recovery technique and general context.

		N=							%						
	phase	1	1–2a	2a	2b	3	1–3	totals	1	1–2a	2a	2b	3	1–3	totals
swans															
whooper swan	*Cygnus cygnus*	2	–	3	–	–	–	5	5	–	+	–	–	–	0.1
Bewick's swan	*Cygnus bewickii*	–	–	3	–	–	3	6	–	–	+	–	–	–	0.2
mute swan	*Cygnus olor*	–	2	3	1	–	2	8	–	1	+	+	–	1	0.2
swan	*Cygnus sp.*	2	4	26	6	3	4	45	5	2	2	1	+	1	1.2
Subtotal		*4*	*6*	*35*	*7*	*3*	*9*	*64*	*10*	*3*	*3*	*1*	+	*2*	*1.7*
geese															
barnacle goose	*Branta leucopsis*	1	–	–	–	–	–	1	2	–	–	–	–	–	0.0
brent goose	*Branta bernicla*	–	–	2	2	–	–	4	–	–	+	+	–	–	0.1
barnacle/brent goose	*Branta sp.*	–	–	2	–	–	–	2	–	–	+	–	–	–	0.1
white-fronted goose	*Anser albifrons*	–	1	1	–	–	–	2	–	+	+	–	–	–	0.1
greylag goose	*Anser anser*	1	1	9	–	1	1	13	2	+	1	–	+	+	0.3
goose	*Anser sp.*	2	3	36	13	2	12	68	5	1	3	1	+	3	1.8
Subtotal		*4*	*5*	*50*	*15*	*3*	*13*	*90*	*10*	*2*	*4*	*1*	+	*3*	*2.4*
ducks															
pintail	*Anas acuta*	–	–	–	–	7	–	7	–	–	–	–	1	–	0.2
wigeon	*Mareca penelope*	1	4	13	8	30	1	57	2	2	1	1	5	+	1.5
goosander	*Mergus merganser*	–	–	–	1	–	–	1	–	–	–	+	–	–	0.0
teal	*Anas crecca*	–	1	5	–	–	–	6	–	+	+	–	–	–	0.2
teal / garganey	*A. crecca / querq.*	1	23	65	77	19	37	222	2	9	5	7	3	10	5.9
garganey	*Anas querquedula*	–	–	1	–	–	1	2	–	–	+	–	–	+	0.1
mallard	*Anas platyrhynchos*	18	71	364	260	146	117	976	44	29	28	23	24	31	26.1
eider	*Somateria mollissima*	–	–	2	1	1	1	5	–	–	+	+	+	+	0.1
shoveler	*Anas clypeata*	–	–	9	3	7	1	20	–	–	1	+	1	+	0.5
duck	*Anatidae*	10	119	709	728	391	188	2145	24	49	54	65	63	50	57.4
Subtotal		*30*	*218*	*1168*	*1078*	*601*	*346*	*3441*	*73*	*89*	*88*	*96*	*97*	*91*	*92.1*
birds of prey															
white-tailed eagle	*Haliaeetus albicilla*	2	4	14	5	2	–	27	5	2	1	+	+	–	0.7
marsh harrier	*Circus aeruginosus*	–	1	3	–	–	–	4	–	+	+	–	–	–	0.1
Subtotal		*2*	*5*	*17*	*5*	*2*	–	*31*	*5*	*2*	*1*	+	+	–	*0.8*
waders															
grey plover	*Pluvialis squatarola*	–	–	1	1	–	–	2	–	–	+	+	–	–	0.1
ruff	*Philomachus pugnax*	–	–	4	4	1	1	10	–	–	+	+	+	+	0.3
oystercatcher	*Haematopus ostralegus*	–	–	1	–	–	–	1	–	–	+	–	–	–	0.0
curlew	*Numenius arquata*	–	–	–	–	1	–	1	–	–	–	–	+	+	0.0
small wader	*Tringa sp*	–	–	–	–	–	1	1	–	–	–	–	–	+	0.0
Subtotal		–	–	*6*	*5*	*2*	*2*	*15*	–	–	+	+	+	*1*	*0.4*
other species															
gannet	*Sula bassana*	–	1	–	3	1	–	5	–	+	–	+	+	–	0.1
cormorant	*Phalacrocorax carbo*	–	1	23	5	4	2	35	–	+	2	+	1	1	0.9
grey heron	*Ardea cinerea*	–	–	4	–	1	1	6	–	–	+	–	+	+	0.2
crane	*Grus grus*	1	6	21	8	5	5	46	2	3	2	1	1	1	1.2
great black-backed gull	*Larus marinus*	–	2	1	–	–	–	3	–	1	+	–	–	–	0.1
carrion crow	*Corvus corone*	–	–	–	–	–	1	1	–	–	–	–	–	+	0.0
Subtotal		*1*	*10*	*49*	*16*	*11*	*9*	*96*	*2*	*4*	*4*	*1*	*2*	*2*	*2.6*
Totals		*41*	*244*	*1325*	*1126*	*622*	*379*	*3737*	*100*	*100*	*100*	*100*	*100*	*100*	*100.0*

Table 23.6 Bird remains collected by hand; identifications per phase, numbers of identifications and percentages. + = < 0.5%.

		W=							%						
	phase	1	1-2a	2a	2b	3	1-3	totals	1	1-2a	2a	2b	3	1-3	totals
swans															
whooper swan	*Cygnus cygnus*	11	–	18	–	–	–	29	9	–	1	–	–	–	0.9
Bewick's swan	*Cygnus bewickii*	–	–	18	–	–	7	26	–	–	1	–	–	2	0.8
mute swan	*Cygnus olor*	–	16	74	3	–	46	138	–	5	5	+	–	12	4.1
swan	*Cygnus sp.*	25	69	198	16	17	37	362	21	24	14	2	4	10	10.7
Subtotal		*36*	*85*	*309*	*19*	*17*	*90*	*555*	*31*	*30*	*22*	*2*	*4*	*24*	*16.5*
geese									0						
barnacle goose	*Branta leucopsis*	4	–	–	–	–	–	4	3	–	–	–	–	–	+
brent goose	*Branta bernicla*	–	–	2	4	–	–	5	–	–	+	+	–	–	+
barnacle/brent goose	*Branta sp.*	–	–	4	–	–	–	4	–	–	+	–	–	–	+
white-fronted goose	*Anser albifrons*	–	9	2	–	–	–	11	–	3	+	–	–	–	+
greylag goose	*Anser anser*	17	2	47	–	3	2	71	14	1	3	–	1	1	2.1
goose	*Anser sp.*	7	4	68	25	3	24	131	6	2	5	3	1	6	3.9
Subtotal		*27*	*15*	*122*	*29*	*6*	*26*	*225*	*23*	*5*	*9*	*4*	*2*	*7*	*6.7*
ducks									0						
pintail	*Anas acuta*	–	–	–	–	5	–	5	–	–	–	–	1	–	+
wigeon	*Mareca penelope*	1	2	9	7	14	–	33	1	1	1	1	3	–	1.0
goosander	*Mergus merganser*	–	–	–	+	–	–	+	–	–	–	+	–	–	+
teal	*Anas crecca*	–	+	2	–	–	–	2	–	+	+	–	–	–	+
teal / garganey	*A. crecca / querq.*	+	7	20	19	4	11	62	–	3	1	3	1	3	1.8
garganey	*Anas querquedula*	–	–	+	–	–	+	+	–	–	+	–	–	+	+
mallard	*Anas platyrhynchos*	28	89	335	251	141	129	972	24	31	24	32	35	35	28.8
eider	*Somateria mollissima*	–	–	2	2	2	1	7	–	–	+	+	1	+	+
shoveler	*Anas clypeata*	–	–	5	2	2	1	10	–	–	+	+	1	+	+
duck	*Anatidae*	12	54	388	373	183	89	1097	10	19	27	48	45	24	32.5
Subtotal		*40*	*152*	*761*	*654*	*350*	*231*	*2188*	*34*	*53*	*54*	*84*	*87*	*62*	*64.9*
birds of prey									0						
white-tailed eagle	*Haliaeetus albicilla*	11	22	41	22	1	–	97	10	8	3	3	+	–	2.9
marsh harrier	*Circus aeruginosus*	–	1	2	–	–	–	3	–	+	+	–	–	–	+
Subtotal		*11*	*23*	*43*	*22*	*1*	*–*	*100*	*10*	*8*	*3*	*3*	*+*	*–*	*3.0*
waders									0						
oystercatcher	*Haematopus ostralegus*	–	–	+	–	–	–	+	–	–	+	–	–	–	+
grey plover	*Pluvialis squatarola*	–	–	+	+	–	–	+	–	–	+	+	–	–	+
ruff	*Philomachus pugnax*	–	–	1	1	+	+	2	–	–	+	+	+	+	+
curlew	*Numenius arquata*	–	–	–	–	1	–	1	–	–	–	–	+	–	+
small wader	*Tringa sp.*	–	–	–	–	–	+	+	–	–	–	–	–	+	+
Subtotal		*–*	*–*	*1*	*1*	*1*	*1*	*4*	*–*	*–*	*+*	*+*	*+*	*+*	*+*
other species															
gannet	*Sula bassana*	–	1	–	12	4	–	17	–	+	–	2	1	–	+
cormorant	*Phalacrocorax carbo*	–	4	73	14	9	9	110	–	1	5	2	2	2	3.3
grey heron	*Ardea cinerea*	–	–	7	–	2	3	13	–	–	1	–	1	1	+
crane	*Grus grus*	3	7	96	24	16	13	160	3	3	7	3	4	4	4.7
great black-backed gull	*Larus marinus*	–	1	2	–	–	–	3	–	+	+	–	–	–	+
carrion crow	*Corvus corone*	–	–	–	–	–	+	+	–	–	–	–	–	+	+
Subtotal		*3*	*13*	*179*	*51*	*31*	*25*	*301*	*3*	*4*	*13*	*7*	*8*	*7*	*8.9*
Totals		*118*	*288*	*1414*	*775*	*405*	*373*	*3374*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

+ = 0.1 - 0.5 gram

Table 23.7 Bird remains collected by hand, identifications per phase; weight in grams and weight percentages.

		N=						%					
	phase	1-2a	2a	2b	3	1-3	totals	1-2a	2a	2b	3	1-3	totals
swans	*Cygnus sp.*	1	–	–	–	1	2	+	–	–	–	+	0.1
geese	*Anser sp.*	–	–	3	1	2	6	–	–	+	1	+	0.3
ducks													
pintail	*Anas acuta*	–	–	–	–	1	1	–	–	–	–	+	+
wigeon	*Mareca penelope*	3	–	5	–	1	9	1	–	1	–	+	+
teal	*Anas crecca*	1	–	–	–	–	1	+	–	–	–	–	+
teal / garganey	*A. crecca / querquedula*	35	7	105	26	147	320	12	29	13	13	25	16.8
mallard	*Anas platyrhynchos*	43	5	91	33	99	271	15	21	11	16	17	14.3
shoveler	*Anas clypeata*	–	–	1	–	–	1	–	–	+	–	–	0.1
duck	*Anatidae*	197	12	579	140	339	1267	70	50	73	69	57	66.7
Subtotal		*279*	*24*	*781*	*199*	*587*	*1870*	*99*	*100*	*98*	*99*	*99*	*98.4*
birds of prey													
white-tailed eagle	*Haliaeetus albicilla*	1	–	1	1	–	3	+	–	+	1	–	0.2
waders													
bar-tailed godwit	*Limosa lapponica*	1	–	1	1	–	3	+	–	+	1	–	0.2
dunlin	*Calidris alpina*	–	–	2	–	–	2	–	–	+	–	–	0.1
jack snipe	*Lymnocryptes minimus*	–	–	–	–	1	1	–	–	–	–	+	0.1
ruff	*Philomachus pugnax*	–	–	4	–	3	7	–	–	1	–	1	0.4
Subtotal		*1*	–	*7*	*1*	*4*	*13*	+	–	*1*	*1*	*1*	*0.7*
other species													
cormorant	*Phalacrocorax carbo*	–	–	1	–	1	2	–	–	+	–	+	0.1
crane	*Grus grus*	–	–	2	–	1	3	–	–	+	–	+	0.2
carrion crow	*Corvus corone*	1	–	–	–	–	1	+	–	–	–	–	0.1
Subtotal		*1*	–	*3*	–	*2*	*6*	+	–	+	–	+	*0.3*
Totals		*283*	*24*	*795*	*202*	*596*	*1900*	*100*	*100*	*100*	*100*	*100*	*100.0*

Table 23.8 Bird remains from 4-mm sieve residues, identifications per phase; numbers and percentages.

The remains gathered by hand from units and those recovered from features are more or less the same in terms of composition. There is for example little difference in the distribution of the skeletal elements: in the case of both the remains from units and those from features wing bones constitute more than three-quarters of the total number of identifiable remains (table 23.3). A slight difference is incidentally observable in the 4-mm sieve fraction: although the majority of the remains from both contexts derive from wings, the proportion of body and leg parts is substantially higher in the case of the remains recovered from features. The remains all came from one feature (11-532). Teals were evidently processed in a slightly different way.

23.3.2 Spatial distribution

The spatial distribution of the hand-gathered bird bones shows largely the same patterns as the distributions of the other find groups (fig. 23.1; see also chapter 4). Most remains were found in the wet swampy zone bordering the southern and southeastern flanks of the dune: 86% of the hand-gathered bird remains from units derive from those areas. A smaller cluster was found in the northwestern part. Relatively few remains were collected higher up the dune, also in comparison with the bones of mammals. This will be attributable to the fact that bird bones are more fragile, and will hence have been more susceptible to fracture due to trampling and bioturbation, certainly under the unfavourable preservation conditions higher up the dune.

23.3.3 Phasing

Most of the hand-gathered bird remains date from phases 2a and 2b and – to a slightly lesser extent – phase 3 (table 23.6). The majority of the 4-mm sieve remains date from phase 2b, whereas most of the remains from the 1-2-mm sieve fraction date from phases 2a and 3. A similar imbalance was observed in the remains representing the background fauna (chapter 24). It is directly associated with the unequal distribution of samples among the different occupation phases.

Remains from phase 1 were either absent or very scarce in all the fractions due to the find context (heavy clay) and the employed collection method.

		W=						%					
	phase	1-2a	2a	2b	3	1-3	totals	1-2a	2a	2b	3	1-3	totals
swans	*Cygnus sp.*	1	–	–	–	2	2	1	–	–	–	1	1
geese	*Anser sp.*	–	–	3	+	1	4	–	–	2	+	1	1
ducks													
pintail	*Anas acuta*	–	–	–	–	+	+	–	–	–	–	+	+
wigeon	*Mareca penelope*	1	–	1	–	+	2	2	–	+	–	+	+
teal	*Anas crecca*	+	–	–	–	–	+	+	–	–	–	–	+
teal / garganey	*A. crecca / querquedula*	5	1	14	3	19	42	11	24	9	8	18	12
mallard	*Anas platyrhynchos*	13	1	30	21	34	100	28	41	19	48	33	28
shoveler	*Anas clypeata*	–	–	+	–	–	+	–	–	+	–	–	+
duck	*Anatidae*	26	1	107	18	49	201	57	35	67	42	47	56
Subtotal		*44*	*3*	*152*	*43*	*103*	*345*	*98*	*100*	*95*	*98*	*97*	*96*
birds of prey													
white-tailed eagle	*Haliaeetus albicilla*	+	–	1	+	–	1	+	–	+	+	–	+
waders													
bar-tailed godwit	*Limosa lapponica*	+	–	+	+	–	1	+	–	+	+	–	+
dunlin	*Calidris alpina*	–	–	+	–	–	+	–	–	+	–	–	+
jack snipe	*Lymnocryptes minimus*	–	–	–	–	+	+	–	–	–	–	+	+
ruff	*Philomachus pugnax*	–	–	1	–	+	1	–	–	+	–	+	+
Subtotal		+	–	*2*	+	+	*3*	+	–	*1*	+	+	*1*
other species													
cormorant	*Phalacrocorax carbo*	–	–	3	–	+	3	–	–	2	–	+	1
crane	*Grus grus*	–	–	1	–	+	1	–	–	1	–	+	+
carrion crow	*Corvus corone*	+	–	–	–	–	+	+	–	–	–	–	+
Subtotal		+	–	*4*	–	*1*	*5*	+	–	*3*	–	*1*	*1*
Totals		*45*	*3*	*160*	*44*	*106*	*358*	*100*	*100*	*100*	*100*	*100*	*100*

+ = 0.1 - 0.5 gram

Table 23.9 Bird remains from 4-mm sieve residues; identifications per phase; weight in grams and weight percentages.

23.3.4 *Taphonomy*

In spite of the fairly high degree of fragmentation, the preservation of the bird remains can be classed as reasonable to good: in many cases the surface of the bone is not or only slightly worn.

Considering the assemblage as a whole, the proportion of burnt bone is small. The percentage of traces of burning is lowest in the case of the hand-gathered remains; it is substantially higher in the case of the remains from the sieve fractions (table 23.4). This is attributable to the fact that burning has a strong fragmenting effect, and smaller fragments are comparatively better represented in the finer sieve fractions.

A comparatively larger quantity of burnt remains ended up in the features (table 23.5). They do not represent residues remaining in hearths or hearth pits as none of the burnt remains were recovered from such features. It is more likely that they are fine burnt and trampled remains that made their way into former wells from the farmyards.

Traces of gnawing were observed on only six hand-gathered bones recovered from units. This by no means implies that gnawing played no part in the taphonomy of the bird bones. The fragile bird bones will have been much more readily devoured in their entirety by gnawing dogs than mammal bones, which will explain why half-eaten bones with tooth impressions were only sporadically encountered.

Evidence of butchering was likewise observed on only a few bird bones (five in total). This implies that birds – unlike mammals – were not dismembered prior to consumption, but cooked in their entirety, presumably after the removal of the head and the lower parts of the legs.

All in all, this scarcity of secondary evidence means that most of the bones were discarded in the places where they were found immediately after the processing and cooking of the birds, out of reach of scavengers and fire, and did not end up in those places via secondary processes such as colluviation. This confirms the interpretation of the find areas along the flanks of the dune – in particular that along the southeastern flank – as areas where waste was deliberately discarded.

Traces of burning, butchering and gnawing were observed on bones of a limited number of species. Traces of burning were almost exclusively found on bones of ducks in general and on those of shoveler (*Anas clypeata*), mallard (*Anas platyrhynchos*), teal or garganey (*Anas crecca*/*A. querquedula*). They were also observed on two fragments of goose bones (*Anser* sp.), one whooper swan bone (*Cygnus cygnus*) and one grey plover bone (*Pluvialis squatarola*). Of the three bones showing traces of gnawing by a dog two derive from a swan (*Cygnus* sp.) and one from a duck. One mallard bone shows evidence of gnawing characteristic of a small(er) carnivorous animal. Evidence of butchering, finally, was observed on two swan bones, one mallard bone and one cormorant bone. The evidence concerned in all cases consists of cut marks on wing bones, indicating that the meat was cut from the bones.

23.4 Identifications

23.4.1 Species spectra (tables 23.6-10)

Ducks, geese and swans (fig. 23.2)

Although the bones represent a broad range of species, ducks are by far the most numerous, amounting to >90% in numbers of identifications (fig. 23.3a). The most important duck species are mallard and teal or garganey (figs. 23.4-5). The latter two species can only be distinguished on the basis of one skeletal element (coracoid). The other species – wigeon (*Mareca penelope*), shoveler *(Anas clypeata),* pintail (*Anas acuta*), eider (*Somateria mollissima*) and goosander (*Mergus merganser*) – are represented in only small numbers. The majority of the goose remains derive from greylag goose (*Anser anser,* fig. 23.6).

Only a few remains of brent goose (*Branta bernicla,* fig. 23.7), barnacle goose (*Branta leucopsis*) and white-fronted goose (*Anser albifrons*) were identified. The identified swan remains are almost equally distributed among the three species whooper swan *(Cygnus cygnus,* fig. 23.8), Bewick's swan (*Cygnus bewickii*) and mute swan (*Cygnus olor*).

The majority of the duck, goose and swan bones are wing bones. Parts of the legs, body and head are much less numerous. The distribution of the skeletal elements was not affected by the employed collection method – the patterns observable in the hand-gathered remains and the various sieve fractions are largely the same (table 23.11).

Waders

Remains of waders are extremely scarce and were only encountered among the hand-gathered remains and in the 4-mm sieve fraction. Only remains of ruff (*Philomachus pugnax*) were regularly encountered. Other species are represented by only one or a few remains. The species in question are oystercatcher (*Haematopus ostralegus*), grey plover (*Pluvialis squatarola*), curlew (*Numenius arquata*), bar-tailed godwit (*Limosa lapponica*), dunlin (*Calidris alpina*), jack snipe (*Lymnocryptes minimus*) and *Tringa* sp., possibly redshank or spotted redshank. With the exception of leg bones of curlew and jack snipe, all the wader remains are wing bones.

Birds of prey (fig. 23.9)

Of the two represented birds of prey – marsh harrier (*Circus aeruginosus*) and white-tailed eagle (*Haliaeetus albicilla*) – the latter was encountered the most frequently. The marsh harrier bones are all wing bones. The proportion of elements from the (lower) legs of white-tailed eagle is remarkably high (approx. 67%). Most of those bones – 15 out of 20 – are phalanges (including claws). Wing bones constitute just over a quarter of the total number of remains. The other remains are part of a body (*sternum*) and part of a lower beak.

Other species (fig. 23.9)

The category of other species comprises the remains of six species, predominantly cormorant (*Phalacrocorax carbo*) and common crane (*Grus grus*), and to a lesser extent gannet (*Sula bassana*), great black-backed gull (*Larus marinus*), blue heron (*Ardea cinerea*) and carrion crow (*Corvus corone*). The cormorant bones derive from the head, body, wings and legs, with the proportion of wing bones being by far the largest (78%). Crane is represented by bones deriving from the same parts (except the head), but in the case of this species the proportion of (lower) leg bones is the highest (63%). The same distribution was observed in the case of white-tailed eagle. Wing and leg bones are equally distributed among the small numbers of gannet and blue heron bones, while the few great black-backed gull and carrion crow remains all derive from wings.

23.4.2 Differences in identification results between differently collected samples

As was to be expected, the average weight of the bird remains recovered from the 4-mm sieve fraction is lower than that of the hand-gathered remains: 0.2 g as opposed to 0.9 g. At 0.3 g, the average weight of the remains from the residue of the 1-2 mm sieve sample is a little higher, largely as a result of a number of larger remains of mallard and ducks in general, and one whooper swan bone. These samples were not dug up by hand but were taken from vertical sections.

The collection method of course influenced the identification ratios. Large species are overrepresented among the hand-gathered remains and underrepresented in the 4-mm sieve residues because the soil was in the latter case first picked over by hand. Remains of small species, but also identifiable small fragments dominate the sieve residues. Small teal and/or garganey remains and remains that could be identified with no greater precision than as deriving from ducks for example scored relatively high in the sieve residues. With due allowance for the ratio of the three fractions (1000:80:1) we may assume that the teals/garganeys

		N=							W=						
	phase	1	1-2a	2a	2b	3	1-3	total	1	1-2a	2a	2b	3	1-3	total
whooper swan	*Cygnus cygnus*	–	–	–	–	–	1	1	–	–	–	–	–	2.5	2.5
teal	*Anas crecca*	1	–	–	–	–	–	1	0.4	–	–	–	–	–	0.4
mallard	*Anas platyrhynchos*	2	1	12	–	21	9	45	2.8	0.3	3.3	–	13.2	5.2	24.8
teal / garganey	*A. crecca / querq.*	1	2	12	2	–	18	35	0.2	0.1	0.9	0.1	–	2.1	3.4
shoveler	*Anas clypeata*	–	–	–	1	–	–	1	–	–	–	0.1	–	–	0.1
duck	*Anatidae*	5	2	30	11	34	26	108	2.2	0.3	4.2	2.1	8.6	3.4	20.8
Totals		*9*	*5*	*54*	*14*	*55*	*54*	*191*	*5.6*	*0.7*	*8.4*	*2.3*	*21.8*	*13.2*	*52.0*

Table 23.10 Bird remains from 1- and 2-mm-sieve residues; identifications per phase; numbers and weights in grams.

Figure 23.2 Bird remains, water fowl (scale 1:1).

7811	Bewick's swan	*Cygnus bewckii*	carpometacarpus and scapula
6572	white-fronted goose	*Anser albifrons*	humerus
2019	mallard	*Anas platyrhynchus*	humerus
5502	shoveler	*Anas clypeata*	coracoid
8297	eider	*Somateria mollissima*	femur

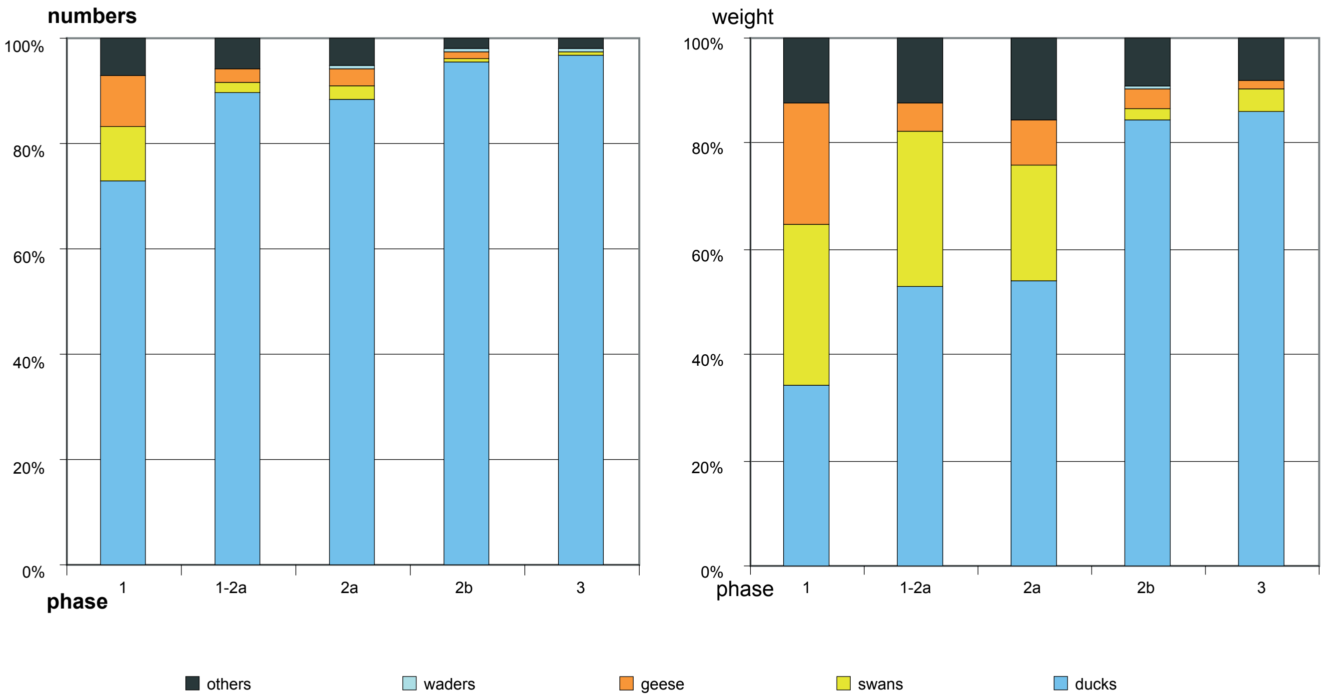


Figure 23.3 Birds, ratio of five main classes per phase. All classes, except ducks, show a decrease through time, especially swans and geese.
a numbers of identifications
b bone weight

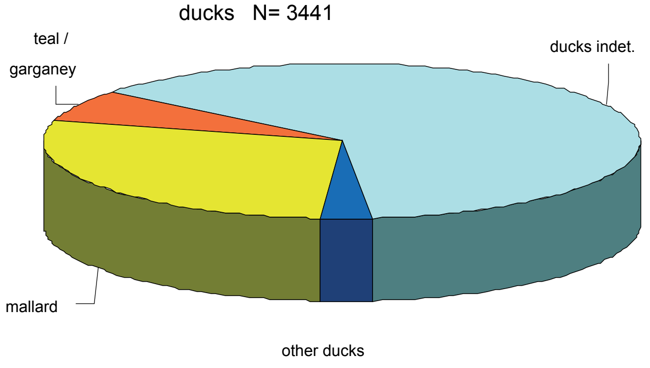


Figure 23.4 Ducks, manually collected bones; proportion of mallard and teal/garganey.

Figure 23.5 Mallard.

Figure 23.6 A family of greylag geese. Greylag geese started breeding (again) in the Netherlands in 1970 and are nowadays common wetland breeding fowl, unlike the other goose species. They were regularly shot by the Schipluiden inhabitants.

Figure 23.7 Part of a large group of brent geese on the island of Wieringen. The wetlands of the Netherlands are one of the main wintering regions for many goose species, which may form flocks of many thousands of individuals. The estuaries will have attracted the geese in prehistory, too, although there will then have been a wider range of suitable terrains. Brent geese are indicative of brackish and salt conditions.

Figure 23.8 Whooper swans, Oostvaardersplassen, March 2005. Whooper swans are arctic breeders and one of the most reliable winter indicators.

are greatly underrepresented in the hand-gathered bones. In numbers they are nevertheless no more significant than the mallard remains, because most of the *Anatidae* remains that could not be identified to species level will derive from mallard.

Species identified in the case of the wader remains recovered from the 4-mm sieve residues are, besides the relatively small ruff, one larger (bar-tailed godwit) and two new, smaller species (dunlin and jack snipe). The 1-2-mm sieve remains show no continuation of this trend. No remains of smaller birds, in particular *Passeriformes*, were identified in spite of the fact that 1.3 m^3 of find-containing soil was sieved. Such remains were also completely absent in the much larger 4-mm sieve sample. This indicates a systematic absence of such birds, which is in accordance with the general picture. Remains of small *Passeriformes* are even rarely found among the bones collected by sieving. In the rare cases in which they have been encountered, the remains each time comprised only one or a few bones, as for example at Hardinxveld-Giessendam De Bruin and Polderweg, Zeewijk and Kolhorn (Overstegen *et al*. 2001; Van Wijngaarden-Bakker *et al*. 2001; Zeiler 1988, 1997).

The question is which range represents the actual situation. This question is of particular importance in comparing the Schipluiden remains with other find assemblages. In view of the fact that around 8% of the soil was sieved, the actual archaeological ratios can be roughly reconstructed by adding 12 times the remains from the 4-mm sieve fraction to the remains gathered by hand. The totals thus obtained can be directly compared with figures from excavations in which all the soil was sieved, such as those of Hardinxveld and Swifterbant. The results are presented in table 23.11.

23.5 Subsistence

The large quantities of remains imply that fowling was practised on a large scale. The range of represented species is broad, but no more diverse than that of other large assemblages from the western Netherlands, such as the older ones of the Hardinxveld Polderweg and De Bruin sites and the younger ones of Kolhorn and Mienakker. The fowling activities focused on ducks. Being larger birds, geese and swans were of greater economic importance than the numbers of identified remains would suggest. Their relative importance is evident from the weight ratios, that of geese and swans together relative to ducks being 1:3 (fig. 23.3b). Most species will of course have been consumed. There are two further sources of evidence supporting this: traces of butchering and the distribution of the skeletal parts. The scarce traces of butchering in all cases (swan, mallard, cormorant) show that meat was cut from the bones. The great majority of the bones of ducks, swans and geese, but also that of for example the cormorant and wader bones are wing bones (table 23.12). In a natural assemblage, leg and wing bones will be represented in more or less equal proportions. In the case of consumption waste, wing bones are always represented in greater quantities than leg bones (Ericson 1987; Livingston 1989). The legs were evidently cut off before the other parts were cooked and were discarded in a different place from the bones from which the meat had been eaten. Two species are clearly exceptions in this respect: white-tailed eagle and crane. In the case of these species the numbers of identified leg bones are twice as high as the numbers of wing bones. This implies that these birds were treated differently, and were killed not (or at least not exclusively) for their meat, but (also) for other purposes. This will be discussed further in section 23.8.

The bird remains provide no clues as to the employed fowling methods. The birds were most probably caught with a bow and arrow and nets. In one case a bird was probably caught because it was less mobile: a scapula of a duck shows a thickened part, probably representing a healed fracture, which may have caused some stiffness in the wing.

Besides practising active fowling, the Schipluiden occupants probably also gathered dead birds that were washed up on the shore after storms. Anyone walking along the floodmarks left on a beach or salt marsh after a heavy storm today will regularly come across dead birds. It is quite conceivable that the dune's occupants gathered such birds – for either their

Figure 23.9 Bird remains, various species (scale 1:1)

4573	white-tailed eagle	*Haliaeetus albicilla*	phalanx
375	white-tailed eagle	*Haliaeetus albicilla*	coracoid
3257	blue heron	*Ardea cinerea*	humerus
530	cormorant	*Phalacrocorax carbo*	humerus
10,470	great black-backed gull	*Larus marinus*	coracoid
9820	crane	*Grus grus*	coracoid

	N=			%		
	collected by hand	4-mm corr. (×12)	totals	collected by hand	4-mm corr. (×12)	totals
swans	64	24	88	1.7	0.1	0.3
geese	90	72	162	2.4	0.3	0.6
mallard	977	3,252	4,229	26.1	14.3	15.9
teal / garganey	230	3,852	4,082	6.2	16.9	15.4
other duck species	90	132	222	2.4	0.6	0.8
ducks	2,144	15,204	17,348	57.4	66.7	65.4
Subtotal	*3,441*	*22,440*	*25,881*	*92.1*	*98.4*	*97.5*
birds of prey	31	36	67	0.8	0.2	0.3
waders	15	156	171	0.4	0.7	0.6
other species	96	72	168	2.6	0.3	0.6
Totals	*3,737*	*22,800*	*26,537*	*100.0*	*100.0*	*100.0*

Table 23.11 Birds, calculation of the total numbers of bird remains >4 mm present at the site by adding the volume-corrected data of the 4-mm sieve samples to the remains collected by hand.

meat or their feathers and down, depending of course on the freshness of the cadavers. Birds that may have been gathered like this are gannet and great black-backed gull, but also small waders that are relatively difficult to catch such as dunlin and jack snipe.

Some important shifts took place over the years. In the first place, the importance of both geese and swans decreased, from 20% in terms of the number of identified bones (fig. 23.3) in the case of both species in phase 1, via 7% in phase 2a to less than 1% in phase 3. This trend is even more pronounced in the weights of the bones. Some other species also decreased in importance, in particular white-tailed eagle. The already dominant importance of ducks meanwhile increased from 73 to 97%, presumably due to changes in the landscape; this will be discussed further in section 23.7. These observations are made with due allowance for the facts that the number of identified remains from phase 1 is limited, and that the majority of these remains come from

	head	body	wings			legs			totals
			long bones	carpalia phalan.	total	long bones	tarsalia phalan.	total	
collected by hand									
ducks	17	230	2919	68	2987	206	1	207	3441
geese	1	8	63	1	64	17	–	17	90
swans	2	1	43	3	46	15	–	15	64
cormorant	1	2	28	–	28	4	–	4	35
white-tailed eagle	1	1	8	–	8	4	13	17	27
crane	–	5	13	–	13	24	4	28	46
waders	–	–	14	–	14	1	–	1	15
other	–	–	14	–	14	5	–	5	19
4-mm sieve									
ducks	19	162	1204	342	1546	138	5	143	1870
geese	–	–	3	–	3	3	–	3	6
swans	–	1	1	–	1	–	–	–	2
cormorant	–	–	1	–	1	1	–	1	2
white-tailed eagle	–	–	–	–	–	–	3	3	3
crane	–	–	–	–	–	1	1	1	2
waders	–	–	12	–	12	1	–	1	13
other	–	–	1	–	1	–	–	–	1
1- and 2-mm sieve									
ducks	2	12	143	26	169	7	–	7	190
swans	–	–	1	–	1	–	–	–	1

Table 23.12 Birds, skeletal elements of body parts versus species and recovery technique.

clay Unit 19S, which was largely excavated with the aid of a digging machine. That will have led to a bias in favour of large remains, such as swan and goose bones. It should however also have led to a higher percentage of bones of other large species (cormorant, white-tailed eagle, crane and the like), and that is not the case.

Equally remarkable is that the group of ducks shows no comparable shifts, and that various species are represented in several phases. The latter holds for gannet, cormorant, crane, ruff and grey plover, and in the case of the ducks for wigeon, eider, shoveler and teal/garganey. This must imply that the environmental changes that took place between phases 1 and 3 were certainly not dramatic.

23.6 Seasonal evidence

Seasonal evidence is based on the presence of remains of migratory bird species and the assumption that the migratory behaviour of the species concerned was largely the same in the Neolithic as it is today. Recent shifts in migratory behaviour and breeding areas of various species however show that some degree of caution is called for in drawing conclusions. The periods indicated in figure 23.13 are based on the months in which the numbers of a particular species are nowadays the highest (Bekhuis *et al.* 1987; Bijlsma *et al.* 2001).

Determining in which seasons the site was occupied is not as simple as it may seem. In the first place the 'duck' and 'goose' identifications tell us nothing, because breeding and migratory behaviour are species-specific. Secondly, all resident birds provide no helpful information. A third difficulty is that many birds may indeed be migratory species, but they often spend a large part of the year in these areas and are truly absent for only a few months. And, finally, we suspect that the migratory behaviour of some species was different in the past than it is today, but that is hard to prove. When all these factors are taken into consideration even a large database like that of Schipluiden actually proves to contain only relatively few useful data. Some 'problematic cases' deserve special attention.

The *mute swan* (fig. 23.8) is currently a (fairly scarce) breeding bird in the Netherlands. The species has however

Figure 23.10 Common cranes as winter visitors in pastureland bordered by alders near Ruurlo in the eastern part of the Netherlands. It is assumed that common cranes bred in the wooded marshland along the lower courses of the Rhine and Meuse in prehistoric times.

enjoyed this status only since around 1950; before then it was exclusively a winter bird, visiting our parts from mid-November until early April (*Commissie voor de Nederlandse Avifauna* (Dutch Avifauna Committee) 1970). For this reason we may regard the mute swan as an indicator of winter site use in the Neolithic.

The *common crane* (fig. 23.10) nowadays occurs in the Netherlands in autumn and spring during its migration. In the past few years it has (again) been breeding in the Netherlands, in the Fochtelooërveen peat area. The bird avoids populated areas. This characteristic and the species' distribution in historical times make it highly likely that in prehistoric times cranes bred all over Europe in wooded swamps, so also in the Netherlands (Voous 1960). Crane remains in a Neolithic context may hence be regarded as evidence of summer site use, with a poorly known range. Whether cranes also bred in the Schipluiden region is not certain, especially as the earliest occupation phases are concerned, considering the site's former biotopes. There may have been breeding areas further east in the peat area.

The *white-tailed eagle* (fig. 23.11) likewise avoids populated areas. It may well have bred in the Netherlands in the Neolithic, though there is no unambiguous evidence to prove it. At present, it occurs in our country in the winter months, from September until March.

The *ruff* (fig. 23.12) is known in the Netherlands primarily as a breeding bird, favouring wet pastures, but in the past decades the disappearance of that biotope has led to a dramatic decline in the number of breeding birds of this species. The ruff also passes through the Netherlands on its migrations, and is then only scarce in the middle of winter. The same holds for the *marsh harrier*. The marshy beach plain at Schipluiden would appear to have been an ideal breeding biotope for both species. The *grey plover* breeds in northwestern Russia and western Siberia, but is nevertheless to be found in the Dutch coastal areas virtually throughout the year. Two other northern breeding birds, the *bar-tailed godwit* and the *dunlin,* show the same behaviour. These species are scarce for only one or two months in the summer (June-July). The *gannet* is a typical northern sea bird that is currently to be

Figure 23.11 Two white-tailed eagles – an adult and a juvenile – on a carcass of red deer in the Oostvaardersplassen nature reserve. The white-tailed eagle – nowadays a winter visitor only – has bred in 2006 for the first time in this large reserve, which has conditions similar to those of Delfland more than 5000 years ago: a rich fauna and large flocks of water fowl in summer and winter. The white-tailed eagle will have been shot for prestige and its feathers.

Figure 23.12 Two male ruffs fighting on their display ground. The ruff must have been a common bird in Delfland. It prefers marshy grassland, which was in prehistoric times widespread, but is nowadays rare, as are consequently also the ruff. The ruff is one of the few summer indicators. The males may have been shot especially for the colourful feathers of their collars.

found along the Dutch coast outside its breeding season, especially in the months from Augustus until November.

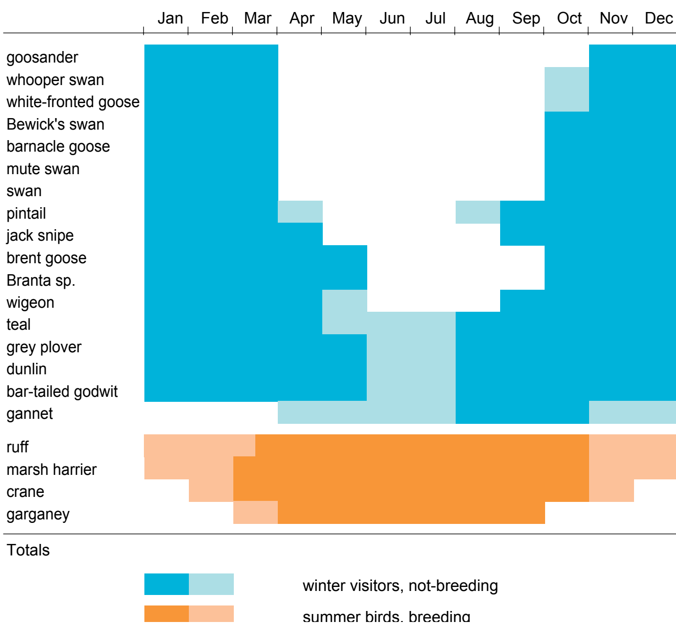
Winter birds 'proper' are to be found primarily among the *Anatidae*, the family comprising ducks, geese and swans: all swans and all geese except the greylag goose are winter visitors in the Netherlands. White-fronted goose and whooper swan have the shortest residence period, immediately followed by Bewick's swan, mute swan, barnacle goose and goosander (fig. 23.13). They are (or were) all actually absent in our country throughout the summer, so they provide the most convincing evidence of site use in winter. As all the three swan species are regarded as winter visitors, the remains that could not be identified with any greater precision than as deriving from 'swan' were also taken as evidence of winter use.

All in all, 243 out of the total of 2308 bird remains identified to species or genus level (9.3 %) could be used in determining the seasons of the site's use because the majority of the bones derive from mallard and teal/garganey.

All winter birds except for the wigeon are represented by only one or a few bones. Some typical winter visitors known from other Neolithic delta sites such as the red-throated diver (September-April), smew (November-March) and goldeneye (October-April) are absent. The seven pintail bones were all recovered from one find concentration and derive from (at least) three individuals.

Good summer indicators are scarce, but were at Schipluiden nevertheless represented by ruff, crane, marsh harrier and garganey, the first two both by several dozen bones. No remains of birds such as purple heron or Dalmatian pelican were found, but that may be partly attributable to the biotope.

Both the winter and the summer evidence are modest, but we do indeed have evidence relating to both seasons from all phases, and in equal proportions (figs. 23.14-15). The overall seasonal spectrum comprises at least one short period of occupation, either in March-April or from the end of September until the beginning of November. All the represented birds could in principle have been killed in one of these two short



	phase 1	1-2a	2a	2b	3	1-3	totals
goosander				1			1
whooper swan	2		3			1	6
white-fronted goose		1	1				2
Bewick's swan			3			3	6
barnacle goose	1						1
mute swan		2	3	1		2	8
swan	2	5	26	6	3	5	47
pintail					7	1	8
jack snipe						1	1
brent goose			2	2			4
Branta sp.			2				2
wigeon	4	4	13	13	30	2	66
teal	1	2	5				8
grey plover			1	1			2
dunlin				2			2
bar-tailed godwit		1		1	1		3
gannet		1		3	1		5
ruff			4	8	1	4	17
marsh harrier		1	3				4
crane	1	6	21	10	5	6	49
garganey			1				1
Totals	11	23	88	48	48	25	243

Figure 23.13 Birds as seasonal indicators. The combination of all identified species points to a presence at least in both early spring (March-April) and late autumn (October-November).

blue winter visitors
brown breeding birds
right: numbers of identifications per phase

periods. The actual period of occupation was in all probability however much longer, as all the species except gannet will have been present in the Netherlands in larger concentrations outside these periods. But the actual period cannot be determined with greater precision on the basis of the bird bone identifications alone. It would be too rash a conclusion to interpret the presence of 'summer birds' and 'winter birds' as evidence of permanent occupation. There is no concrete evidence, especially not for phase 3, for occupation in the winter, from November until the end of March.

23.7 Reconstruction of the former landscape

The bird remains reflect the landscape in the dune's wide surroundings via the eyes and preferences of the fowlers of the community that lived on the dune. We assume that their activities will have extended many kilometres from the site. In what parts of the landscape those activities took place will have depended on the territorial organisation (see chapter 27). Through their way of life and preferences for specific biotopes, the hunted bird species in turn enable us to form a more precise impression of the former landscape, in particular the water conditions. They also reveal the fowlers' range.

The many ducks, geese, swans and also the cormorant point to open water – both fresh and brackish to salty – bordered by reeds and swamp vegetation. The same conditions are indicated by the marsh harrier, crane, blue heron and white-tailed eagle. The latter two species also imply the presence of some (sturdy) marsh woodland for breeding. Most of the geese and some of the duck species, for example the wigeon, will moreover have required grassy foraging areas such as those afforded by the salt marshes and the beach plain.

All represented duck species forage in shallow water and on (partly submerged) grasslands, salt marshes and the like. Van Eerden (1998) reports as follows on wigeon, teal and garganey: "These species feed on salt marshes, sea grasses *Zostera* ssp. in tidal bays and pioneer vegetations under freshwater conditions." Diving ducks, whose distribution is largely dependent on the presence of open water with a depth of more than 50 cm, are totally absent. Two represented species are typical of deeper water – the cormorant and the goosander. The latter is however represented by only one bone fragment. This implies that there was fairly little deep water in the dune's surroundings in all the phases.

The scarcity of wader remains is in marked contrast with the landscape reconstructions based on physical-geographical and palaeobotanical evidence, which are dominated by openness, tidal influence and a salt-marsh vegetation that

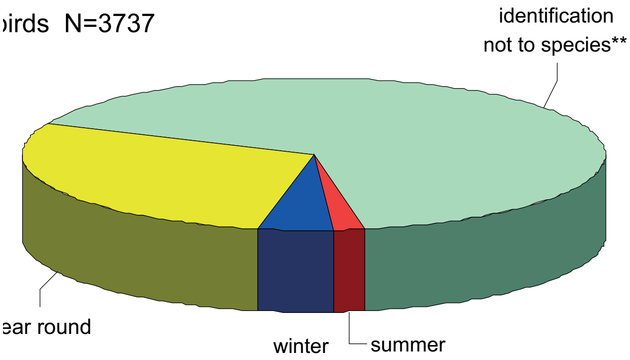


Figure 23.14 Proportions of summer and winter indicators among all bird bone identifications, material collected by hand. Not arranged per species: 'goose', 'duck', 'teal/garganey'.

later evolved into a swamp vegetation. The biotope typical of the ruff consists of wet pastures. A small range of species (grey plover, bar-tailed godwit, dunlin) indicates the presence of salt marshes in the vicinity of the dune and mud flats along the coast. Other birds indicating a marine environment are eider, brent and barnacle goose, gannet and great black-backed gull. The question is whether these birds were incidentally to be found in the dune's immediate surroundings or whether they were killed or gathered by fowlers at the coast.

The relative importance of geese and swans as hunted animals appears to have decreased in the course of the occupation period. This shift may be attributable to the changes that took place in the landscape. The landscape however remained attractive for various duck species, and the importance of water fowl relative to that of other hunted species (chapter 22) does not seem to have declined insofar as statements can be made on this issue on the basis of the recovered faunal remains.

The various palaeoecological studies show that the initially brackish conditions in phase 1 gradually gave way to a fresh-water environment in the course of the occupation period. This process was accompanied by the growth of sedge peat. These changes may have affected the numbers of birds in the dune's surroundings in different ways. For a good understanding of the effects of these changes on the avifauna we must first consider (differences in) the biological diversity and carrying capacity of the ecozones concerned. According to Van Eerden (1998), densities of water birds are much higher in salt marshes and tidal flats than in fen peats because the latter are partly wooded or "covered with rough shrubs not suitable for water birds." Peatlands are moreover poorer in food, especially if they are covered with sedge vegetations; vegetations consisting largely of reed are somewhat richer in food (Weeda *et al.* 1995). On top of this, the highly dynamic conditions in such environments constantly degrade the vegetational succession, each time leading to the formation of a new pioneer vegetation (Van Eerden 1998, Weeda *et al.* 1995). Pioneer vegetations are very productive and hence highly attractive for many bird species. A final factor to which attention should be called in this context is the great profusion of birds that is to be found in the mud-flat areas of northwestern Europe, which is largely attributable to the short food chain (algae–soil animals–birds) (Van de Kam *et al.* 1999).

The formation of sedge peat swamps at Schipluiden will hence have led to a (substantial) decrease in the density of birds in the dune's immediate surroundings. In the earliest occupation phase the brackish environment will have attracted large quantities of birds, and the occupants will have been able to kill birds on a large scale close to their settlement. But in the later phases the biotopes that were most attractive for birds (salt marshes, mud flats and the like) came to lie further away from the dune, and people will have had to travel further on their fowling expeditions.

The change to freshwater conditions and the growth of peat may also have led to a decrease in the area of open water. Sedge swamps are generally densely vegetated, with little room for open water. This will have been particularly unfavourable for geese and swans; ducks are much better capable of living in densely vegetated swamps. But this is not entirely clear. In

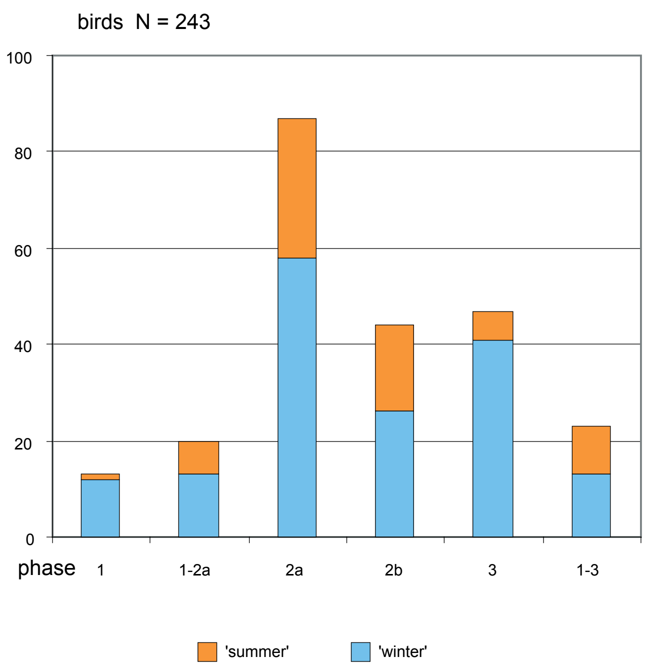


Figure 23.15 Numbers of identifications of bones of summer and winter birds per phase.

principle, the foraging of greylag geese could for example have held the swamp open (see *e.g*. Van Eerden 1998), but this was evidently not the case. Perhaps the rate at which things changed was too high and/or the greylag goose population was too small to have any impact on the vegetation.

The presence among the remains from the later occupation phases (2b and 3) of bones of a number of species that are characteristic of brackish and/or saltwater environments such as barnacle goose, eider, grey plover and gannet indicates that the occupants continued to exploit the coastal area in those phases.

23.8 Other purposes for which birds may have been killed

Most of the represented bird species were evidently consumed (see section 23.5). Indications of non-consumptive use are less clear. Feathers and down will certainly have been used but, unlike the skinning of mammals, the plucking of birds leaves no traces on the bones. The main indications of other uses of certain species are provided by the distributions of the skeletal elements. Contrary to those of most species, the remains of crane and white-tailed eagle are not dominated by wing elements but by parts of the legs – in the case of the cranes predominantly fragments of the long bones and in the case of the white-tailed eagle mainly phalanges (including claws). The latter is not attributable to white-tailed eagle phalanges and claws being more easily identifiable than those of other species. Generally speaking, these elements, and also other small elements such as carpal bones, are readily recognisable and can be identified to species level fairly well. This holds for both small and larger species. Some find numbers or successive numbers relate to bones that appear to derive from the same leg, suggesting that entire (lower) legs were discarded and later disintegrated. This will partly explain the relatively large number of bones, and may largely account for the deviating ratios.

Oddly enough, no such 'deviating' distributions of the skeletal parts of these two species were observed at the nearby Hazendonk site of Ypenburg. Of the 300 or so remains that were identified as deriving from *(cf.)* crane, 47% are wing elements and 41% leg elements, and of the 25 white-tailed eagle remains 15 are wing bones and 10 are parts of legs, including one claw (De Vries 2004). So the predominance of leg elements of white-tailed eagles and cranes at Schipluiden would seem to be an incidental rather than a structural feature.

The distributions of the skeletal elements of white-tailed eagle and crane at Schipluiden indicate that these birds were not, or at least not only, killed for their meat, but (partly) for some other purpose. Albarella (1997) suggests that cranes and large birds of prey were killed predominantly for their feathers. The meat of adult birds is assumed to be tough and not very tasty, making it unlikely that they were consumed, especially if there was a sufficient supply of other, more palatable birds. Von den Driesch (1999) however writes that the meat of cranes was on the contrary highly appreciated in classical antiquity.

Reichstein (1974) is of the opinion that white-tailed eagle may have been killed for ideological reasons, but also for its meat or feathers. Ethnographic evidence leads him to choose the latter as the most likely option. In his opinion the fact that the proportion of wing elements greatly exceeds that of leg elements at nine pre- and protohistoric sites in northern and central Europe confirms the assumption that white-tailed eagles were killed primarily for their feathers. This interpretation not only contradicts that of Ericson (1987) and Livingston (1989), who regard predominating quantities of wing bones as consumption waste, but is not supported by taphonomic evidence either.

Even if cranes and white-tailed eagles were indeed partly killed for their feathers at Schipluiden, this does not explain the large proportion of leg elements. There may have been other reasons why these birds were killed. Prestige and ascribed significance may have played a role in the fowling of these two species, which – especially white-tailed eagle – were impressive birds. It could be that their legs, in particular the claws of the white-tailed eagle, were for the same reasons deliberately deposited in other places than the same elements of 'ordinary' birds.

23.9 Conclusions

Throughout the entire period of occupation, the Schipluiden occupants killed birds – in particular water birds and especially ducks – on a large scale. They also – more incidentally – fowled for a broad range of other species. In combination with the (scarce) cut marks, the prevalence of wing bones of almost all species indicates that the birds were consumed. Along with the results of the analyses of remains of mammals (chapter 22) and fish (chapter 25), this indicates a highly diverse diet.

The presence of remains of both summer and winter visitors among the remains from all phases cannot be unambiguously interpreted by itself, but in combination with the results of the other analyses it may be an argument supporting the permanent presence of people at the site and occupation all the year round.

On the basis of the bird remains, the landscape in the wide surroundings of the dune can be described as wet and largely open, with marine influences. Elements characteristic of this landscape were shallow open water (both freshwater and brackish/salt water), salt marshes, swamps and – to a limited extent or further away – a coast with estuaries. Open water with a depth of more than 50 cm must have been relatively scarce in the dune's surroundings.

English	Dutch	scientific
barnacle goose	brandgans	*Branta leucopsis*
bar-tailed godwit	rosse grutto	*Limosa lapponica*
Bewick's swan	kleine zwaan	*Cygnus bewickii*
brent goose	rotgans	*Branta bernicla*
carrion crow	zwarte kraai	*Corvus corone*
cormorant	aalscholver	*Phalacrocorax carbo*
crane	kraanvogel	*Grus grus*
curlew	wulp	*Numenius arquata*
ducks	eenden	*Anatidae*
dunlin	bonte strandloper	*Calidris alpina*
eider	eidereend	*Somateria mollissima*
gannet	jan van gent	*Sula bassana*
garganey	zomertaling	*Anas querquedula*
goosander	grote zaagbek	*Mergus merganser*
goose	ganzen	*Anser sp.*
great black-backed gull	grote mantelmeeuw	*Larus marinus*
grey heron	blauwe reiger	*Ardea cinerea*
grey plover	zilverplevier	*Pluvialis squatarola*
greylag goose	grauwe gans	*Anser anser*
jack snipe	bokje	*Lymnocryptes minimus*
mallard	wilde eend	*Anas platyrhynchos*
marsh harrier	bruine kiekendief	*Circus aeruginosus*
mute swan	knobbelzwaan	*Cygnus olor*
oystercatcher	scholekster	*Haematopus ostralegus*
pintail	pijlstaart	*Anas acuta*
ruff	kemphaan	*Philomachus pugnax*
shoveler	slobeend	*Anas clypeata*
swan	zwanen	*Cygnus sp.*
teal	wintertaling	*Anas crecca*
white-fronted goose	kolgans	*Anser albifrons*
white-tailed eagle	zeearend	*Haliaeetus albicilla*
whooper swan	wilde zwaan	*Cygnus cygnus*
wigeon	smient	*Mareca penelope*

Table 23.13 Glossary of the English, Dutch and scientific names of the birds mentioned in the text.

In the course of the occupation period the number of geese and swans killed decreased while that of ducks increased. This will be attributable to changes in the landscape. The change to freshwater conditions and the associated growth of peat, in particular sedge peat, led to a biotope with a rougher vegetation that was less rich in food, and possibly also to a decrease in the area of open water. Biotopes that were most suitable for geese and swans (salt marshes, mud flats and the like) may consequently have come to lie further away from the dune, outside the occupants' action radius. The occupants nevertheless went on fowling expeditions far away from their site in the later occupation phases, too, as can be inferred from the presence of remains of species typical of the coastal area, such as eider, grey plover and gannet.

Besides the birds' meat, the occupants will have used their feathers and down, too, though there is no direct evidence to prove this. The distributions of the skeletal parts do however seem to indicate that white-tailed eagle and crane were not, or at least not only, killed for their meat, but possibly (also) for their feathers or for prestige-related reasons.

The large numbers of bird remains found at Schipluiden are in accordance with our understanding of Neolithic sites in the open coastal environment. That understanding is based largely on evidence obtained at Late Neolithic sites in the northwest of the Netherlands (Zeiler 1997; Gehasse 2001; De Vries 2001), but also on the evidence of the Hazendonk sites of Ypenburg and Wateringen 4, which lie in the same microregion as Schipluiden (Raemaekers *et al.* 1997; De Vries 2004). Sites in freshwater swampy areas on the whole yielded far fewer bird remains (Zeiler/Clason 1993), the most important exceptions being the early Hardinxveld-Giessendam De Bruin and Polderweg sites (Overstegen *et al.* 2001; Van Wijngaarden-Bakker *et al.* 2001). These differences between coastal areas and freshwater swamps will be partly due to factors such as the character of occupation (seasonal or permanent) and subsistence strategies (more or less stock keeping/hunting), but also largely to differences in ecological diversity. Being poor in food and having a rough vegetation, peat bogs are much less attractive for (migratory) birds than dynamic landscapes with estuaries, salt marshes and mud flats. The occupants of the Schipluiden dune probably selected this particular site partly on the basis of the abundance of birds in this area.

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24 Background fauna: small mammals, amphibians and reptiles

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Besides bones of animals that were brought to the settlement on the dune by the occupants – cattle, shot wild animals, caught fish – we also found remains of animals that ended up on the dune without human intervention, or secondarily via owls' pellets. The animals in question are small rodents and insectivores, amphibians and reptiles. They are to be regarded as representing the site's background fauna, and hence as indicators of the local environmental conditions.

24.1 Research questions

The animals covered in this chapter – small rodents and insectivores, amphibians and reptiles – can be regarded as background fauna. Their remains, unlike those of domestic and hunted animals, will generally speaking have ended up at the site without human intervention. That is why they are being discussed separately from the remains of birds and other mammals. The aim of the analysis of the background fauna was to obtain information on environmental conditions on and around the dune.

24.2 Methods

One of the aims of the special ecological sieving programme, using sieves with mesh widths of 1 and 2 mm, was to obtain a sample of remains of small mammals, amphibians and reptiles. Remains of these groups of animals were also recovered from the 4-mm sieve fraction and some were incidentally gathered in the general manual recovery of finds. As the cranial elements (including molars) of small rodents and insectivores

	phase	1-2a	2a	2b	3	1–3	totals
collected by hand							
mole	*Talpa europaea*	–	1	–	4	1	6
wood mouse	*Apodemus sylvaticus*	–	–	–	1	–	1
root vole	*Microtus oeconomus*	–	8	–	11	–	19
vole	*Microtidae*	–	1	7	10	–	18
small rodent	*Rodentia*	–	3	8	25	1	37
Totals		–	*13*	*15*	*51*	*2*	*81*
4-mm							
mole	*Talpa europaea*	4	–	4	8	–	16
common shrew	*Sorex araneus*	–	–	–	–	2	2
ground vole	*Arvicola terrestris*	2	–	–	1	–	3
root vole	*Microtus oeconomus*	9	8	16	2	13	48
vole	*Microtidae*	12	4	15	3	8	42
small rodent	*Rodentia*	8	10	8	6	14	46
Totals		*35*	*22*	*43*	*20*	*37*	*157*
1-and 2-mm							
common shrew	*Sorex araneus*	–	2	1	–	–	3
common / french shrew	*Sorex araneus / coronatus*	–	1	–	–	1	1
harvest mouse	*Micromys minutus*	–	–	–	–	1	1
wood mouse	*Apodemus sylvaticus*	–	–	–	1	–	1
bank vole	*Clethrionomys glareolus*	–	–	–	2	–	2
root vole	*Microtus oeconomus*	1	17	3	5	3	29
vole	*Microtidae*	4	66	10	28	20	128
small rodent	*Rodentia*	5	6	1	1	4	17
Totals		*10*	*92*	*15*	*37*	*29*	*183*

Table 24.1 Remains of small mammals presented according to recovery technique, species and phase.

samples N=	phase	1-2a	2a	2b	3	1-3	totals
collected by hand							
Units		–	13	15	51	2	81
features		–	–	–	–	–	–
Totals		–	*13*	*15*	*51*	*2*	*81*
4-mm sieve							
Units	320	35	22	43	20	34	154
features	8	–	–	–	–	3	3
Totals	*328*	*35*	*22*	*43*	*20*	*37*	*157*
1- and 2-mm sieve							
Units	119	10	85	15	37	3	150
features	19	–	7	–	–	26	33
Totals	*138*	*10*	*92*	*15*	*37*	*29*	*183*

Table 24.2 Remains of small mammals presented according to recovery technique, context and phase.

are the most suitable for species identification, only this category was used for this purpose. Postcranial elements were recorded as deriving from ‘small rodents’. An exception is the mole, whose postcranial elements can also be readily identified thanks to their specific morphology. The remains of small rodents and insectivores were identified by D.L. Bekker (*Vereniging voor Zoogdierkunde en Zoogdier-bescherming*; Association for the Study and Conservation of Mammals). The amphibians were identified on the basis of the data of Böhme (1977). The remains were only counted, not weighed.

24.3 Materials

The majority of the remains of small mammals and insectivores, amphibians and reptiles were found in the samples from phases 2a, 2b and 3. That none of the remains can be indisputably dated to phase 1 is to be attributed to the facts that the remains from the Unit concerned on the southeastern flank of the dune were collected mechanically and only a very small number of features can be dated to phase 1.

By far the most small mammal remains were recovered from the sieved material, the proportion recovered from the 4-mm sieve fraction being of the same order of magnitude as that recovered from the ecosieve fraction (table 24.1). Remarkably, 19% of the total number of remains were recovered by hand, indicating that the collecting was done most meticulously. It should incidentally be borne in mind that the figures quoted in table 24.1 are not representative of the actual ratios, as the ratio of the volumes of soil sampled according to the three collection methods (collection by hand, 4 mm sieve, 1 and 2 mm sieves) was roughly 1000 : 80 : 0.7 (m^3).

As for the context, the great majority of the remains (more than 91%) come from Units. The remains recovered from features almost all come from well fills; three remains were collected from depressions (table 24.2). Almost all the remains of amphibians and reptiles come from Units. Exceptions are four amphibian remains that were recovered from the ecosieve fractions of soil from two well fills. The number of amphibian remains is remarkably low, especially in relation to the number of small rodent remains (table 24.3). The fact that so few small mammal and amphibian remains were found in well fills indicates that the wells did not remain open for a long time and that they did not contain water for a long time either.

	phase	1-2a	2a	2b	3	1-3	totals
collected by hand							
common toad	*Bufo bufo*	–	1	–	1	–	2
toad	*Bufo sp.*	–	–	–	3	–	3
grass snake	*Natrix natrix*	134*	–	–	–	–	134
4-mm sieve							
frog	*Rana sp.*	–	–	1	1	–	2
toad or frog	*Anura*	–	–	1	1	–	2
1- and 2-mm sieve							
common toad	*Bufo bufo*	–	–	–	–	2	2
toad	*Bufo sp.*	–	2	–	–	–	2

* one individual

Table 24.3 Remains of amphibians and reptiles presented according to recovery technique and phase.

24.4 Results

24.4.1 General results

Tables 24.1 and 24.3 present the remains of small mammals, amphibians and reptiles per collection method and phase. The (few) amphibian remains are equally distributed across the three fractions in terms of numbers. Remains of reptiles, in this case grass snake (*Natrix natrix*), were encountered only among the remains collected by hand. The mammal remains almost all derive from small rodents and insectivores.

24.4.2 Rodents and insectivores (figs. 24.1-5)

As already mentioned above, all the rodent remains that were identified to species or genus level are cranial elements (jaws and stray molars). Two of those elements derive from wood mouse (*Apodemus sylvaticus*) and one from harvest mouse (*Micromys minutes*, fig. 24.2-3). The latter species had previously not been found at a prehistoric site in the Netherlands. What makes this find (a mandible) extra remarkable is that the length of the row of molars (2.93 mm) exceeds the maximum of 2.8 mm employed for Dutch harvest mice.

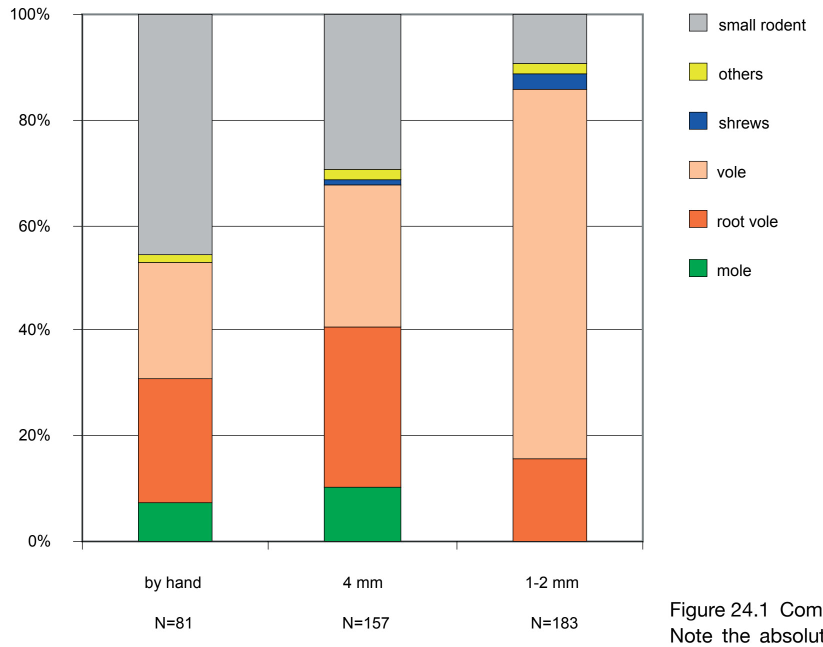

Figure 24.1 Composition of the samples of remains of small mammals. Note the absolute dominance of root vole. The graph illustrates the modest effect of the recovery technique on the species composition.

Higher values (of up to 3.1 mm) are however employed further east, for example in Germany. This implies regional variation in size. The Schipluiden find could imply chronological variation, too.

The others are all remains of voles. Insofar as they could be identified to species level, they almost all derive from the root vole (*Microtus oeconomus,* fig. 24.4-5), except for three remains of ground vole (*Arvicola terrestris*) and two of bank vole (*Clethrionomys glareolus*). This means that most of the remains that were identified as 'vole-like' will derive from root vole. The large differences in the numbers of remains of (root) voles between the occupation phases in the three fractions are attributable to the unequal distribution of the samples over the distinguished phases and to differences in preservation and recovery processes in the different kinds of soil in which the remains were buried.

Of the insectivores, the mole (*Talpa europaea*, fig. 24.4) was represented in the largest quantities. The remains concerned comprise both cranial and postcranial elements. Those of small insectivores (shrews) are exclusively cranial elements (mandibles). Five of those elements derive from the common shrew (fig. 24.4), two from the common shrew or Millet's shrew (*Sorex araneus*/*S. coronatus*).

24.4.3 Amphibians and reptiles

Nine out of the total of thirteen amphibian remains come from toads – four of which from the common toad (*Bufo bufo*), two from frog or toad (Anura) and two from frog (*Rana* sp.). As already mentioned above, the reptiles are represented by grass snake. The remains concerned are 81 vertebrae and 53 rib fragments from one individual (fig. 24.6).

24.5 Reconstruction of the former landscape

The facts that the small rodents are dominated by a single species and that the remains do not constitute a combination of species from different biotopes indicate that the assemblage represents the local rodent fauna of the dune and its flanks,

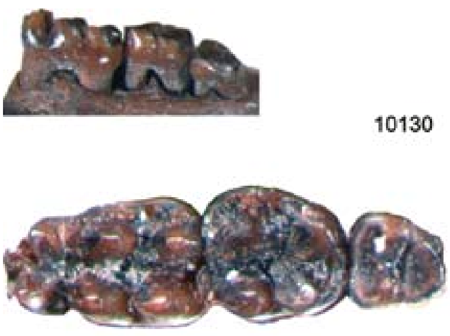

Figure 24.2 10,130 right mandible of harvest vole.
a lateral view (10×)
b occlusal view (20×)

Figure 24.3 Harvest vole.

but it may also include remains secondarily deposited via owls' pellets. A pronounced dominance of root vole is quite normal in highly dynamic biotopes.

The root vole and the ground vole are clear indicators of a wet landscape abounding in water. Water voles are found

Figure 24.4 Some remains of small mammals (magnification 4×).
4620 right mandible of mole
1482 right mandible of common shrew
2336 left mandible of root vole

along the banks of stagnant and slowly flowing water, preferably with a dense bank vegetation. The root vole prefers moist to waterlogged biotopes with a dense grass or shrub vegetation, such as peats, bogs, soggy and intensively used pastures and bank vegetations of streams and rivers. Unlike other vole species such as the field vole, this species can survive well in areas with varying water levels. The fact that this species was well represented at Neolithic sites such as Ypenburg (De Vries 2004), Swifterbant and Kolhorn (Zeiler 1997) indicates that it was quite common in those days. The dynamic environment during the Neolithic – with a coastline that was still interrupted by waterways, and creeks and rivers that could flood their banks without restraint – will have afforded an ideal habitat for the root vole (chapter 14).

The presence of bank vole in phase 3 indicates that the area was not entirely devoid of trees. This species prefers (moist) woods with a lush undergrowth, though it is also found in other biotopes (reed borders, tall herb vegetations), providing they do not lie too far from areas with plenty of trees. Of importance for harvest mice is a tall, dense vegetation. The species is to be found in areas of tangled growth, copses, (fairly dry) reedlands and dunes.

The other mammal species – wood mouse, wood shrew and mole – can live well in the landscape outlined above, but they are not characteristic of it. Moles will avoid very dry soil rather than excessively wet soil, and mole remains have also been found at other wet sites such as Swifterbant and Barendrecht (Zeiler 1997, 2000).

The amphibian and reptile remains, finally, also provide some information on the local environment: a moist to very

Figure 24.5 Root vole.

Figure 24.6 Vertebrae of grass snake *(Natrix natrix),* no. 2883 (magnification 4×).

wet landscape that however also contained drier areas (Arnold *et al*. 1992). The common toad has a fairly broad ecological amplitude; outside its mating and overwintering season it shows a preference for drier soil with some cover in the form of shrubbery. As the frog remains cannot be identified to species level they tell us little more about the former landscape than that it contained open (fresh) water. In general terms the very small number of amphibian remains implies that this biotope was rare on the dune and in its immediate surroundings. The presence of grass snake likewise points to open (fresh) water, although the species is also found in drier areas.

Diachronic changes in the environmental conditions on and around the dune cannot be demonstrated on the basis of the background fauna.

24.6 The microfauna in relation to the occupants

Generally speaking, the remains of small mammals, amphibians and reptiles will have ended up at the site without human intervention. They may have been secondarily deposited, via owls' pellets. The remains found at Schipluiden show no traces suggesting human use. They may therefore be interpreted as background fauna, and hence as indicators of the local environmental conditions. It should however be noted that this will not always be the case. Moles, for example, may have been caught for their skins (Jensen 1984). And as for amphibians: remains of natterjack toad (*Bufo calamita*) and common toad found at the Bronze Age sites P14 (Gehasse 1995) and De Bogen (Van Dijk *et al*. 2002) showed cut marks indicating consumption, or possibly medicinal or ritual use. In their survey of grass snake remains found in archaeological contexts, Van Wijngaarden and Troostheide

(2003) draw attention to the fact that the remains are all vertebrae (in one case combined with rib fragments). If the animals concerned had died a natural death then, according to the authors, parts of the head should have survived, too, but no such parts were found. One explanation for this could be that the animals were killed by a blow to the head that fractured their skulls. Possible reasons for killing grass snakes could have been use of the skin, consumption of the meat or use for ritual purposes.

English	Dutch	scientific
bank vole	rosse woelmuis	*Clethrionomys glareolus*
common shrew	gewone bosspitsmuis	*Sorex araneus*
french shrew	tweekleurige bosspitsmuis	*Sorex coronatus*
ground vole	woelrat	*Arvicola terrestris*
harvest mouse	dwergmuis	*Micromys minutus*
mole	mol	*Talpa europaea*
root vole	noordse woelmuis	*Microtus oeconomus*
small rodents	kleine knaagdieren	*Rodentia*
voles	woelmuizen	*Microtidae*
wood mouse	bosmuis	*Apodemus sylvaticus*

Table 24.4 Small mammals, glossary of the English, Dutch and scientific names.

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25 Fish

Dick Brinkhuizen

The occupants of the Schipluiden dune caught fish – especially the three migratory species eel, flounder and sturgeon – in an estuarine environment. They also caught freshwater fish (mainly Cyprinidae) and marine fish (grey mullets, bass, roker), even in the last occupation phase, by which time the local environment had become largely dominated by freshwater conditions. This means that the occupants purposely continued to exploit the estuarine environment. Large quantities of remains of young herring and smelt in old wells reflect incidental marine ingressions in the early occupation phases. A concentration of remains of eel and a few cyprinids may imply fishing in the freshwater environment, but these species may also have been caught in the estuary.

25.1 Research questions

The abundant quantities of – on the whole – reasonably well-preserved fish remains constitute an important source of information in the study of the Neolithic occupation of the Schipluiden-Harnaschpolder site. The ichthyoarchaeological research whose results are discussed in this chapter focused on the following questions:

- Subsistence: which fish species were exploited, in what quantities and in what manner? What can be said about the diversity of the fishing activities?
- Character of occupation: what information do the caught fish species provide on the seasons in which the site was occupied?
- Landscape: what information does the composition of the fish fauna provide on the aquatic environment in the dune's surroundings and on the exploited ecozones?
- Did any changes take place in the aforementioned aspects in the course of the occupation period?

25.2 Methods

The fish remains were collected in the same ways and for the same purposes as the mammal and bird remains (sections 22.2 and 23.2): the manual recovery technique focused on the fraction >2 cm, and the fraction up to 4 mm was recovered via systematic sieving through sieves with a mesh width of 4 mm. In addition, 5-litre samples were sieved through sieves with mesh widths of 2 and 1 mm to recover the finest remains.

To what extent the manual collection objective was realised was not checked in the case of the fish remains, partly because the remains were not measured. We may assume that the principles outlined in chapter 4 for pottery and flint also hold for the fish remains. This is indeed evident from the range of identifications. The manually collected remains moreover comprise a relatively random and small proportion of the finer fractions, and, the other way round, some remains of >2 cm were overlooked during the manual shovelling.

As for the fine (1- and 2-mm) sieved fraction: fish remains were identified in three samples from pit fills and six samples from the aquatic deposits.

The fish remains were separated from the manually collected remains and the remains recovered from the 4-mm sieve by J.T. Zeiler during his work on the other faunal remains.

In view of the vast quantities of remains recovered and the limited time and means available, a selection was made of the fish remains, as was also done for the mammal and bird remains. Only the (easily) identifiable fragments of the manually collected remains and those of the remains recovered from the 4-mm sieve fraction were selected for further analysis. The same procedure was followed for the selected 1- and 2-mm samples. This does however mean that only the number of identified remains is known; the total number of remains was not determined.

The manually collected fish remains were identified to species, genus or family level by examining them with the naked eye. Attempts were made to refit fragments to minimise the consequences of fracture. Many fragments of the bones of sturgeon (*Acipenser sturio*) were thus refitted.

In view of their minute dimensions, the fragments recovered from the sieves were studied under a stereomicroscope with 3.6×, 6× or 12× magnification. The remains were identified with the aid of the author's collection of present-day fish skeletons.

The fish remains were not weighed, except for the sturgeon bones from the manually collected assemblage and the 4-mm sieve fraction.

Noteworthy characteristics such as traces of burning, slaughtering and gnawing were recorded in order to obtain information on taphonomic processes. Pathologies (skeletal deviations) were also recorded.

25.3 Material

25.3.1 *Quantity*

Tens of thousands of fish remains were collected, and they represent only a proportion of the total number of remains that had survived at the site. Extrapolation leads to a total quantity of more than 100,000 fragments in the >4 mm fraction. It is impossible to estimate even roughly the number of remains in the finer fractions. After the aforementioned selection step, 7701 remains, representing all the distinguished phases and contexts and the different fractions, were identified to species, genus or family level (table 25.1).

phase	1	1-2a	2a	2b	3	1-3	totals
collected by hand							
Units	15	68	913	319	201	96	1612
features	2	12	29	–	–	167	210
Totals	*17*	*80*	*942*	*319*	*201*	*263*	*1822*
4-mm mesh							
Units	–	294	44	1076	339	493	2246
features	–	–	–	–	–	265	265
Totals	–	*294*	*44*	*1076*	*339*	*758*	*2511*
1-mm mesh							
Units	77	36	196	129	–	–	438
features	–	75	1922	–	768	165	2930
Totals	*77*	*111*	*2118*	*129*	*768*	*165*	*3368*

Table 25.1 Fish remains presented according to recovery technique, context and phase.

25.3.2 *Preservation*

The fish remains were found concentrated along the flanks of the dune, where the (wet) conditions were most favourable for preservation (fig. 25.1). Very few fish bones were found higher up the dune, which is largely attributable to the less favourable preservation conditions in those parts. Fish bones will moreover have been crushed by trampling and have been discarded by the occupants in the dump zones bordering the dune.

In the areas where fish bones were found, conditions for their preservation proved to have been good to moderately good. In the case of the majority of the bones except those of sturgeon, the outside of the bone had survived reasonably well. Many of the sturgeon bones had flaked or totally disintegrated into scales. Almost all the bones of sturgeon and the largest individuals of the other species were severely fragmented, as a result of which only very few dimensions could be measured.

25.3.3 *Contexts*

The fish bones came from two different contexts. The first context is the succession of deposits (units) covering the flanks of the dune. The manually collected bones and the remains recovered from the 4-mm sieve together accounted for almost 4000 identifications. They were supplemented with more than 1000 identifications obtained for the sieved residues of eleven 5-litre samples. One of these samples (no. 898) contained a distinct concentration of remains.

The second context comprised the large features (pit fills) found on the dune. In total, 210 fish remains manually collected from 35 pit fills were identified. They were supplemented with 265 identifications obtained for a sample from one pit that was sieved through a 4-mm mesh width. Large (5-litre) samples from two features on the northwestern side of the dune and one on the southeastern side were passed through sieves with mesh widths of 2 and 1 mm. These samples yielded more than 2000 identified remains. So the units and features show reversed ratios of large and small remains. This is due to the exceptional specific formation processes of the feature samples concerned, which were taken from concentrations of fine fish remains that were identifiable as such in the field.

25.4 The fish

25.4.1 *The species spectrum*

Twenty species were identified in the total quantity of fish remains – the manually collected bones and the remains recovered from the various sieve residues. Tables 25.2 – 25.4 provide a survey of the numbers of remains and the percentages of the identified species per phase for each of the recovery techniques. The publications of Nijssen/De Groot (1987) and De Nie (1996) were used for the species' scientific names.[1]

The spectrum comprises fish species of saline and fresh water, some of which migrate between the two. In the fractions from all the phases that yielded sufficiently large samples, migratory species dominated, being represented by 80-90%. In migratory fish a distinction is made between anadromous and catadromous species.

Anadromous species are fish that spend the greater part of their lives in the sea or in the brackish water of estuaries, but swim up rivers to spawn. Some species spawn just above the transition from the brackish water, others in the fast-flowing water of the upper courses of rivers. Six of the encountered fish species are anadromous: sturgeon *(Acipenser sturio),* allis shad/twaite shad (*Alosa alosa*/*A. fallax*), smelt *(Osmerus eperlanus),* whitefishes (*Coregonus* sp.), salmon/sea trout (*Salmo salar*/*S. trutta*) and three-spine stickleback (*Gasterosteus aculeatus*).

Catadromous species spend the greater part of their lives in fresh or brackish water and leave that environment to reproduce in salt water. Two of the encountered species are catadromous: eel (*Anguilla anguilla*) and flounder *(Pleuronectes flesus).*

Six of the represented species are stationary freshwater fish that can also live in weakly brackish water (Redeke,

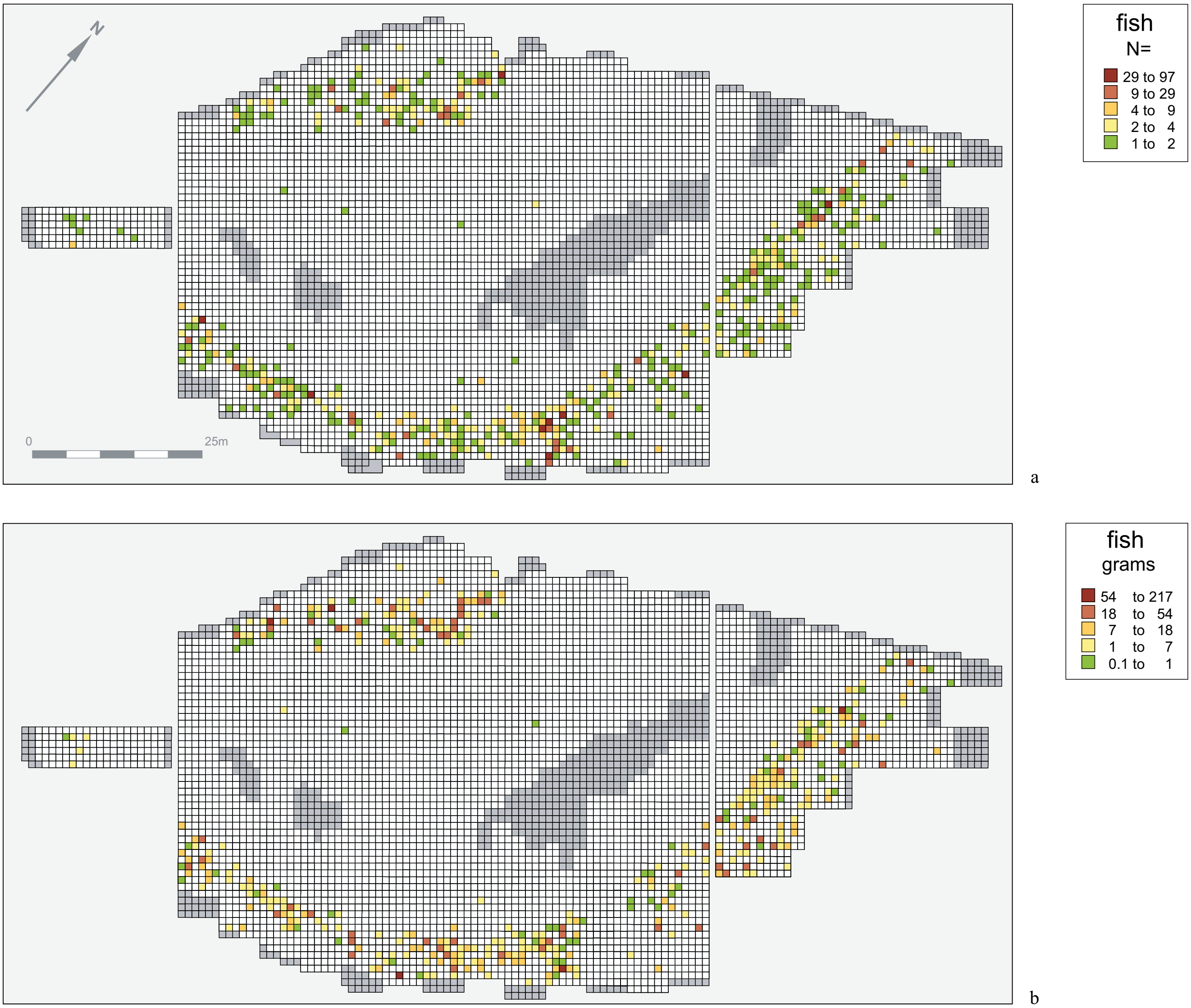


Figure 25.1 Distribution patterns of manually collected fish remains per square metre.
a number of identified bones
b bone weight

1941): pike (*Esox lucius*), perch (*Perca fluviatilis*) and members of the carp family (Cyprinidae): bream (*Abramis brama*), ide (*Leuciscus idus*), rudd (*Rutilus erythrophthalmus*) and roach (*Rutilus rutilus*). Most of the remains of this family could however not be identified to species level. The encountered species all commonly occur in stagnant or (gently) flowing fresh water – in the area known as the bream zone, which includes the basins of tidal rivers. Only modest numbers of remains of these species were found in all the fractions.

A freshwater fish species characteristic of the bream zone of which remains have been found at Neolithic sites, especially in the Rhine-Meuse-Scheldt basin, is the European catfish (*Silurus glanis*). No remains of this species were found at Schipluiden. Bones of large individuals would certainly have been encountered among the manually collected remains if this species had been caught and consumed. Evidently de European catfish did not occur in the waters fished by the Schipluiden occupants. It could be that the waters' salt content was too high for

		Units							selected features					other features					
	phase	1	1-2a	2a	2b	3	1-3	Totals	1-2	1-2a	2a	2	1-3	1	1-2	2a	2	1-3	Totals
	feature no.								13-585	12-48	12-36	10-140	18-350	N=1	N=2	N=7	N=2	N=16	
fresh water (stationary)																			
Abramis brama	bream	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Cyprinidae	carp family	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	1	2
Esox lucius	pike	–	–	2	–	1	1	4	–	–	–	–	–	–	–	–	–	–	–
Perca fluviatilis	perch	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
	Subtotal	*0*	*0*	*5*	*0*	*1*	*1*	*7*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*1*	*2*
anadromous / catadromous																			
Acipenser sturio	sturgeon	15	59	896	299	180	90	1539	31	–	–	26	38	2	1	2	5	16	121
Anguilla anguilla	eel	–	–	1	2	3	–	6	–	–	–	–	–	–	–	10	–	–	10
Coregonus spec.	whitefishes	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Salmo salar / trutta	salmon / sea trout	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Pleuronectes spec.	flounder / plaice / dab	–	2	4	12	5	–	23	–	12	6	1	–	–	–	2		2	23
	Subtotal	*15*	*62*	*902*	*313*	*188*	*90*	*1570*	*31*	*12*	*6*	*27*	*38*	*2*	*1*	*14*	*5*	*18*	*154*
marine																			
Raja clavata	roker	–	–	2	–	–	1	3	–	–	–	–	–	–	–	–	–	–	–
Liza ramada	thin-lipped grey mullet	–	2	1	1	6	–	10	–	–	2	2	–	–	5	1	–	2	12
Liza ramada / aurata	thin-lipped grey mullet / golden grey mullet	–	–	1	2	1	3	7	–	–	2	–	–	–	–	–	–	2	4
Mugilidae	grey mullets	–	1	2	1	4	1	9	–	–	1	–	–	–	–	1	–	–	2
Dicentrarchus labrax	bass	–	3	–	2	1	–	6	34	–	–	–	–	–	–	1	–	1	36
	Subtotal	*0*	*6*	*6*	*6*	*12*	*5*	*35*	*34*	*0*	*5*	*2*	*0*	*0*	*5*	*3*	*0*	*5*	*54*
	Totals	*15*	*68*	*913*	*319*	*201*	*96*	*1612*	*65*	*12*	*11*	*29*	*38*	*2*	*6*	*18*	*5*	*24*	*210*

Table 25.2 Fish remains collected by hand; numbers of identifications presented according to context and phase.

this species. It is also possible, though less likely, that European catfish did occur in small quantities, but were not caught.

The represented marine species are roker (*Raja clavata*), bass *(Dicentrarchus labrax),* thin-lipped grey mullet (*Liza ramada*), herring (*Clupea harengus*), common goby (*Pomatochistus microps*) and members of the flounder family (*Pleuronectes* spec.).

Roker and bass may enter estuaries, but only the saline parts. The various species of the Mugilidae (grey mullets family) likewise live in the sea, but are known not to shun brackish and fresh water. About one third of the remains identified as deriving from 'grey mullets' could be attributed to the thin-lipped grey mullet.

Herring and allis shad/twaite shad live in schools of fish of the same size and age. A school usually consists of a single species, but sometimes the fish are joined by a few individuals of different species. They are known as pelagic species, which are fish that don't forage for food along the seabed, but at the surface of the water or a few metres beneath it. Schools of young herring may be encountered close to the shore and they are tolerant of brackish to fresh water. In recording fish populations in the river IJ and the Noordzeekanaal near Amsterdam, Melchers/Timmermans (1991) frequently encountered young herring.

The common goby (figs. 25.2 and 25.10) is a species typical of brackish water. The three species – common goby, sand goby and Lozano's goby – are now common along the Dutch coast. The common goby can live in the sea, but it is most often encountered in brackish water; the other two are marine species that can live in brackish water, too. The common goby is the smallest of the three, growing to lengths of at most 6.5 cm. The sand goby is the largest, reaching lengths of up to 10 cm (Nijssen/De Groot 1987). Gobies (Gobiidae) have so far not been encountered in archaeological contexts in the Netherlands. Their occurrence at Schipluiden was restricted to one feature (12-36), which contained 18 remains of this family, among which were three operculars of the common goby. The fact that remains of this family were found at Schipluiden we owe to the use of the fine-meshed 1-mm sieve. No remains of this family were found in the 2-mm fraction of the same sample (see fig. 25.6).

A number of ossa pharyngea inferiores and cleithra of right-eyed flatfishes (*Pleuronectes* spec.) were found to still possess sufficient characteristics to allow identification to species level. The remains in question all derive from

		N=							%						
		Units						feature	Units						feature
	phase / feature	1-2a	2a	2b	3	1-3	Totals	11-532	1-2a	2a	2b	3	1-3	Totals	11-532
fresh water (stationary)															
Abramis brama	bream	–	–	–	–	3	3	–	–	–	–	–	0.6	0.1	–
Rutilus erythrophthalmus	rudd	–	–	2	–	–	2	–	–	–	0.2	–	–	0.1	–
Rutilus rutilus	roach	–	1	–	–	1	2	–	–	2.3	–	–	0.2	0.1	–
Cyprinidae	carp family	10	4	113	7	25	159	4	3.4	9.1	10.5	2.1	5.1	7.1	1.5
Esox lucius	pike	1	–	7	3	3	14	–	0.3	–	0.7	0.9	0.6	0.6	–
Perca fluviatilis	perch	–	–	7	1	1	9	–	–	–	0.7	0.3	0.2	0.4	–
	Subtotal	*11*	*5*	*129*	*11*	*33*	*189*	*4*	*3.7*	*11.4*	*12.1*	*3.3*	*6.7*	*8.4*	*1.5*
anadromous / catadromous															
Acipenser sturio	sturgeon	25	3	342	188	80	638	106	8.5	6.8	31.8	55.5	16.2	28.4	40.0
Anguilla anguilla	eel	48	9	105	18	48	228	21	16.3	20.5	9.8	5.3	9.7	10.2	7.9
Alosa alosa	allis shad	–	–	1	–	1	2	–	–	–	0.1	–	0.2	0.1	–
Alosa alosa / fallax	allis / twaite shad	–	–	2	–	1	3	1	–	–	0.2	–	0.2	0.1	0.4
Coregonus spec.	whitefishes	8	2	13	3	12	38	4	2.7	4.5	1.2	0.9	2.4	1.7	1.5
Salmo salar / trutta	salmon / sea trout	2	–	23	–	4	29	–	0.7	–	2.1	–	0.8	1.3	–
Gasterosteus aculeatus	stickleback	–	1	–	–	–	1	13	–	2.3	–	–	–	0.1	4.9
Pleuronectes flesus	flounder	1	–	1	–	1	3	–	0.3	–	0.1	–	0.2	0.1	–
Pleuronectes spec.	flounder / plaice / dab	179	22	424	113	297	1035	87	60.9	50.0	39.4	33.3	60.2	46.1	32.8
	Subtotal	*263*	*37*	*911*	*322*	*444*	*1977*	*232*	*89.4*	*84.1*	*84.7*	*94.2*	*90.1*	*88.0*	*87.5*
marine															
Raja clavata	roker	2	–	7	–	2	11	–	0.7	–	0.7	–	0.4	0.5	–
Liza ramada	thin-lipped grey mullet	3	–	4	3	1	11	–	1.0	–	0.4	0.9	0.2	0.5	–
Liza ramada / aurata	thin-lipped grey mullet / golden grey mullet	4	–	3	1	2	10	24	1.4	–	0.3	0.3	0.4	0.4	9.1
Mugilidae	grey mullets	6	–	4	–	9	19	–	2.0	–	0.4	–	1.8	0.8	–
Dicentrarchus labrax	bass	5	2	18	2	2	29	5	1.7	4.5	1.7	0.6	0.4	1.3	1.9
	Subtotal	*20*	*2*	*36*	*6*	*16*	*80*	*29*	*6.8*	*4.5*	*3.5*	*1.8*	*3.2*	*3.6*	*11.0*
	Totals	*294*	*44*	*1076*	*339*	*493*	*2246*	*265*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Table 25.3 Fish remains from 4-mm sieve residues; numbers of identifications presented according to context and phase.

flounders (*Pleuronectes flesus*). In addition, a number of dermal denticles were found, in particular in the 1-mm sieve fraction. They are characteristic of flounders; plaice and dab have no dermal denticles. They are hence indisputable evidence of flounders, making it very likely that many of the other *Pleuronectes* spec. remains derive from this species. Perhaps even all the remains in question derive from flounders. For this reason, the *Pleuronectes* spec. have in the tables been listed under the heading of anadromous/catadromous species. As already mentioned, flounders are catadromous fish.

25.4.2 Dimensions

For a good estimate of the economic importance of the various fish species and an impression of the employed fishing methods it is interesting to know the dimensions of the most important fish species. To this end the total lengths were estimated of a number of large individuals of sturgeon, *Pleuronectes* spec., thin-lipped grey mullet and bass on the basis of the dimensions of certain skeletal parts. No efforts were made to estimate the lengths of other caught species such as salmon/sea trout, pike*, etc*. due to the absence of undamaged remains.

Sturgeon

For sturgeon, Desse-Berset (1994) uses two dimensions (1 and 2) of the palatopterygoideum to estimate an individual's length. In a present-day sturgeon with a length of 180 cm, dimension 1 is about 9.0 mm and dimension 2 about 14.7 mm. A very large, almost complete palatopterygoideum, whose dimension 1 was 12.4 mm and dimension 2 was 20.2 mm, was found in Unit 18 (no. 7455, fig. 25.3).

		N=								%							
		Units				features				Units				features			
	phase	1	1-2a	2a	2b	1-2a	2a	3	1-3	1,0	1-2a	2a	2b	1-2a	2a	3,0	1-3
	feature / find no.	4742	4215	sum	sum	12-48	12-36	898	17-332	4742	4215	sum	sum	12-48	12-36	898	17-332
fresh water (stationary)																	
Leuciscus idus	ide	–	1	–	–	–	–	–	–	–	2,8	–	–	–	–	–	–
Rutilus erythrophthalmus	rudd	1	–	4	–	–	–	1	1	1	–	2,0	–	–	–	+	1
Cyprinidae	carp family	9	17	21	23	–	15	27	2	12	47	11	18	–	1	4	1
	Subtotal	*10*	*18*	*25*	*23*	*0*	*15*	*28*	*3*	*13*	*50*	*13*	*18*	–	*1*	*4*	*2*
anadromous / catadromous																	
Acipenser sturio	sturgeon	1	–	5	2	–	3	–	1	1	–	3	2	–	+	–	1
Anguilla anguilla	eel	43	5	54	47	–	45	740	9	56	14	28	36	–	2	96	6
Alosa alosa / allax	allis shad / twaite shad	–	–	–	–	–	4	–	–	–	–	–	–	–	+	–	–
Osmerus eperlanus	smelt	–	1	12	7	1	916	–	83	–	3	6	5	1	48	–	50
Coregonus spec.	whitefishes	2	1	5	–	–	3	–	–	3	3	3	–	–	+	–	–
Salmo salar / trutta	salmon / sea trout	–	–	6	2	–	2	–	–	–	–	3	2	–	+	–	–
Gasterosteus aculeatus	stickleback	2	1	39	7	–	31	–	9	3	3	20	5	–	2	–	6
Gasterosteidae	sticklebacks	–	–	15	25	–	–	–	–	–	–	8	19	–	–	–	–
Pleuronectes flesus	flounder	5	6	6	3	12	31	–	10	7	17	3	2	16	2	–	6
Pleuronectes spec.	flounder / plaice / dab	12	4	29	13	62	495	–	37	16	11	15	10	83	26	–	22
	Subtotal	*65*	*18*	*171*	*106*	*75*	*1530*	*740*	*149*	*84*	*50*	*87*	*82*	*100*	*80*	*96*	*90*
marine																	
Clupea harengus	herring	–	–	–	–	–	52	–	1	–	–	–	–	–	3	–	1
Clupeidae	herring family	–	–	–	–	–	297	–	9	–	–	–	–	–	16	–	6
Liza ramada	thin-lipped grey mullet	–	–	–	–	–	3	–	1	–	–	–	–	–	+	–	1
Liza ramada / aurata	thin-lipped grey mullet / golden grey mullet	1	–	–	–	–	1	–	–	1	–	–	–	–	+	–	–
Mugilidae	grey mullets	1	–	–	–	–	1	–	–	1	–	–	–	–	+	–	–
Dicentrarchus labrax	bass	–	–	–	–	–	5	–	2	–	–	–	–	–	+	–	1
Pomatoschistus microps	common goby	–	–	–	–	–	3	–	–	–	–	–	–	–	+	–	–
P. microps / minutes / lozanoi	common / sand / Lozano's goby	–	–	–	–	–	15	–	–	–	–	–	–	–	1	–	–
	Subtotal	*2*	–	–	–	–	*377*	–	*13*	*3*	–	–	–	–	*20*	–	*8*
	Totals	*77*	*36*	*196*	*129*	*75*	*1922*	*768*	*165*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Table 25.4 Fish remains from 1- and 2-mm sieve residues; numbers of identifications presented according to context and phase.

This sturgeon must have been between 247 and 248 cm long.

Desse-Berset (1994) also introduced two dimensions (1 and 2) for the sturgeon's dentale for estimating an individual's length. The dentale's height is measured at two points. In a present-day sturgeon with a length of 180 cm, dimension 1 is about 8.1 mm and dimension 2 about 9.3 mm. In total, three measurable sturgeon dentalia were found at Schipluiden (nos. 4351, 3179 and 2926, fig. 25.3). The calculated lengths of the animals range from 185 to 367 cm (table 25.5).

It should also be possible to calculate a sturgeon's total length on the basis of the greatest length of the aforementioned skeletal elements. The dimensions of the excavated palatopterygoideum and the three dentalia are given in table 25.5.

The outcomes of the different calculations clearly differ substantially from one another. Which outcomes most closely approach the Schipluiden sturgeons' actual lengths is not clear at this stage. A length of 350 cm is feasible. Hochleithner (1996) states that a sturgeon can grow to a total length of 6 m. What we do know for sure is that some of the sturgeons caught by the Schipluiden occupants were longer than 2 m, and that means that they were adult individuals (of a spawning age).

Eel

The dimensions of the eel remains show that the Schipluiden occupants caught eels with a body diameter of 2 to 3 cm.

Right-eyed flatfishes

To obtain an impression of the sizes of the caught flatfishes, the largest widths (in mm) of the posterior articular surface of the smallest and the largest specimens of vertebra I of *Pleuronectes* spec. were measured. Enghoff (1989) gives a formula for calculating the relation between the total length (TL) of *Pleuronectes flesus* and the aforementioned width

Figure 25.2 Remains of Gobiidae, including those of common goby (*Pomatoschistus microps*) (magnification 10×).

(W). This regression formula is: $TL = 69.7268 \times W^{0.9068}$. The smallest and largest dimensions yielded lengths of 18.3 cm and 46.0 cm, respectively. The dimensions of two ossa analia from feature 12-36 yielded lengths of 25.4 and 28.5 cm according to the formula developed by Brinkhuizen (1989).

Thin-lipped grey mullet

Among the fish remains found at Schipluiden are also some thin-lipped grey mullet operculars. In the case of eleven of these operculars, the distance between the dorso-rostral corner and the bottom side of the articular cavity could be measured. A thin-lipped grey mullet's length can be calculated on the basis of this dimension.[2] The lengths of the Schipluiden individuals were found to range from 27.2 to 53.5 cm.

Find number 435 contained a very large penultimate caudal vertebra, with a length of 10.3 mm, of thin-lipped grey mullet/golden grey mullet. In a 48-cm-long present-day thin-lipped grey mullet this vertebra was found to be 7.4 mm

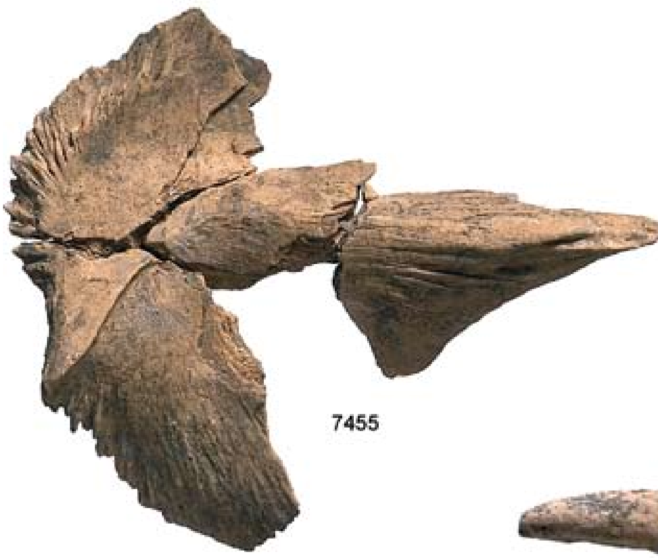
Table 25.5 Sturgeon (*Acipenser sturio*), total length of some individuals calculated on the basis of the dimensions of palatopterygoideum and dentale.

no.	skeletal element	measurement	result (mm)	multiplication factor based on recent sturgeon with a length of:		estimated total length (cm)
				1800 mm.	940 mm.	
7455	palatopterygoideum	m 1	12.4	200	–	248
		m 2	20.2	122.4	–	247
		gr. length	85.0	–	33.6	286
4351	dentale	m 1	–	222.2	–	–
		m 2	15.5	193.6	–	300
		gr. length	–	–	31.1	–
3179	dentale	m 1	13.8	222.2	–	307
		m 2	15.0	193.6	–	290
		gr. length	59.4	–	31.1	185
2926	dentale	m 1	16.5	222.2	–	367
		m 2	16.6	193.6	–	321
		gr. length	68.6	–	31.1	213

3916

4351

3179



7455

2926

3842

4263 + 4282

974

Table 25.6 Bass (*Dicentrarchus labrax*), total length of some individuals estimated on the basis of the dimensions of various skeletal elements.

no.	skeletal element	measurement	result (mm)	factor	estimated total length (mm)
7728	vertebra I	gr. width:	9.8	40.20	394
8329	vertebra I	gr. width:	11.4	40.20	458
598	quadratum L.	gr. width:	5.4	80.39	434
10179	operculare L.	gr. height:	43.9	11.14	489
10179	operculare R.	gr. height:	44.2	11.14	492
10179	operculare R.	gr. height:	40.8	11.14	455
6524	urohyale	gr. width:	6.1	117.41	716
8946	posttemporale L.	gr. length:	6.7	16.27	109

long. Conversion shows that the excavated vertebra derives from a fish with a length of around 66.5 cm. This means that it must come from a thin-lipped grey mullet, because according to Nijssen/De Groot (1987), golden grey mullets have a maximum length of 45 cm. Thin-lipped grey mullets can grow to a length of 70 cm. The excavated vertebra hence represents a very large individual.

Bass
The fish remains include several fragments of bass that could be used to calculate the individuals' total length (table 25.6). Use was made of the dimensions of two present-day specimens with lengths of 41 cm and 68 cm. The calculated length of the largest Schipluiden bass is 71.6 cm. This is quite large, because Nijssen/De Groot (1987) quote a maximum total length of 80 cm.

25.4.3 Taphonomy

Cut marks
Cut marks and surfaces formed by cutting are not usually observed on fish bones. There where they are present, they are usually observed on the largest elements of large individuals. Among the Schipluiden fish remains were only two sturgeon bones showing what could be a surface formed in cutting (fig. 25.3, lower row). The first (no. 4282) fits one of the sturgeon remains of find no. 4263. Together they constitute the greater part of a left parietale, an element from the fish's cranium. This parietale showed a straight edge on the caudal side that may have been formed in cutting. If so, the bone was transversely cut from the medial side and then snapped. The second fragment is a cranial fragment of the first fulcral plate of a sturgeon's anal fin (no. 974). The plate seems to have been obliquely cut from both the left and the right side, because its edges are caudally partly straight. These surfaces may have been formed in cutting. No scratches were however visible at the edges of either piece under the microscope.

Traces of burning
Of all the identified fragments, only 301 (4%) showed traces of burning. Of the manually collected remains, 118 fragments (6.5%) are carbonised, calcined or show traces of burning. 152 (6.1%) of the remains recovered from the 4-mm sieve and 31 (1%) of those from the 1-2-mm sieves had been in contact with fire. These low percentages of burnt bone suggest that burning was of minor importance in the taphonomy of the fish remains. It is however very doubtful that this was indeed the case. Burning has a far more destructive effect on fragile fish bones than on for example mammal bones. The author's own experience has shown that thorough burning results in predominantly very fine crumbs. Such minute fragments will have been contained mainly in the finest sieved fractions. But as they could not be identified, and were hence not counted, the volume of this fraction is unknown.

Traces of gnawing
Traces of gnawing were observed on a very small number of sturgeon fragments, notably a pectoral fin ray (no. 2728), a large dorsal plate (no. 3245) and one left and one right

◀Figure 25.3 Remains of sturgeon (*Acipenser sturio*) (scale 1:1).

4351, 3179, 2926	dentales from the right side
3916	right cleithrum showing pathology
7455	palatopterygoideum
3842	spina pinnae pectoralis, pathologically deformed
974	fulcral plate with possible (straight) cutting edges
4263 + 4283	medial view of left parietale with possible cutting edge

opercular (no. 10,179). The marks observed on the first two elements were almost certainly made by dogs. This small amount of evidence does not mean that gnawing played no role in the taphonomy of the fish remains. Quite the contrary – many fish bones will have disappeared completely as a result of gnawing.

Vertebrae showing metabolic distortion
According to Wheeler/Jones 1989), when a mammal devours a fish complete with its head and tail, the fish's bones may suffer distortion during their passage through the gastrointestinal tract. The aforementioned authors illustrate this with some photos of distorted vertebrae recovered from medieval cesspits. They assume that the bones in question were flattened and distorted during the time they spent in the stomach and intestines. Beerenhout (1996) in this context speaks of vertebrae showing 'metabolic distortion'.

At Schipluiden, a total of 3280 vertebrae were identified. Twelve of those vertebrae (0.4%) showed signs of such metabolic distortion. Nine of the vertebrae concerned derive from *Pleuronectes* spec., one from smelt, one from whitefishes (C*oregonus* sp.) and one from bass (*Dicentrarchus labrax*). Interestingly, three of these vertebrae (two of *Pleuronectes* spec. and one of smelt) were found in the 1- and 2-mm sieve fractions of feature 12-36 (see 25.5.3).

25.4.4 Pathologies
Bones showing aberrant growth, signs of trauma or disease are commonly found in human, and sometimes other mammalian bone assemblages. Aberrant fish bones are however very rare in collections of fish remains and are usually misinterpreted as anomalous specimens. It should be stressed that little is known about which fish diseases can be detected in a study of fish bones, scales or other hard tissues. This contrasts markedly with the extensive literature on diseases and their imprints on human and other mammalian bones. There is however ample evidence showing that abnormalities in fish bones may be induced by parasites, spawning stress and changes in environmental conditions.

The Schipluiden fish bone assemblage included three bones showing pathologies (figs. 25.3-4). No. 3916 comprises a right postorbital and a dorsal fragment of a right cleithrum of a sturgeon showing an anomalous thickening of the bone on the medial side. No. 3842 is a ray from a sturgeon's right pectoral fin, which is proportionally too short and has a distorted distal end. Besides other fish remains, find no. 332 contained an eel's right dentale with abnormal proportions. The element may have become substantially shorter than normal due to an infection that affected the bone (fig. 25.4).

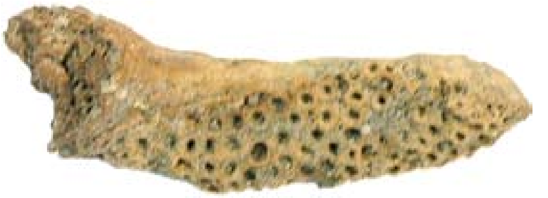


Figure 25.4 Eel (*Anguilla anguilla*), right dentale showing pathology (no. 332, magnification 6×).

25.5 FISHING
25.5.1 Representativeness of the samples and identifications
The identified fish remains cannot be easily interpreted in terms of answers to the set research questions. The great differences in the dimensions of the caught individuals, and hence of their remains, of course imply substantial differences in the species spectra and the ratios of the individual species between the assemblages collected according to the different methods. Differences in deposition processes have moreover led to remarkable differences between a number of contemporary find groups.

Manually collected remains versus sieved fractions (fig. 25.5)
Due to the differences in the fish remains' dimensions, the species spectra of the assemblages collected according to the different methods differ substantially, in both qualitative and quantitative terms (tables 25.2-4). Each fraction provides its own picture of the prehistoric fishing practices, and that was indeed one of the reasons for following the different sieving procedures.

The manually collected remains provide a very biased impression of the fishing practices. This assemblage is dominated by the (large) remains, predominantly bony plates, of sturgeons, representing 91%, with a weight of 4258 grams. The assemblage also contains some chance remains of other species.

The various sieved fractions provide essential complementary information (fig. 25.5): right-eyed flatfishes and sturgeon account for 28 and 46%, respectively, of the 4-mm residue, but they were represented by only a few fragments in the fifteen 5-litre samples. The remains of the relatively large marine fish such as roker, grey mullet and bass were also almost all found in the 4-mm fraction.

Small fish remains are underrepresented in this fraction as they could only be collected in the sieving through a smaller mesh width, and this of course holds in particular for all remains of small fish. Remains of herring, smelt and stickleback were recovered (almost) exclusively thanks to the sieving through a 2-mm mesh, and remains of

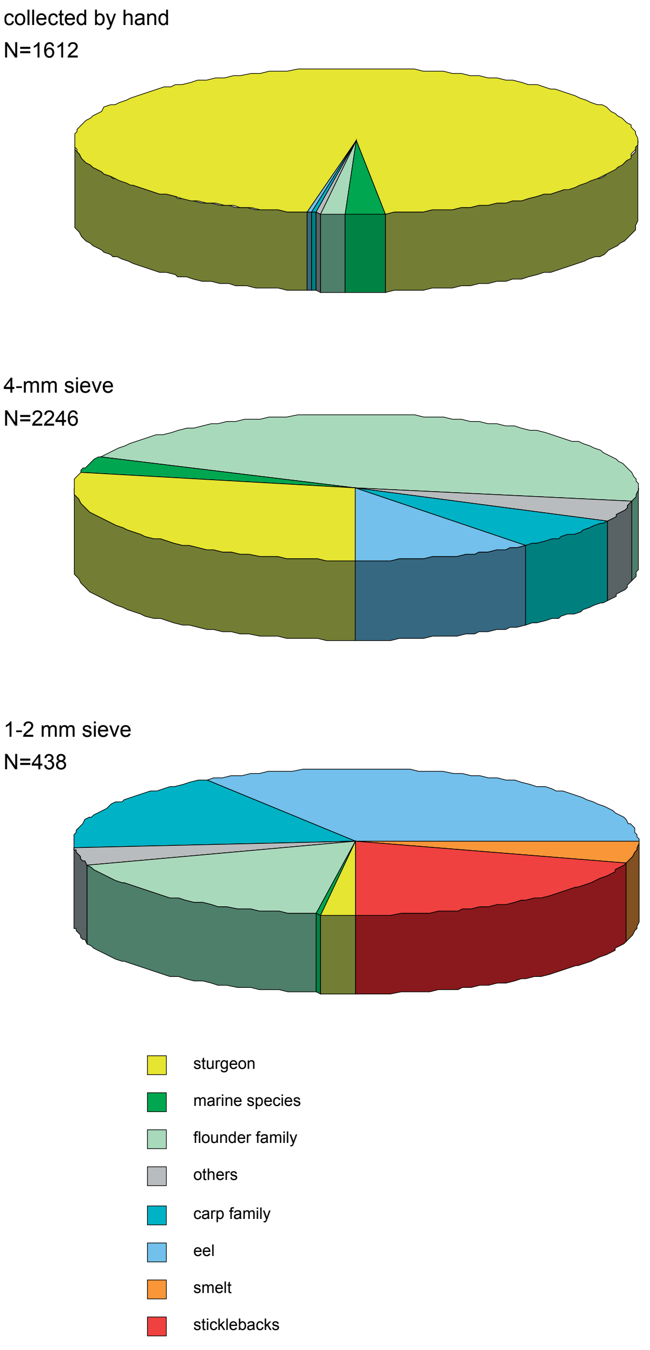


Figure 25.5 Species compositions of the assemblages of fish remains recovered by hand and by systematic wet sieving over a 4-mm mesh and compositions of selected, relatively rich samples sieved over 2- and 1-mm meshes. Remains from units only.

common goby were found only in the 1-mm fraction (fig. 25.6).

As the soil was sieved only after all clearly visible remains had been collected by hand, large remains are of course underrepresented in the 4-mm sieve residue, and this residue is for that reason not representative of this fraction. The total find population >4 mm (P) can however be easily calculated: P = M + 12S (see chapter 4). As the two fractions are both of the same order of magnitude (N= 1610 and 2246, respectively) and as M is totally dominated by sturgeon remains (96%), there is only little discrepancy: the sturgeon score increases by a few percent (from 28 to 32%) and the scores of all the other species decrease correspondingly by about 1/20 (fig. 25.7).

The results of the small number of samples that were sieved through the 1-mm mesh cannot be converted in a comparable simple manner. The volume of soil (55 litres as opposed to around 1000 m^3) cannot be used because these samples were selected for identification because they were relatively rich in finds. Neither can the find density of the only theoretically suitable common element – sturgeon remains – be used as the densities in the 4-mm fraction were a factor of 20 lower. The results of the fine fractions must hence be independently interpreted and may not be added to the results obtained for the other remains.

Differences in context and deposition

The remains recovered from the various units will on the whole represent the occupants' (different) fishing practices throughout many dozens of years. This holds for both the manually collected remains (M) and the remains recovered from the 4-mm sieve (S) through which part of the excavated soil was washed (see chapter 1). It does not hold for the analysed samples of the 2- and 1-mm sieve fractions (fig. 25.8 left), since most of these were taken from concentrations of fish remains, such as no. 898 (which is hence not representative of phase 3). Neither does it hold for at least two of the four samples from pit fills. The spectra that deviate from the average spectrum are attributable to single depositions of remains of specialist fishing expeditions (no. 898) or to a pit's functioning as a fossil trap (features 12-36 and 12-48). Herring, smelt and common goby were (almost) exclusively encountered in one or two pit samples. These exceptional depositions are responsible for the relatively high scores in the fine fractions of the pits as a group.

Marine fish – both large and small species – scored remarkably higher in the pit samples than in the samples from the deposits. In the case of the large marine species this proved to be largely attributable to one case (feature 13-585, table 25.2) of 34 manually collected bass remains, and of 24 grey mullet remains in a different pit fill (feature 11-532,

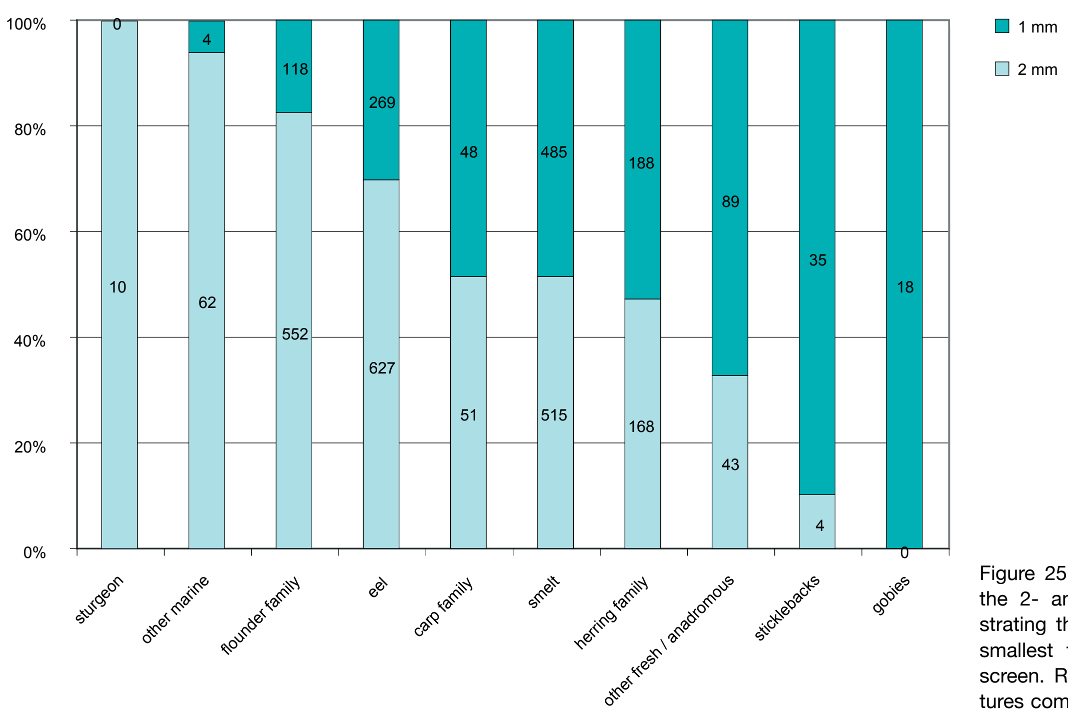


Figure 25.6 Species compositions of the 2- and 1-mm fractions demonstrating the selective recovery of the smallest fish species on the 1-mm screen. Remains from units and features combined.

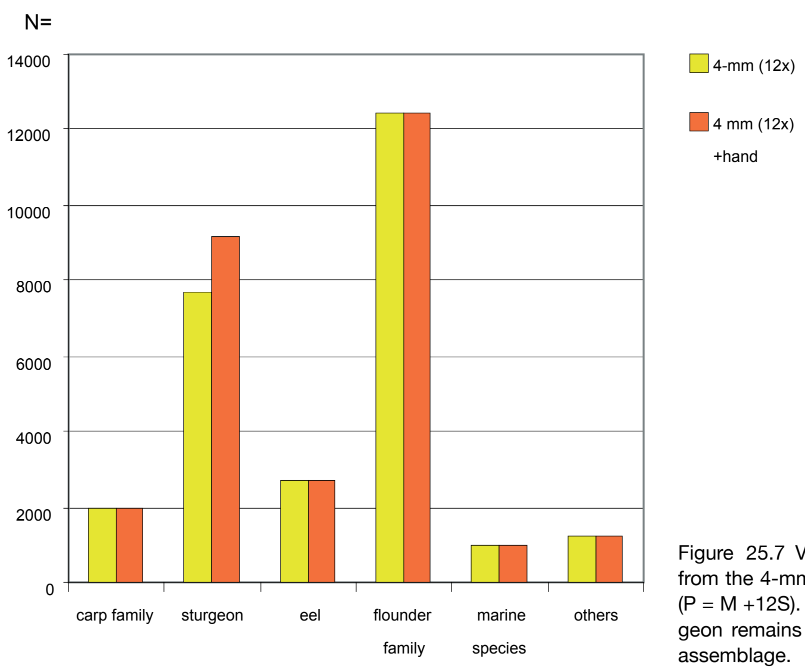


Figure 25.7 Volume-corrected composition of the fish assemblage from the 4-mm screen compared with the calculated total assemblage (P = M +12S). The remains collected by hand – almost exclusively sturgeon remains – have hardly any influence on the composition of the assemblage.

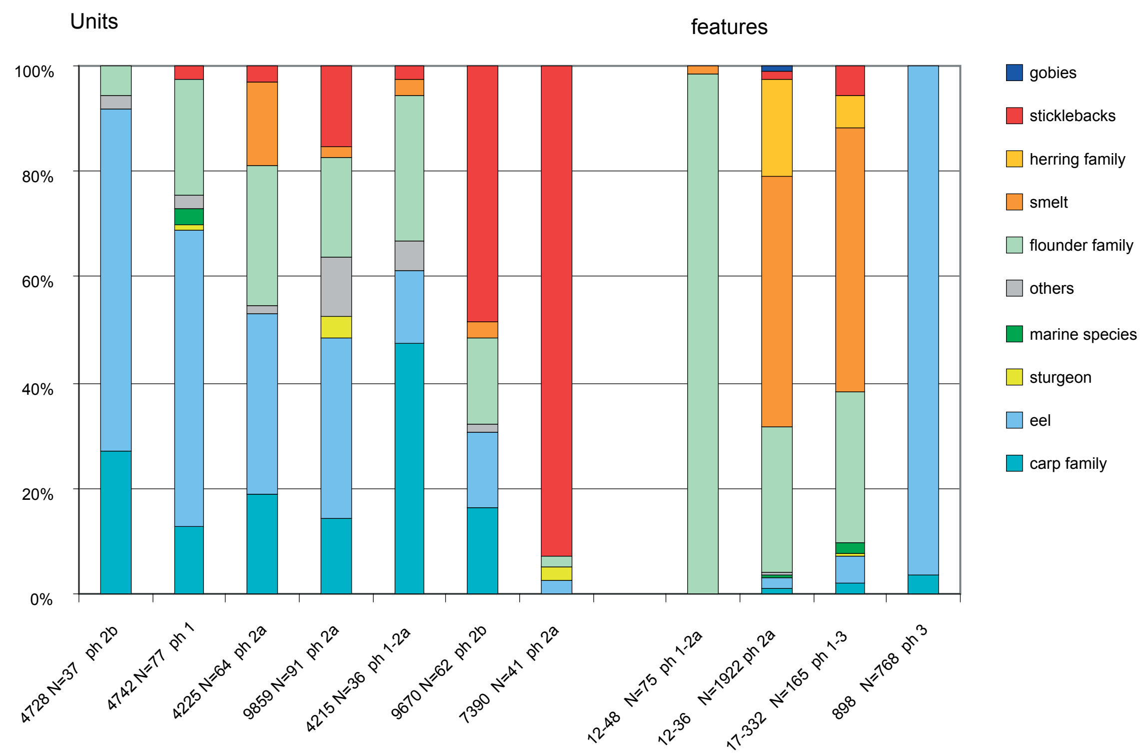


Figure 25.8 Species composition of all analysed 1- and 2-mm samples from units and features. Note the extreme diversity, pointing to a single-event deposition of at least more than half of the remains.

table 25.3). The remains could in each case derive from a single fish or a small number of individuals.

25.5.2 *The species caught – the general picture*

From the manually collected remains, the 4-mm sieve residues and the 1-mm sieved samples from the deposits it can be concluded that the occupants' fishing strategies focused on three species: sturgeon, eel and flounder. In all the sufficiently large fractions from all the phases these three species together account for more than 80% of the remains.

The relative importance of sturgeon is difficult to assess. Sturgeons are much bigger than the other fish, but on account of their long rows of bony plates they also produce larger quantities of waste, which is moreover readily identifiable, even in small fragments. This waste is however also brittle. These factors make it impossible to compare sturgeon remains directly with remains of other fish species. It is therefore better to consider the sturgeon remains separately from the 'fish total' (100%) of the calculations, and to specify their percentage relative to this calculation basis. The importance of sturgeon can best be assessed in the aforementioned calculated total population of remains (P = M + 12S, fig. 25.7).

The sturgeon percentages thus calculated vary substantially, but are almost all high, ranging from an exceptionally low 10% in phases 1-2a to 183% in phase 2a. These fluctuations are more likely to be attributable to differences in deposition and taphonomy than to differences in ecological and/or subsistence factors. In view of its size and the large numbers of remains, sturgeon may be assumed to have been an important source of animal protein at Schipluiden, as it was likewise to be in later times at the Vlaardingen settlements in the Rhine/Meuse estuary.

Flounder remains were prominently represented in the 4-mm fraction, amounting to 54-75% of all the fish remains, whereas eel remains were – to a slightly lesser extent – dominant in the 2- and 1-mm fractions. In view of the difference in their shapes it is not really possible to say which of the two species was the most important; neither can their importance relative to sturgeon be assessed.

The volume of the other fish species caught was relatively modest. The assemblage includes a small component of relatively large marine species, which will have swum into the estuary: grey mullets, bass, roker. Salmon and allis shad

Figure 25.9 Smelt (*Osmerus eperlanus*). Dentales retrieved from the 2 mm sieve (magnification 2×).

or twait shad were incidentally caught, too. On account of their size, they will have been of greater economic importance than is suggested by the number of surviving remains.

The same cannot be said of the freshwater component. The largest fish (pike and bream) were caught in only small quantities. The freshwater score is largely attributable to members of the carp family, probably predominantly roach and rudd.

25.5.3 *Short-term depositions at random moments in time* (fig. 25.8 right)

Feature 12-36, no. 7013 (phase 2a)

A rich concentration of predominantly very small fish remains was found in the secondary fill of a medium-sized unlined well (3.60 × 1.45 m). A 5-litre sample was sieved through a 1-mm-mesh sieve. The preservation conditions in the well had been good enough to ensure the survival of 38 branchialia (parts of the gill arch skeleton) of *Pleuronectes* spec. This means that the well became filled with sediment, and its contents cut off from the air, shortly after the fish had been deposited in it. Table 25.4 specifies the encountered species and the numbers of remains and percentages per species. Another eleven fish remains were collected from the well by hand.

The species spectrum of this well differs substantially from the general spectrum. Two other species are dominant among the 1922 identified remains: smelt (N=916) and members of the herring family (N=349). Among these remains are a relatively large number of bones of herring itself plus remains of a few small allis shads or twaite shads. The smelt had an estimated length of 10 cm. The number of left dentales (fig. 25.9) points to a minimum of 60 individuals. The herrings were 6 to 8 cm long; the remains represent at least 13 individuals. Almost all skeletal elements were encountered. Besides these herring and smelt remains the well also yielded a relatively large number of remains of two other small fish species: stickleback (N=31) and goby (*Pomatoschistus* species), including the common goby (N=18).

The third most frequently encountered species is *Pleuronectes* spec., represented by 526 identifications, including 31 of flounder, with calculated lengths of between 18.3 and 37.5 cm, *i.e.* of the same dimensions as the bones in the general assemblage.

Finally, the well assemblage also included some remains of grey mullets, salmon/sea trout, a small bass, eel, *Coregonus* and members of the carp family, plus the cranium of a very small sturgeon (3 fragments).

Well 17-332 yielded a smaller fish assemblage with a very similar composition.

These assemblages seem to be the outcomes of different deposition processes. The isolated, relatively large remains mentioned last in the above survey may be assumed to represent part of the fish remains that occurred scattered across the site. The numerous remains of right-eyed flatfishes of ‘normal’ dimensions could be the waste of a single specialist fishing expedition. The fact that almost all elements of their skeleton are represented suggests that the smaller fish (smelt and herring, but also allis shad/twaite shad, stickleback and common goby) ended up in the pit complete with their heads and tails. The question is whether this is attributable to a natural process or to activities of the occupants.

The remains themselves provide somewhat contradictory information in this respect. They do seem to have undergone the usual postdepositional processes. Eighteen fragments of different species, including five smelt vertebrae, are carbonised or burnt. This proportion of burnt bone does not differ from the overall percentage obtained for the 1-2-mm sieve fractions. Three vertebrae, including one of smelt, show metabolic distortion, pointing to consumption. The option that the remains represent the stomach contents of a fish-eating mammal, as Beerenhout

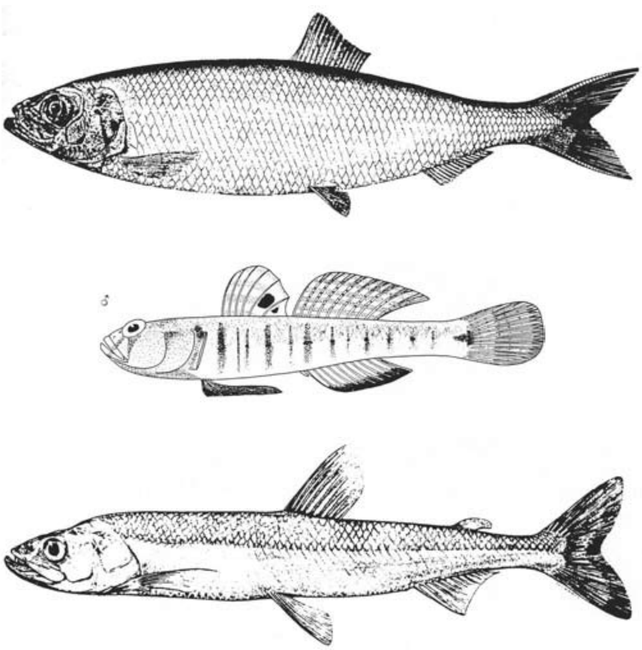


Figure 25.10 Herring (up to 40 cm), common goby (up to 6.4 cm) and smelt (up to 30 cm).Their remains – together with those of three-spine stickleback – are important indicators of salt incursions in the fills of some wells. After Whitehead *et al.* 1984-'86.

(1996) assumed for a similar case at Wateringen, is not very likely as the bones are not very fragmented. Moreover, at most only 8% of the vertebrae of the identified minimum number of 60 smelt individuals were found, so most of the vertebrae were missing. This could be attributable to consumption, but also to the sieving process. The best explanation for this concentration of remains of more or less complete small fish in this former well would ultimately appear to be that the assemblage was formed when a group of small fish became trapped in the well due to a natural process – flooding of the area with saline or brackish water at an extremely high tide.

The well's position makes this explanation quite plausible. It was one of the lowest-lying wells, at the periphery of the large concentration of wells, and the edge of its fill was intersected by a fence. The well was nevertheless dated to phase 2a, rather than phase 1, on the basis of the nature of its fill. As this is the only observed case of such a concentration of fish remains, and the well in question lay at a low position on the dune slope, we must conclude that tides that were so high as to cause the foot of the dune to be flooded by seawater were quite exceptional.

Schools of herring or smelt may well have been washed into the estuary and have become caught there during storm tides. Writing about the fish fauna of the Dutch Biesbosch area, Verhey (1961) mentions that many dead young smelt would sometimes be found when the water retreated from flooded pastures after a storm tide. It is quite conceivable that something similar happened in the first phases of the dune's occupation, and that the retreating water left behind dead fish in a depression, and possibly also on the ground around it. Any remains left on the surrounding ground will for some time have undergone various postdepostional processes such as burning and consumption by animals before secondarily ending up in the fill of the depression. The smelt, small herring, stickleback and common goby in this sample – and probably more in general too – are therefore to be interpreted as 'natural background fauna', and not as fished species (fig. 25.10).

Feature 12-48, no. 6085

A second noteworthy feature in which fish remains were found is feature 12-48 – a small, deep, low-lying pit that was interpreted as a deposition pit and was dated to phases 1-2a (chapter 3). This pit represents a remarkable archaeological phenomenon. Besides more than 60 mammal remains (section 22.3.7) and – at a deeper level – a large number of sloes (section 19.5.1), this pit also yielded fish remains – almost exclusively remains of right-eyed flatfishes (N=74), including 12 flounder remains. This also points to intentional deposition.

No. 898 (trench 16, Unit 10, phase 3)

This sample contained a concentration of well-preserved fish remains from the peat of Unit 10, *i.e.* from phase 3, to the northwest of the dune, at an exceptional location: at a relatively large distance (approx. 20 m) from the foot of the dune, outside the dump zone. The sample is the only one of its kind, but it is possible that we owe its discovery to an excavator with a particularly keen eye and that other, similar concentrations remained unobserved. A 15-litre sample was sieved through a 1-mm-mesh sieve.

Of the 768 identified remains, 740 (96.4%) derive from eel (717 of which are vertebrae) and 28 from cyprinids. From the most frequently encountered skeletal element we may conclude that the remains represent at least six eels and three members of the carp family. The sample seems to represent the remains of eel fishing, in which the odd cyprinid was caught, too. This fishing will have been done in a freshwater environment, for example using wicker traps. In phase 3 eel may have been caught in the dune's immediate surroundings.

25.5.3 Fishing methods

The wide variety of caught fish species implies that the dune occupants used several different fishing techniques. There is unfortunately virtually no evidence on the employed fishing techniques, but fish traps and fish weirs made of wooden

Figure 25.11 A 60-cm-long Atlantic sturgeon fished in February 1993 in Amsterdam harbour. It must be a specimen of a French reintroduction programme. The Atlantic sturgeon was fished in the Dutch lower river courses until the 19th century and has – after occasional catches until the mid-20th century – now disappeared from the Netherlands (De Nie 1996).

posts and nets are known from other Mesolithic and Neolithic sites in the Rhine-Meuse delta. Fish hooks are extremely rare.

Sturgeon
The fishing of the important – for very large – sturgeon (fig. 25.11) focused on fully grown individuals in the spawning season. Verhey (1961) states that sturgeons spawn in shallow water with a maximum depth of two metres and that sturgeons used to occur in shallow parts of the Nieuwe Merwede canal. The fish spawn on hot days, when they swim close to the surface of the water and sometimes jump above it. Only the males show this lively behaviour (Siebelink, 2004). The females are heavily loaded with roe, and swim just above the riverbed. The behaviour of sturgeons in the spawning season will at the time of the occupation of the Schipluiden dune have been no different from that observed by Verhey. This means that the settlement's occupants will have seen the sturgeons swimming close to the surface in the spawning season, and will have been able to catch them easily with a harpoon or a spear. A different way of catching sturgeon is described by Boddeke (1971), who was inspired by wooden posts found in a creek at Vlaardingen. He assumes that at this site, fish were caught in a double weir built in a small creek; when the tide fell, the entrance of the downstream weir would be closed with a wide-meshed net.

Eel
The fishing gear used to catch eel was most probably a lightweight osier trap of the kind that has been found at various Mesolithic and earlier Neolithic sites, such as Hardinxveld-De Bruin (5100 cal BC), Hoge Vaart (4800 cal BC) and Bergschenhoek (4200 cal BC). Small individuals of other species may also have been caught in such traps, as assumed in the case of sample 898. Such species may have been roach, but also smelt and three-spine stickleback.

Flounder
Flounders can be caught fairly easily, for example via 'flounder trodding' or with the aid of spears or a special flounder net (a rectangular knitted net) that is set up on a sandbank at low tide and checked for the presence of fish at the next low tide. The predecessor of such a net was an osier fence (a weir) permanently erected on a sandbank. Besides flatfishes, species such as roker, allis shad/twaite shad, grey

mullets and bass may have been retained behind such a fence at low tide and collected for consumption.

25.6 The fished waters

The former physical-geographical conditions in the site's immediate and wider surroundings were determined in the landscape-genetic research (chapter 14) and the diatom analysis (chapter 15). The site was situated on tidal deposits several kilometres behind the coastline. At the southern periphery of the assumed territory was an estuary, via which the lower reaches of the Meuse and possibly also a branch of the Rhine flowed into the sea. A short distance to the east of the site was the boundary of the vast area of Holland peat. In the course of the occupation period the site's immediate surroundings became less susceptible to marine ingressions and the estuary appears to have become narrower.

We assume that the dune occupants caught their fish not too far from their settlement, that is, within the site territory over which they enjoyed exclusive or collective rights of use (*cf.* chapter 27). The size of that territory can be only roughly indicated, but even if we assume that it had a radius of only a few kilometres, it will have contained a good range of fishing waters in which all the aforementioned ecozones were represented. Do the results of the study of the fish remains tell us where the fish were caught?

The remains of freshwater fish imply that people fished in the fresh water, while those of marine fish tell us that they also caught fish in salt water. Either the dune occupants had access to both environments or the salt content of their fishing grounds varied throughout the period of occupation. In times when a river discharges large quantities of water, for example in spring due to the melting of ice and snow, the salt/fresh water boundary will move seawards. Fishermen then catch mainly freshwater and migratory fish. When little fresh water is discharged – for example in the summer – or in the event of storm floods, the salt water may penetrate deeper into an estuary. Besides migratory species, the catch will then also comprise marine species that tolerate brackish water.

Of particular importance in this context are the observations that provide information on the fishing practices reflected by the mixed samples from the deposits. Eels were caught in water in which members of the carp family were also to be found (no. 898) and there are two indications of specialist fishing for flounder (features 12-36 and 12-48). We moreover

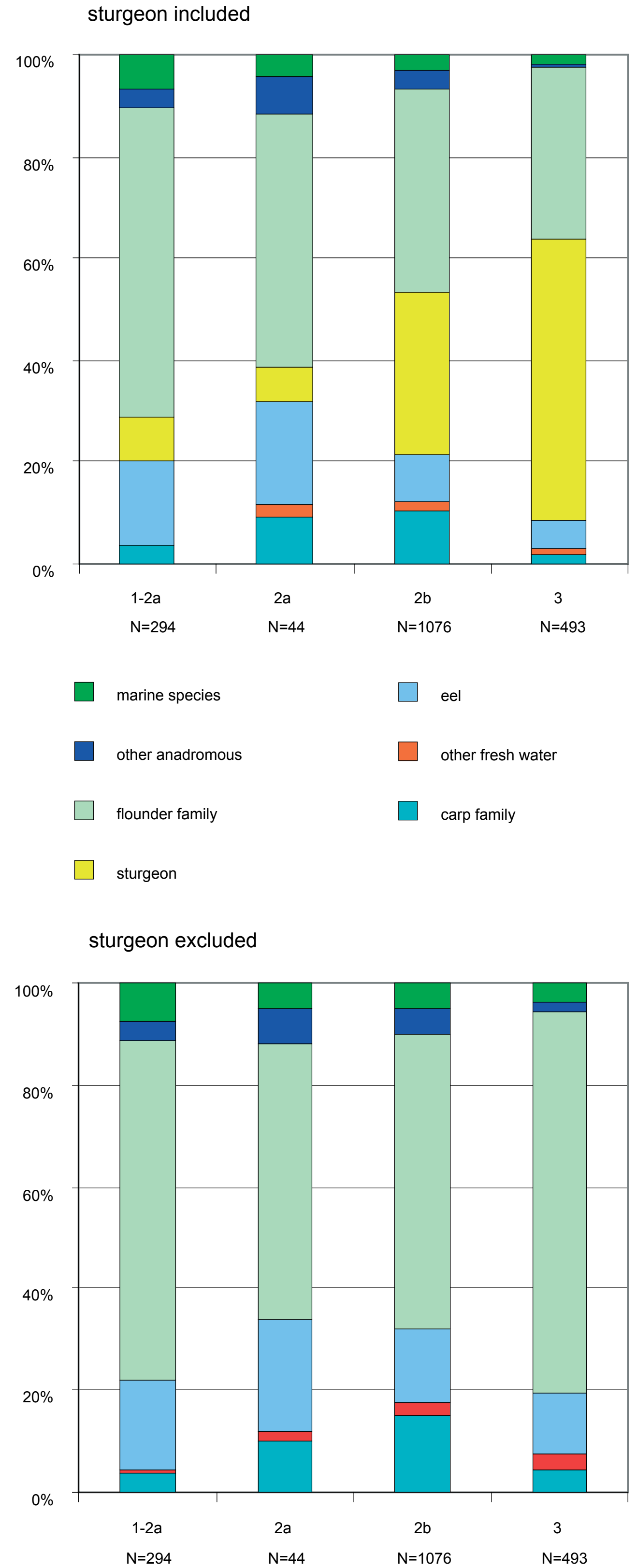


Figure 25.12 Trends in the composition of the fish assemblage from the 4-mm sieve residues through time. The ratio of species other than sturgeon (lower graph) remains constant. The increase in remains of sturgeon (upper graph) may be the result of differential preservation.

have evidence of marine ingressions and flooding with salt water in phase 2a. In addition to these observations and their interpretations we also know that prehistoric man usually purposefully focused on specific species using specialist fishing techniques. With each fishing method – certainly those involving untended facilities such as traps, weirs and nets – other fish will of course have been caught along with the intended species. This partly explains the great variety of species that were encountered in low percentages. The fishing activities however primarily focused on a restricted number of species, which were each caught at suitable locations using species-specific methods. In the case of the right-eyed flatfishes those locations will have been the shallow parts of the estuary itself and the mud flats when they were temporarily submerged. The sturgeons will have been caught in the smaller side creeks that provided access to the backswamps bordering the estuary. Eel may also have been caught in the estuary, especially in the autumn, when the adult individuals migrated to the sea to spawn. The various members of the carp family, pike and perch may have been caught there, too.

That the occupants indeed caught their fish in such a purposeful manner is confirmed by the fact that very few changes took place in their fishing practices throughout the occupation period, in spite of the substantial environmental changes that took place in the settlement's surroundings (fig. 25.12). This means that the occupants continued to exploit the brackish water, even though it lay further away from the site in later phases.

25.7 Seasonal evidence (fig. 25.13)

On the assumption that the annual cycle of Dutch fish in general, and their migratory behaviour in particular, was in prehistoric times comparable with their behaviour in present and historical times, statements can be made about the season in which certain fish species were caught. An important condition – which was met at Schipluiden – is that the fishing waters were directly connected to the sea. The small fish (herring, smelt, stickleback and common goby) whose presence in the archaeological record is assumed to be attributable to natural processes of course have nothing to do with prehistoric fishing practices.

From the following seasonal evidence it can be concluded that fishing was in all the occupation phases definitely a summer activity.

Sturgeon

Sturgeons are anadromous fish that spend the greater part of their lives in the sea and temporarily exchange saltwater for freshwater only in order to reproduce. Sturgeons swim up rivers to spawn in late spring. In the 19th century, sturgeons migrated in the Rhine from early May until mid-August, with

Figure 25.13 Seasons of presence in inland waters of the fish species identified at Schipluiden showing first of all that the site was occupied at least from April to October and, secondly, that fishing was mainly a summer activity.

a peak around the end of June. The fish were seen to make use of the tides in their journey upriver, and to cover substantial distances especially around low and high tide, when currents are minimal. At high water levels they would swim further upriver. They also swam further if there happened to be many fish in the estuary and the lower course of the river. Juvenile sturgeons were seen to migrate upriver along with the adult fish, but did not usually venture beyond the brackish water zone (Siebelink 2004). At Schipluiden, remains of both adult and juvenile individuals were found.[3] Magnin (1962, 155) writes the following about the occurrence of sturgeons in the brackish water of the Gironde estuary: "… here, we actually find sturgeons of all ages and all sizes and in different stages of sexual maturity.". This means that sturgeon remains can be interpreted as seasonal evidence only at inland sites such as Swifterbant and Hazendonk (Zeiler 1997) and not at a coastal site such as Schipluiden.

Flounder
Flounders are in principle catadromous. They reproduce in the sea in spring and then migrate into freshwater if it is freely accessible. They gather in autumn and then return to the sea to spend the winter there. So flounder remains constitute evidence of summer use of the site at Schipluiden.

Eel
Eels are likewise catadromous. They arrive in freshwater from the sea as elvers. In the wintertime, eels are lethargic and live in soft substrates on the riverbeds. If fishermen know where eels spend the winter, they can catch them with a special eel spear. Eels can be easily caught with traps in late spring, summer and autumn. They can be caught in large numbers in the autumn, when the adult individuals migrate to the sea to spawn.

Bass and grey mullets
Bass and grey mullets are heat-loving species that swim into the Dutch coastal waters from the south in spring and cross the Channel to waters off the southern English coast towards the winter. On their journeys, these species, especially thin-lipped grey mullets, may swim far upriver in the summer. So they can be caught in estuaries only in the summer.

Allis shad/twaite shad
Allis shad and twaite shad are both anadromous. According to Boddeke (1971), allis shad appeared in estuaries around April-May at the time of his study. Twaite shad would follow in June-July. The spawning grounds of allis shad were usually a little further upstream than those of twaite shad, which tended to spawn in freshwater just above the transition from brackish water.

Whitefishes
Verhey (1961) writes that, at the time of his study, whitefishes (*Coregonus oxyrhynchus*) made their appearance in estuaries as anadromous fish in the autumn and swam further upstream to spawn in the winter. That makes whitefishes one of the few fishes that may be interpreted as providing evidence of winter use of a site. The percentage of *Coregonus* remains found at Schipluiden is however fairly low. This means that the occupants did fairly little fishing in the late autumn and winter, or they did not fish in the deep main river stream where the migrating whitefishes were to be found.

Salmon and sea trout
Salmon and sea trout are also anadromous species. De Groot/Schaap (1973) write that Dutch river fishermen make a distinction between winter and summer salmon and what they call *jacobszalmen* (Jacob's salmon) on the basis of the fish's migration times, differences in weight, the development of the sexual organs and the associated physical condition. Winter salmon swim upriver from October until the end of April, summer salmon from May until the end of November. The *jacobszalm* is the smallest variety, with a length between 61 and 67 cm (Van Doorn 1971). These salmon swim upriver from early July until some time in November, with a peak around 25 July, the name day of the Apostle St. Jacob. From this evidence it can be concluded that salmon, unlike sturgeon, could be caught in rivers all year round. In the years 1870-1874 exceptionally small quantities of salmon were however supplied to the market of Kralingen in the months from September to March (Boddeke 1971, 173). Viewed in this light, large quantities of salmon remains must therefore be interpreted as evidence of summer use of a site, but salmon remains have not been found in large quantities at any of the prehistoric sites in the rivers area.

Sea trout are less particular about their choice of rivers than salmon, but they don't swim as far upriver as the latter. According to Redeke (1941), sea trout were caught mainly in the summer, in tidal rivers.

In the light of what has been said above it is remarkable that only very few remains of salmon/sea trout were found at Schipluiden. Evidently the fishing practices focused on more slowly flowing side gullies and smaller tidal creeks rather than on the broad, deeper main river stream in which the migrating salmon swam. The reason for this could be that the prehistoric occupants did not yet know how to make sufficient large, strong nets of the kinds used in salmon fishing with weirs, drift nets and seine nets in historical times.

Researchers such as Lepiksaar/Heinrich (1977) and Beerenhout (2001) have pointed out that bones of many oily fish species such as salmon and sea trout readily disappear due to dissolution by fatty acids released after their deposition (autolysis). Tchernavin, quoted by Wheeler (1978), writes that calcium is absorbed from a salmon's skull skeleton during its migration to its spawning ground. This makes the skull paper-thin. These processes however have no influence on the fraction of calcined vertebrae.

Smelt
Writing about the fish fauna of the Biesbosch area, Verhey (1961) stated that smelt swim upriver to spawn from early February until the end of April.

Three-spine stickleback
Some three-spine stickleback populations are known to live exclusively in freshwater. The species is however in principle anadromous if it has unhindered access to the sea. Sticklebacks migrate into freshwater to reproduce in large quantities in spring. They gather in the autumn and return to the sea to spend the winter there.

25.8 Trends

Only the non-specialist spectra obtained for the units can be used for identifying any changes that may have taken place in fishing practices as reflected in the composition of the fish remains. The spectra relating to the features are insufficiently representative. The dates obtained for the features are moreover less reliable.

A major handicap is that we have insufficient amounts of remains for the early phases (table 25.1). For phase 1 we have only a small sample of manually collected remains that consist exclusively of sturgeon bones. The clay of Unit 19 concerned was not sieved through a 4-mm-mesh sieve and only incidentally through a 1-mm-mesh sieve. This lack of evidence is partly compensated by a modest amount of evidence for phases 1-2a (Unit 19N). The later phases are well represented, except that we have no representative fine fraction sample from phase 3. Only for the 4-mm sieve fraction do we have a sufficiently large series of spectra, except that the sample from phase 2a is actually a little too small.

With due consideration for these factors it is surprising to see that the ratios of the species (excluding sturgeon) for the different phases are more or less the same, in spite of the fairly drastic environmental changes that took place in the dune's immediate and wider surroundings (fig. 25.13).

It is not so easy to obtain an impression of any changes that may have taken place in the relative proportion of the important fish species sturgeon. The 4-mm sieve residues show a distinct increase in the ratio of sturgeon and all other fish, from less than 10% to more than 50% of the remains. There are two possible explanations for this: an increase in economic importance and a higher degree of fragmentation of the sturgeon remains. The second option could hold for the difference between the clay of phase 2a and the colluvium of phase 2b, but the overall increase can hardly be explained by taphonomy alone, and must to some degree reflect increased importance.

The other fish remains show an absolute dominance of migratory species (80-90%), in particular *Pleuronectes* spec. (55-75%), in all the phases. The ratio of marine and freshwater species varies from 1:2 to 1:3.5, and is reversed only in the case of phases 1-2a. What is remarkable is that the environmental changes (switch to freshwater conditions) are not reflected by these fish remains.

As far as the 1-mm fraction is concerned, we only have a reliable impression of phases 2a and 2b. They show an absence of marine species and a low score of *Pleuronectes* spec., which is compensated by the scores of species with small remains such as eel, smelt and stickleback. Eel was of greater economic importance than is suggested by the fraction of large remains.

25.9 Comparison with other assemblages

Data relating to three Hazendonk settlements in the Rijswijk microregion are available for comparison. Those sites are Wateringen 4, Rijswijk Rijksweg A4 and Ypenburg. They are comparable with Schipluiden in terms of their environmental context and artefactual data, but differ substantially as regards the dimensions of the dunes supporting the settlements and the sizes of the sites themselves. The methods used to collect small faunal remains also differ considerably from site to site, and that implies differences in the fish spectra, too.

The fish remains of Wateringen comprise 26 manually collected bones and a sieved sample from a pit fill that contained 396 fragments (Beerenhout in Raemaekers *et al.* 1997).[4] Of those remains, 24 and 228, respectively, could be identified to species, genus or family level. Evidence of gnawing and metabolic distortion and the severely fragmented condition of the remains led the researcher to conclude that the sieved sample represents the stomach contents of a fish-eating mammal, probably an otter. This is however not really in accordance with the presence of remains of at least seven species with a varying ecology, and also burnt remains. Probably only part of the sample represents a stomach contents. The limited number of manually collected fish bones reveal an ichthyofauna that is comparable with that of Schipluiden, except that it includes a relatively large proportion of grey mullets.

During the emergency excavation of the Rijswijk Rijksweg A4 site (site 1) a total of 218 fish remains were collected by hand (Laarman 2004). No samples were taken for sieving. Almost all of the 207 identifiable remains derive from sturgeon and *Mugilidae*. The proportion of grey mullet remains is again remarkably high. According to Laarman (2004), these remains represent at least 54 individuals.

The data relating to Rijswijk-Ypenburg (De Vries, 2004) are the most directly comparable with those of Schipluiden. There, the fish remains were collected by hand and by sieving 3000 m^2 through a sieve with a 2-mm mesh width. In total, 2360 fragments were identified to species or family level.

Acknowledgements

I would like to thank Jaap Buist (*Stichting Monument & Materiaal*) for photographing the Schipluiden fish bones.

notes

1 One exception was made. As most of the skeletal elements of flounder, plaice and dab lacked species-specific characteristics, only few of their remains could be identified to species level. They can however without doubt be attributed to the group of 'right-eyed flatfishes'. In older nomenclature, the three species were all classed as belonging to the genus of *Pleuronectes*. According to the present nomenclature, dab however belongs to a different genus, but remains of flounder, plaice or dab that cannot be identified to species level are still interpreted as remains of *Pleuronectes* spec.

2 The formula expressing the relation between the total length of a thin-lipped grey mullet and the dimension described as the 'distance between the dorso-rostral corner of the opercular and the bottom side of the articular cavity of the opercular' was set up using the dimensions of two present-day specimens with lengths of 44 and 48 cm. The formula concerned is: individual's total length (in mm) = dimension (in mm) × 44.56.

3 The reticulate pattern of the lateral surface of the elements of the species' exoskeleton changes as the individual grows older (Mohr 1956). The elements of smaller (*i.e.* juvenile) individuals are thinner than those of larger (*i.e.* mature) individuals. The reticulate pattern of the former is finer and less rounded (sharp).

4 The numbers quoted in the text do not correspond to those given in the table. The latter numbers are the correct ones (oral comm. Raemaekers, 8 June 2005).

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Appendix

25.1 Glossary of the English, Dutch and scientific names of the fish species mentioned in the text.

English	Dutch	scientific
allis shad	elft	*Alosa alosa*
bass	zeebaars	*Dicentrarchus labrax*
bream	brasem	*Abramis brama*
carp family	karperachtigen	*Cyprinidae*
common goby	brakwatergrondel	*Pomatoschistus microps*
eel	paling	*Anguilla anguilla*
flounder	bot	*Pleuronectes flesus*
golden grey mullet	goudharder	*Liza aurata*
grey mullets	harderachtigen	*Mugilidae*
herring	haring	*Clupea harengus*
herring family	haringachtigen	*Clupeidae*
ide	winde	*Leuciscus idus*
Lozano's goby	Lozano's grondel	*Pomatoschistus lozanoi*
perch	baars	*Perca fluviatilis*
pike	snoek	*Esox lucius*
right-eyed flatfishes	scholachtigen	*Pleuronectidae*
roach	blankvoorn	*Rutilus rutilus*
roker	stekelrog	*Raja clavata*
rudd	rietvoorn	*Rutilus erythrophthalmus*
salmon	zalm	*Salmo salar*
sand goby	dikkopje	*Pomatoschistus minutus*
sea trout	zeeforel	*Salmo trutta*
smelt	spiering	*Osmerus eperlanus*
stickleback	stekelbaars	*Gasterosteus aculeatus*
sticklebacks	stekelbaarsachtigen	*Gasterosteidae*
sturgeon	steur	*Acipenser sturio*
thin-lipped grey mullet	dunlipharder	*Liza ramada*
twaite shad	fint	*Alosa fallax*
whitefishes	houtingachtigen	*Coregonus sp.*

26 Insects

Tom Hakbijl

Six samples, taken from one deposition pit and three unlined wells, were analysed for insect remains. The Coleoptera (beetles), Siphonaptera (fleas), some of the Diptera (flies) and some other insects were identified to various levels. Inferences were made with respect to the use of wells, salinity of the environment, the presence of dung, the presence of synanthropics, such as Musca domestica*, the house-fly, and* Pulex irritans*, the human flea, possible agricultural pests, vegetation, biogeography, and the place of synanthropic insects in the Neolithic.*

26.1 Introduction

The insect kingdom with its large number of species and its variety of life forms and specialisations provides a large number of useful environmental indicators. Some insects play a part in the life of people and are literally closely associated with them. Therefore, the analysis of insect remains can be of great help in archaeology. A limitation, at least in temperate Europe, is that, like seeds, insects are only preserved in abundance under waterlogged conditions. That this was the case at specific localities at Schipluiden was demonstrated by the discovery, during the wet sieving of pit fills on the site, of the ambassador of archaeological insect remains analysis, the large dung beetle with its magnificent violet lustre (figs. 26.1-2). Although this particular species is very indicative, it is its combination with about a hundred or more other taxa that tells the story.

It was decided to use the insects primarily to arrive at a detailed description of local conditions, rather than an

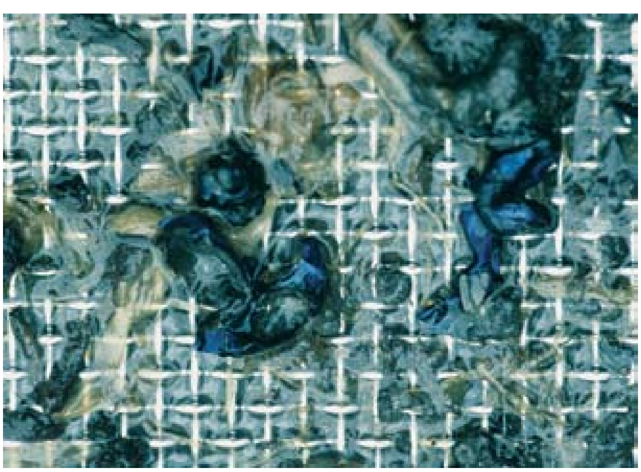

Figure 26.1 Remains of *Geotrupes spiniger* on the 2-mm screen during wet sieving.

a

b

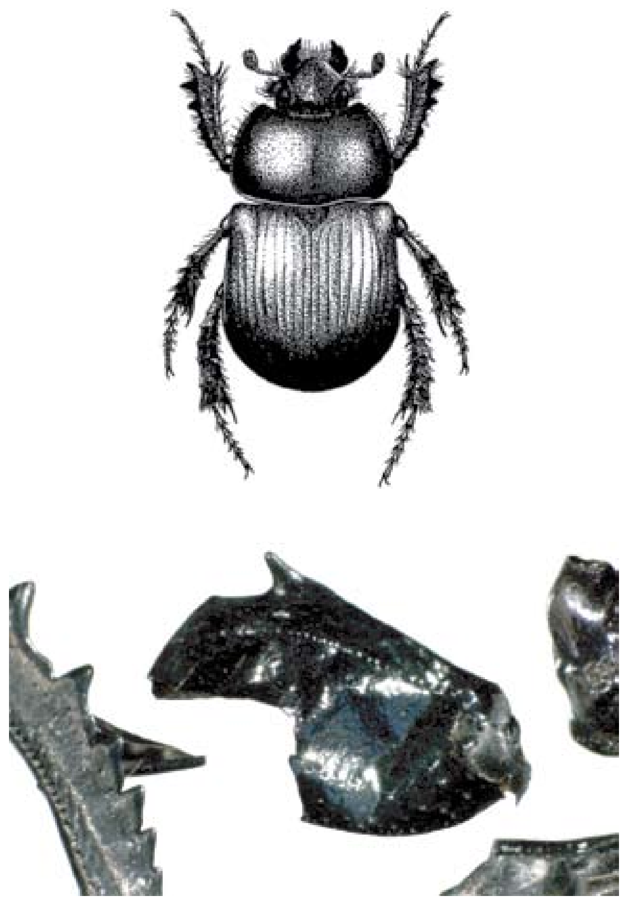

Figure 26.2 *Geotrupes spiniger.*
a habitus (2×), drawing by Michele Reina (from I. Sparacio 1995. Coleotteri di Sicilia).
b fragments from sample 9415, in the centre a part of male hind femur with spine (magnification 8×)

environmental reconstruction on a landscape level. The straightforward, but time-consuming methods will be described in the following section after the procedure of sample selection. The results will be presented feature by feature followed by a discussion by aspect.

26.2 Material and methods

26.2.1 Sample selection

The research programme allowed for the analysis of only a restricted number of samples. Some features seemed promising, combining preservation with archaeological relevance, particularly deep pits on the higher parts of the dune with dark fills containing preserved plant remains. However, the dark colour proved to be attributable to small charcoal particles, the plant remains were roots and insect remains were absent. Therefore, samples had to be taken from deeper layers. As a result of the strategy, clear, man-made features were selected. Six samples were taken from four pits – three unlined wells and one deposition pit. Unfortunately, one much debated aspect, *i.e.* environmental change, could hardly be analysed due to the limitations of the sampling intensity.

First, one sample was taken from a deep unlined well (no. 9415), which was found to contain numerous large beetle parts during sieving on the site. A second sample was taken from the base of another deep unlined well (no. 7001). Because analysis revealed important finds, but in low concentrations, a sample was taken from a higher layer, too (no. 7002). Two distinctly different layers in the fill of another unlined well towards the northwestern slope of the dune were also sampled (nos. 8922 and 8923). One sample was taken from the matrix around a concentration of *Prunus* fruits in a deposition pit (no. 6086). Contextual information is given in table 26.1. The sampling points are given in fig. 26.3.

26.2.2 Methods

All samples were sieved over a 0.25 mm sieve, a widely used optimum between practicality and completeness. Some of the samples had to be extensively soaked to effect complete disaggregation of the matrix. The insect remains were concentrated by means of the paraffin floatation method described by Coope/Osborne (1968), using lamp oil as a nonpolar substance to adhere to the likewise nonpolar remains and force them to float in water. Identifiable parts were picked out and stored in alcohol. All heads, thoraxes (pronota) and elytra of Coleoptera, beetles, were systematically collected. Additionally, some distinctive other parts were selected. All identifiable remains of ectoparasites were taken out. A selection was made of the parts of the remaining insect orders, comprising adult flies, fly puparia, Hemiptera and Hymenoptera, but only a few were identified.

feature	context	sample no.	phase
12-314	unlined well	7002	2b
12-314	unlined well	7001	2b
15-21	unlined well	8922	1/2b
15-21	unlined well	8923	1/2a
15-23	unlined well	9415	1/2a
12-48	deposition pit	6086	1/2a

Table 26.1 Context of insect samples.

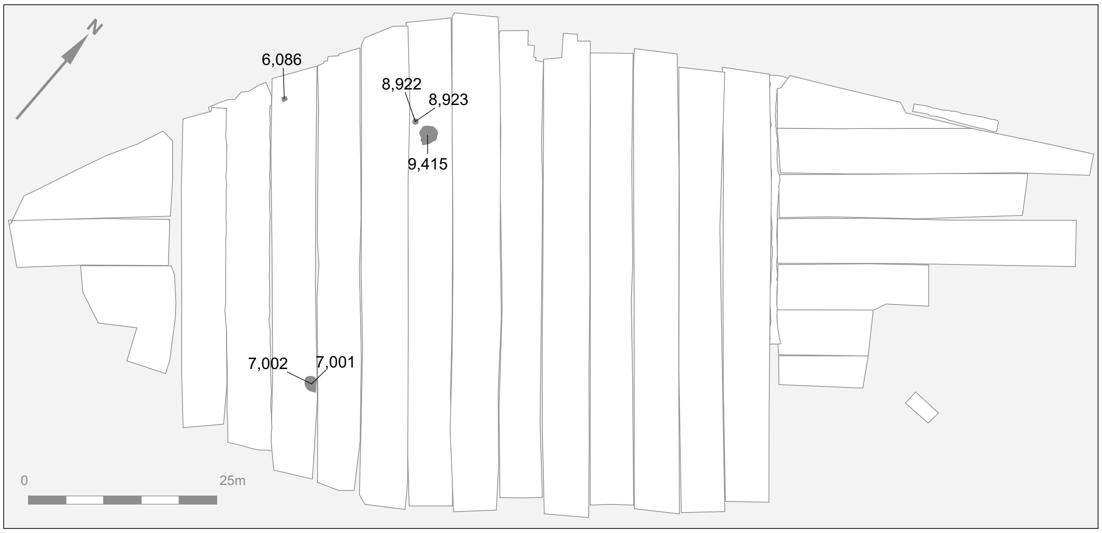

Figure 26.3 Sample points for insect remains.

Waterlogged insect remains fall apart into many loose elements, very much like vertebrates, and these parts break easily. For identification these parts and fragments have to be compared with complete specimens, in this case from the collection of the Zoological Museum of the University of Amsterdam. Regular checks were made to assess the correct-ness of the identifications of reference specimens from the collection. These identifications were based mainly on the *Die Käfer Mitteleuropas* series (Freude/Harde/Lohse 1965-1983). Nomenclature and taxonomy are also based on this series, in particular the extensive revisions in the supplement volumes (Lohse/Lucht 1989-1994).

The identification of some specimens deserves special attention. The *Bembidion* species of the subgenus *Emphades* are rather similar. The identification of the now rare species *B. tenellum* was based on two heads, one pronotum and one elytron. All distinctive characteristics given by Boeken *et al.* (2002) could be verified: frontal furrows also evident on clypeus, pronotum only moderately S-shaped, elytra with apical spot, elytral striae with moderately strong punctures.

Many parts were identified to species level. Some were not, mostly because not all fragments were distinctive enough. Sometimes in-depth identification was assumed to be too time-consuming for the information it was expected to yield. For this reason most of the Alaeocharinae remained unidentified. No counterparts, for instance a *Bembidion* species, for one or two parts with clear characteristics were found after a search of several hours in the collection of beetles from the Netherlands.

Although this is not usually attempted, parts of fly legs were successfully identified. The position of the implantation of setae, colour, size and shape enabled identification of *Scatophaga stercoraria* (fig. 26.4).

Figure 26.4 *Femur* of *Scatophaga stercoraria*, the yellow dung-fly, showing lighter distal end and sockets from which setae originally arose. Sample 9415 (magnification 20×).

Biological information is based mainly on Koch (1989-1992), with additional information from Drost *et al.* (1992), Boeken *et al.* (2002) and Turin (2000).

26.3 Analysis

About one hundred beetle taxa were distinguished. These taxa are presented in Appendix 26.1 along with the few other categories. The numbers represent minimum numbers of individuals.

26.3.1 Deposition pit, sample no. 6086

This sample was taken from feature 12-48, dated to phases 1/2a, a pit with a well-preserved fill containing fruits of *Prunus spinosa* (*cf.* section 4.5.3). This find is intriguing, because the fruits seem to represent a deliberate deposit. It was hoped that insect analysis would provide some information on the formation process.

The beetle assemblage of this sample is dominated by hygrophilous species. A few species, *Anthicus gracilis* for instance, need a heavily vegetated waterside. More important, the insects are predominantly from a brackish environment, as will be demonstrated in a following section. As this is not the natural environment of *Prunus spinosa,* natural deposition of the fruits is unlikely. There are no indications of any additional depositions in the same layer. However, it is not unthinkable that the people who made this deposition actually observed the relatively large, at least partly shining green beetle *Anomala dubia*, or even intentionally included it.

26.3.2 Sample no. 9415

This sample was taken from feature 15-23 and dates from phase 1/2a. The field hypothesis, based on structural characteristics, was that this pit and many similar pits were unlined wells. The sample was taken from the lowest layer of a second backfill. Its contents, therefore, represents not the period of primary use, but either a period of secondary use or a period after use. The layer attracted attention during the standard on-site sieving due to the presence of numerous large beetle remains. The remains were from at least 5 dung beetles of the species *Geotrupes spiniger*, both males and females. The sex of beetles is usually irrelevant from an archaeological perspective, but a very useful characteristic for species identification is the spine on the male hind femur (fig. 26.2). Furthermore, in this species with its specialised behaviour males and females work together excavating and preparing breeding galleries in the soil that are filled with dung. It is during the collection of dung that the beetles can tumble into a pit and drown. There are several examples of archaeological wells, mostly Roman-period and medieval ones, in which remains of large dung beetles and carabids have accumulated, but the specimens found in this excavation, along with those found at the Wateringen 4 site (Raemaekers 1997, 150), represent particularly early cases. *Geotrupes spiniger* was also identified at Ypenburg (Hakbijl in Koot/van der Have 2001, 99).

Geotrupes spiniger is mostly found in association with cow dung, although it is also attracted by horse dung and human excrement. Given other information from this site, it is indeed most likely that it was cattle dung that attracted the beetles. The fly in this sample, *Scatophaga stercoraria*, the yellow dung-fly, is the one that can be seen sitting so abundantly on wet cow dung pads and other dung. Other species in this sample that feed on dung are one *Onthophagus* spec. and four species of *Aphodius*. These *Aphodius* species lay their eggs in the droppings and the larvae develop there. Among the staphylinids there are also many examples of coprophilous species, such as *Oxytelus rugosus* and *O. nitidulus*. For other beetles dung is hardly filthy enough. They are attracted to carrion, too, as in the case of *Creophilus maxillosus* and *Hister brunneus* (=*H. cadaverinus*). More specialised necrophilous beetles are *Silpha tristis* and particularly *Thanatophilus sinuatus*, indicating the presence of decaying animal remains.

Some *Cercyon* species and other hydrophilids breed in dung, but not the species in this sample. These species live mostly at the transition from land to water, sometimes under water, sometimes on land or in the mud, often below detritus and decaying plant matter. There is one real water beetle in this sample, the only one encountered in this study, the dytiscid *Ilybius ater*. These beetles prefer small waters with muddy bottoms, such as cattle watering places (Drost *et al.* 1992, 144). The presence of a caddis larva (Trichoptera) also proves that there was some continuity in the presence of water.

The sample also contained 14 species of carabids (at least 26 individuals). This seems like a concentration of insects that tumbled into the pit, as carabids are fast-walking beetles that are readily caught in pitfalls. However, a number of these species are small beetles that often live in small burrows. The concentration is not as extreme as in some of the more recently consolidated wells from which escape can be difficult. Given the limited number of phytophagous insects (Chrysomelidae and Curculionidae), this place was probably not very heavily vegetated, and probably trampled. *Ceutorhynchus erysimi*, predominantly feeding on *Capsella bursa-pastoris*, fits well in this description.

In the period in which the layer was formed, which was after the first use of the well, the well still contained some water which may have been of use. The animals had access to it at that time and dropped their dung. The fence is of a later date and could therefore not have influenced the accessibility of the well for the animals. The insect assemblage also indicates an influx of salt (*cf.* section 26.3.6), which will have made the well useless as a source of drinking water. It therefore remains unclear whether the animals may have used the well before it became saline.

26.3.3 Sample nos. 8922 & 8923

These samples were taken from feature 15-21, which, like the foregoing, was classified as an unlined well. The samples were dated to phases 1/2a and 1/2b. This feature is smaller and shallower than the foregoing. The section showed two distinct layers, but the beetle spectra are very similar. One or two specimens of the larger beetles appearing in both lists may have been cut in two during the sampling.

The majority of the species and the individuals are hygrophilous, with only two species (*Hoplia philanthus* and *Agrypnus murinus*) preferring dry conditions that may have prevailed higher op the dune. Most of the hygrophilous beetles live predominantly under or in plant remains, including the most abundant species *Megasternum obscurus*. Many of them are also quite common in natural environments. In the literature explicit reference is made to their occurrence in stems and detritus of reeds and sedges of *Bembidion assimile*, *Oodes helopioides*, *Rybaxis longicornis* and *Corylophus cassidioides*. The second most frequently encountered species, *Cyphon* sp., lives under water in the larval stage.

Other categories are almost completely absent. Dung beetles are restricted to a single *Aphodius* sp. in each layer, not enough to prove the slightest amount of dung. The silphid *Blithophaga opaca* is one of the few in the family that is not necrophilous. It is often found in association with *Beta vulgaris* and it is intriguing that remains of roots of this plant were actually found at the site (*cf.* section 20.3.1). On the other hand, we have no positive indications as to the feature's function. More information on the latter beetle will be provided in a following section.

26.3.4 Sample nos. 7001 and 7002

These samples were taken from feature 12-314, which, like the foregoing, was interpreted as an unlined well, situated higher up the slope on the other (SE) side of the dune and dated to a later stage (phase 2b). As wells will have been backfilled in one way or another, and as we are particularly interested in the period of normal use of the well, the transitional layer of the fill at the base was included in the lowest sample (no. 7002). Like other features at the site this layer was dark in colour due to the presence of charcoal. Sample 7002 contained a large amount of it, in minute particles, representing the secondary fill mixed with material from the occupation layer of Unit 20. The contents of the samples from this well were low in concentration and quite different from the contents of sample no. 9415, comprising neither of the species discussed in relation to that sample nor any other representatives of the ecological groups discussed above. Nevertheless, there were two important finds.

The first is *Pulex irritans*, the human flea, represented by at least two individuals (fig. 26.5). The English name does

Figure 26.5 *Metathorax* of *Pulex irritans*, the human flea, part size 0.6 mm (magnification *c.* 150×).

not reflect the full ecological spectrum of this insect. It also feeds on badger, fox and pig/boar, but in this case man was the most likely host. Human fleas can end up in a well when a leap from their host takes them into the water, so the find probably reflects human activity, or at least human presence, near the well.

With the flea another of man's companions, *Musca domestica*, the house-fly, was found in the lowest layer. Unlike many archaeological occasions on which the resistant puparia are found, this was an imago, a fly. This species is now a common fly in rural areas all over the world. In cooler environments the most common breeding medium consists of heaps of manure and other fermenting organic remains. The adults follow man in and around his dwellings and rest on him and his food. Optimal conditions for a population of these flies would be a permanent settlement with robust winter quarters and an abundance of organic refuse. Unfortunately, there are too many limitations for us to infer such a settlement from the present entomological information.

A striking difference with respect to sample 9415 is the lack of dung beetles, which could be explained by the absence of animals and dung around the well. Another explanation could be that the deposit was laid down in winter, but that does not fit in with the presence of *Musca domestica*. Another striking difference is the lack of carabids. Only one was present, and that one belongs to the minority of carabids that climb into the vegetation.

A relatively well represented group consists of mycetophagous and mycetophilous beetles, such as *Agathidium* spec., *Ptenidium intermedium*, *Acrotrichis* spec., *Calyptomerus dubius*, *Enicmus* spec., Corticariini and *Orthoperus* spec. (14 inds. out of 46). These insects may have ended up in the well together with the plant material in which they lived.

There are no indications of salt influx (*cf.* section 26.3.6), no indications of matter that we would now consider dirty, and an indication of human presence in the form of two human fleas. This is what we would expect for the primary use of a well by humans, in which case the well will have been protected against pollution. Part of the protection could have been the fence, keeping out cattle. The section of the well shows vertical unlined walls, suggesting that the water could probably not be approached by cattle without causing damage to the structure.

26.3.5 Synanthropic species

Synanthropic species are a special and archaeologically particularly interesting category. Some of the species concerned evolved together with man, some followed him as he spread across the world and some thrive only in man-made environments. Entomoarchaeological research is gradually revealing a pattern. The results of the excavation at Schipluiden can be fitted into this pattern.

The oldest and most widespread synanthropics are the three species of human lice, which evolved together with man. Wild and domesticated animals also have their lice species. None of these parasites were found here, but there is no reason to assume that they were never present. Animal lice are normally attached to their host and are often found in dung samples. Human lice are attached to either hair or clothing and are usually found in special samples, particularly combs.

The ectoparasite that was found at Schipluiden is *Pulex irritans*, the human flea, presented above. This species was very common until the second half of the 20th century and is regularly encountered in entomoarchaeological studies. There are a few prerequisites. In its immature stages this ectoparasite lives in its host's dwelling. Consequently, it can only reproduce when the host has some sort of dwelling, but as the immature stages are independent of the presence of the host, intermittent use of a dwelling can also imply living conditions for a population of fleas. The presence of the species at this site has biogeographical implications, too, because it is a particularly early find.

Buckland/Sadler (1989) formulated several possible hypotheses for this species' arrival from the New World, where it must have originated. The discovery of the species at the site of the Early Iron Age House Q in the Assendelver Polders (Hakbijl 1989) disproved all hypotheses claiming its arrival in (proto)historic times (Sadler 1990). Older finds are known from a bog body, 2980 ± 35 BP, Emmererf-Scheidenveen (Hakbijl 1990, 170) and from the Middle Bronze Age settlement site of Eigenblok site 5 (Van Dijk/Schelvis 2002). And now, after numerous Neolithic finds in Chalain, France (Yvinec/Ponel/Beaucournu 2000), few possibilities remain. The species must have come from the New World during an early prehistoric period of contact between the continents, borne by man or by another host long before man's presence in the New World.

The second insect that plagued the people of Schipluiden is *Musca domestica* (house-fly). The adults of this species are a nuisance on account of their habit of resting and feeding on the human body, but their alternating feeding on excreta, human food, discharges from wounds, etc. also makes them a health hazard under less hygienic conditions. This find is also of biogeographical importance. The species' original distribution is uncertain, but it probably originated in the southern Palaearctic or the Middle East (Skidmore 1985, 235). At that time it was probably adapted to excreta of ungulates. Since then, it has spread to almost all inhabited parts of the world. Outside the tropics and subtropics it is an eusynanthropic species, *i.e.* living in close coexistence with man, frequenting indoor situations and breeding in all kinds of fermenting household wastes (Greenberg 1971, 70/71). It was also found in the Early Iron Age House Q, Assendelver Polders (Hakbijl, 1989), where it lived in abundance in manure. It may well be that *Musca domestica* made its appearance in the low countries, far outside regions with a climate favourable for this species, during the Neolithic, with its new way of life characterised by more permanent dwellings and the production of large amounts of agricultural waste, in particular dung and manure.

Stock-breeding implied new possibilities for many other insects, among which were dung beetles such as Geotrupids, *Onthophagus* spp. and *Aphodius* spp. and flies such as *Scatophaga stercoraria*. Most of these insects are also found outside occupation areas and pastures, and the Neolithisation process merely implied new opportunities for them.

Today, *Blithophaga opaca* is a stenotopic species of arable and ruderal land, where it feeds on the leaves of crops and weeds, but mainly on *Beta vulgaris*. This species can consequently cause considerable damage in beet crops, particularly in coastal areas (Heinze 1983, 607). This relation with an agricultural crop obscures the beetle's original habitat and distribution. The combined find of the beetle and the plant at Schipluiden could reflect the natural coexistence of the two in the coastal area, the beetle becoming an agricultural pest when the crop began to be cultivated. More research will be needed to learn more about this.

A similar insect-plant combination is the halotolerant *Phyllotreta nemorum*, the turnip flea beetle, which feeds on *Brassica* spp. and is now an agricultural pest. It can destroy the smaller plants completely. Seeds of *Brassica rapa*, rape or turnip, were found at the site. They may have been used at the site, too (*cf.* section 20.3.1). If the plant was already being cultivated at the time of the site's occupation, the beetle would have posed a problem.

Long-term storage of large amounts of food, particularly seeds and fruits, implies possibilities for almost limitless local multiplication of some species, and the original spread of agriculture with the associated storage of produce, followed by gradually intensifying trade, led to the spread of a variety of stored-product arthropods. The Schipluiden site dates from the very beginning of this development, and is probably too early to contain many insects of this category. Indeed, none were found, but it is possible that they were missed due to the limited number of analysed samples.

26.3.6 Salinity

Although the insect study was not intended as an instrument for analysing environmental information on a landscape level, there is no reason not to use the assembled information for this purpose. Salinity of the environment is an obvious aspect, as 20 of the beetle species have some affinity with a saline environment. Four categories were distinguished for a more detailed analysis. The first three are *halobionts* (hb), beetles that live only in a saline or brackish environment, *halophilous* species (hph), having a preference for such environments, and *halotolerant* species (ht), which tolerate them. The fourth category is formed by beetles that live in wet environments to which no specific reference is made in the literature concerning a relation with saline conditions (*negative* information, h-). Selected for this category were all Dytiscidae, Hydrophilidae, Hydraenidae, Heteroceridae, many of the Carabidae and two other hygrophilous species that do not fall in any of the foregoing categories. It is assumed that the majority of the beetles of this category are not regularly found in saline environments. The remaining beetles are not hygrophilous, and were not used in the comparison as they have less contact with saline conditions. The main source of information was Koch (1989-1992), with additional information from Drost *et al.* (1992). The results are presented in table 26.2.

The highest percentage of halobionts (in terms of minimum number of individuals) is 33% in sample 6086, from the artificial deposit of *Prunus spinosa* fruits. The salt-related categories taken together (hb+hph+ht) account for 67% of this sample. The deposit must therefore be saline or brackish. Apparently there was at least occasional salt influx in this early phase (1/2a), which is most evident in this low-lying pit.

sample no.		9415	7001	7002	8922	8923	6086	
Pogonus chalceus (Marsh.)		1	.	.	.	.	.	hb
Ochthebius dilatatus Steph.		11	.	.	.	.	2	hb
Ochthebius marinus (Payk.)		1	.	.	.	.	2	hb
Paracymus aeneus (Germ.)		.	.	.	.	.	2	hb
Heterocerus flexuosus Steph.		.	.	.	.	.	1	hb
Bembidion fumigatum (Duft.)		3	.	.	1	.	1	hph
Bembidion cf. minimum (F.)		.	.	.	.	1	.	hph
Bembidion tenellum/normannum		.	.	.	.	.	1	hph
Ochthebius viridis/pusillus		5	.	.	.	.	.	hph
Limnoxenus niger (Zschach)		1	.	.	1	1	.	hph
Heterocerus obsoletus Curt.		2	.	.	.	.	.	hph
Bembidion tenellum Er.		2	.	.	.	.	.	hph/hb
Dyschirius luedersi Wagn.		1	.	.	.	.	.	ht
Bembidion varium (Ol.)		3	.	.	.	2	.	ht
Cercyon marinus Thoms.		7	.	.	.	.	1	ht
Cercyon tristis Ill.		5	.	2	2	8	2	ht
Cercyon sternalis Sharp		9	1	1	5	5	.	ht
Hydrobius fuscipes (L.)		1	.	.	.	.	.	ht
Cymbiodyta marginella (F.)		1	.	.	.	.	2	ht
Bledius limicola/tricornis/spectabilis		2	.	.	.	.	.	ht
Clivina fossor/collaris		1	.	.	.	.	.	h-
Dyschirius globosus (Hbst.)		6	.	.	.	2	.	h-
Bembidion assimile Gyll.		3	.	.	1	5	1	h-
Pterostichus vernalis (Panz.)		1	.	.	.	.	.	h-
Oodes helopioides F.		.	.	.	.	1	.	h-
Odacantha melanura (L.)		1	.	.	.	.	.	h-
Ilybius ater (Geer)		1	.	.	.	.	.	h-
Ochthebius minimus F.		4	.	.	.	.	.	h-
Coelostoma orbiculare (F.)		1	.	.	.	.	.	h-
Megasternum obscurum (Marsh.)		6	.	.	17	8	1	h-
Lesteva spec.		.	.	.	1	1	.	h-
Oxytelus rugosus (F.)		6	.	1	2	5	2	h-
Oxytelus nitidulus (Grav.)		1	.		.	.	.	h-
Paederus spec.		6	1	2	.	.	1	h-
Rybaxis longicornis (Leach)		.	1	.	1	.	1	h-
Anthicus gracilis Panz.		1	.	.	.	.	1	h-
Totals		*93*	*3*	*6*	*31*	*39*	*21*	
halobiontic	hb	14%	0%	0%	0%	0%	33%	
halophilous	hph	14%	0%	0%	6%	5%	10%	
halotolerant	ht	31%	33%	50%	23%	38%	24%	
	hb + ph + ht	59%	33%	50%	29%	44%	67%	
no relation specified	h-	41%	67%	50%	71%	56%	33%	

Table 26.2. Relation with salinity of selected Coleoptera from Schipluiden. Selected are: Dytiscidae, Hydrophilidae, Hydraenidae, Heteroceridae, many of the Carabidae and two other hygrophilous species.

Surprisingly, sample 9415 (from the assumed cattle watering place) also contained halobiontic beetles (14%), and the salt-related categories together dominate the hygrophilous fauna at 59%. This is not what we would expect for a source of drinking water intended for human consumption. A possible explanation is that the period in which the deposit was laid down was characterised by one or more occasions of the influx of salt or brackish water, making the well useless.

The small pit from which sample no. 8922/3 was obtained occupies an intermediate position, with no halobionts and 5 or 6% halophilous beetles. It was less saline, or was under the influence of a less saline environment than the foregoing well and the deposition pit.

Different was the situation in the pit that yielded sample no. 7001/2, from occupation phase 2b: no halobionts, no halophilous species and only a few halotolerant and 'other' beetles. The low number of hygrophilous specimens and very low total number of specimens can be regarded as negative evidence of salt in this water-filled pit, which was in a preceding section assumed to have been a source of water for human use.

26.3.7 Vegetation

The presence of insect remains can often be used as additional information for the reconstruction of former vegetations. Some of the – scarce – information obtained at Schipluiden has been presented in previous sections. The insects are predominantly from open landscapes. Only *Nebria brevicollis* is often found in woods, but the species is by no means restricted to such a habitat. Furthermore, not a single insect favouring dead wood, less healthy trees, worked wood or decaying wood was found. Two beetles of species that live in, or feed on, the leaves of trees were represented: *Trachys minutus* (phase 2b) is polyphagous, but often lives on *Salix* spp. and adults of *Phyllopertha horticola* (phases 1/2a) are found on a variety of trees. So there are virtually no indications of woodland or the presence of trees nearby.

26.3.8 Special faunal elements

Identifying prehistoric insect remains often involves species that are now rare, or species for which no historical records exist in the area. In this case four of such species were found.

Trachys minutus is not known from the coastal provinces of the Netherlands (Brakman 1966 & ZMA collection). It is widespread in open woods in the higher parts of the Netherlands. Its current absence in the coastal provinces may be attributable to changes in habitat quality, as the area underwent drastic deforestation from medieval times onwards.

Anthicus gracilis no longer occurs in the Netherlands, but must have been quite common once, as it was encountered in a Neolithic well elsewhere in the Netherlands (Kolhorn; Hakbijl/Pals/Troostheide 1989) and also in the Early Iron Age House Q, Assendelver Polders (Hakbijl 1989).

Onthophagus taurus and *O. illyricus* are extremely similar. Taken together they are by far the rarest species of *Onthophagus* in the Netherlands. They are both thermophilous and have a southern distribution, suggesting that their present rarity may be attributable to climatic change.

The halobiontic *Bembidion tenellum* probably disappeared from the Netherlands during the last century (Turin 2000, 281). It was also found in a Roman well with marine influence at Valkenburg (Hakbijl, in progress). Its occurrence in the Netherlands is at the margin of this species' distribution area, suggesting that climate may have been a factor in its disappearance, but the habitat quality of the coastal zone has also suffered greatly due to land reclaims and the construction of water defence works.

26.4 Conclusions

All samples from phases 1/2a yielded insect evidence of at least occasional salt influx.

The sample from the deposition pit (no. 6086) contained the largest number of salt-indicating species, corroborating the artificial nature of the deposition of *Prunus spinosa* fruits.

The rich insect sample (no. 9415) from a second backfill of a well provided much information on that phase in the well's existence. Livestock, which were in those days not yet kept away by the fence (being of later date) had access to the well, dropped their dung and trampled the area. Decaying animal remains were present in/near the well. Salt influx will have made the well useless as a source of drinking water, but it remains unclear whether the animals used the well before its water became saline.

The insect assemblages in the samples from another unlined well, nos. 8922 and 8923, yielded no positive indications as to the feature's function.

The well from which samples 7001 and 7002 were taken yielded no evidence of matter that we would now consider dirty, nor of salt influx. Human presence is indicated by *Pulex irritans*. This is what we would expect from a well intended for human use that was protected against pollution. Part of the protection may have been the fence, keeping out cattle.

Two important synanthropic species were found: *Pulex irritans* and *Musca domestica*. These finds are particularly early and have biogeographical implications. The former may have occurred in this area earlier. As for the latter, the Neolithic may have been the first period in which this species could exist in this region. Many insects that benefit from stock-breeding were found. There was no evidence of any stored product pests; this was indeed the earliest period in which such pests could have occurred in this region. As a group, the synanthropic species fit in with the pattern that may be expected for this period.

The combined occurrence of remains of *Blithophaga opaca,* the beet carrion beetle, and *Beta vulgaris* at the site could reflect the natural coexistence of the two species in the coastal area. When the crop began to be cultivated, the beetle became an agricultural pest.

The insects are predominantly characteristic of open landscapes. Not a single insect favouring dead wood, less healthy trees, worked wood or decaying wood was found.

The samples contained a few species that are no longer found in this region, or that are now rare: *Trachys minutus,* *Anthicus gracilis*, *Onthophagus taurus/illyricus* and *Bembidion tenellum*. Their present rarity or absence may be attributable to both climatic change and changes in habitat quality.

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Appendix

26.1 Insect remains from Schipluiden, presented as minimum numbers of individuals. Taxonomy and nomenclature of Coleoptera after Lohse/Lucht (1989-1994) and Freude/Harde/Lohse (1965-1983).

sample no.	9415	7001	7002	8922	8923	6086
sample size in kg:	?	1	3,2	2,2	2,2	1,2
preservation:	++	+	+	±	±	+
COLEOPTERA						
Carabidae						
Nebria brevicollis (F.)	1	.	.	.	.	.
Clivina fossor (L.) or collaris Hbst.	1	.	.	.	.	.
Dyschirius luedersi Wagn.	1	.	.	.	.	.
Dyschirius globosus (Hbst.)	6	.	.	.	2	.
Bembidion varium (Ol.)	3	.	.	.	2	.
Bembidion fumigatum (Duft.)	3	.	.	1	.	1
Bembidion assimile Gyll.	3	.	.	1	5	1
Bembidion tenellum Er.	2	.	.	.	.	.
Bembidion tenellum or normannum Dej.	.	.	.	.	.	1
Bembidion cf. minimum (F.)	.	.	.	.	1	.
Bembidion spec. a	.	.	.	.	2	.
Bembidion spec. b	.	.	.	.	.	1
Pogonus chalceus (Marsh.)	1	.	.	.	.	.
Poecilus spec.	1	.	.	.	.	.
Pterostichus vernalis (Panz.)	1	.	.	.	.	.
Amara aenea (Geer)	1	.	.	.	.	.
Oodes helopioides F.	.	.	.	.	1	.
Odacantha melanura (L.)	1	.	.	.	.	.
Demetrias or Dromius spec.	1	1	.	.	.	.
Dytiscidae						
Ilybius ater (Geer)	1	.	.	.	.	.
Hydraenidae						
Ochthebius dilatatus Steph.	11	.	.	.	.	2
Ochthebius minimus F.	4	.	.	.	.	.
Ochthebius marinus (Payk.)	1	.	.	.	.	2
Ochthebius viridis Peyrhff. (or pusillus Steph.)	5	.	.	.	.	.
Hydrophilidae						
Helophorus spp.	2	.	.	.	.	.
Coelostoma orbiculare (F.)	1	.	.	.	.	.
Cercyon marinus Thoms.	7	.	.	.	.	1
Cercyon spec. (possibly marinus)	.	.	.	.	1	.
Cercyon tristis Ill.	5	.	2	2	8	2
Cercyon sternalis Sharp	9	1	1	5	5	.
Megasternum obscurum (Marsh.)	6	.	.	17	8	1
Paracymus aeneus (Germ.)	.	.	.	.	.	2
Hydrobius fuscipes (L.)	1	.	.	.	.	.
Limnoxenus niger (Zschach)	1	.	.	1	1	.
Cymbiodyta marginella (F.)	1	.	.	.	.	2
Histeridae						
Hister brunneus F. (=cadaverinus Hoffm.)	1	.	.	.	.	.

sample no.	9415	7001	7002	8922	8923	6086
sample size in kg:	?	1	3,2	2,2	2,2	1,2
preservation:	++	+	+	±	±	+
Silphidae						
Thanatophilus sinuatus (F.)	1	.	.	.	.	.
Blitophaga opaca (L.)	.	.	.	1	1	.
Silpha tristis Ill.	1	.	.	.	.	.
Liodidae						
Agathidium spec.	1	.	.	.	.	.
Ptiliidae						
Ptenidium intermedium Wank.	.	.	8	.	.	.
Ptenidium spec. not punctatum	2	1	.	.	2	2
Acrotrichis spec.	1	1	1	2	1	.
Staphylinidae						
Metopsia retusa (Steph.) (or clypeata (Müll.))	.	.	1	.	1	.
Lesteva spec.	.	.	.	1	1	.
Carpelimus spp.	3	1	3	1	3	2
Oxytelus rugosus (F.)	6	.	1	2	5	2
Oxytelus nitidulus (Grav.)	1	.	.	.	.	.
Bledius limicola, tricornis or spectabilis	2	.	.	.	.	.
Stenus spp.	1+1	.	.	2	.	1
Paederus spec.	6	1	2	.	.	1
Astenus spec.	.	.	2	.	.	.
Rugilus rufipes (Germ.)	.	1	.	.	.	.
Rugilus similis (Er.) or geniculatus (Er.)	1	.	.	.	.	.
Pseudomedon obscurellus (Er.)	.	.	.	1	.	1
Gyrohypnus spec.	1	.	1	.	1	.
Xantholinus spec.	1	.	.	2	2	.
Philonthus spec.	1+1	.	.	.	.	.
Creophilus maxillosus Mannh.	1	.	.	.	.	.
Tachyporus spec.	.	1	.	.	.	.
Drusilla canaliculata (F.)	.	1	1	.	.	.
Alaeocharinae gen. indet.	4	.	1	2	5	1
Pselaphidae						
Rybaxis longicornis (Leach)	.	1	.	1	.	1
Brachygluta spec.	.	.	.	.	.	1
Elateridae						
Agrypnus murinus (L.)	.	.	.	1	.	.
Buprestidae						
Trachys minutus (L.)	.	.	1	.	.	.
Clambidae						
Calyptomerus dubius Marsh.	.	.	1	.	.	.
Scyrtidae						
Cyphon spec.	2	.	.	6	8	.
Heteroceridae						
Heterocerus flexuosus Steph.	.	.	.	.	.	1
Heterocerus obsoletus Curt.	2	.	.	.	.	.
Heterocerus spec.	.	1	1	.	.	.
Cryptophagidae						
Atomaria spec.	.	1	1	.	.	1

sample no.	9415	7001	7002	8922	8923	6086
Phalacridae						
Stilbus oblongus (Er.)	.	.	1	.	.	1
Latridiidae						
Enicmus transversus (Ol.) or histrio Joy	1	.	.	.	.	.
Corticariini indet.	.	.	1	.	.	.
Corylophidae						
Corylophus cassidioides (Marsh.)	.	.	.	1	1	.
Orthoperus spec.	.	.	1	.	.	.
Coccinellidae						
Adalia or Oenopia spec.	1	.	.	.	.	.
Anthicidae						
Anthicus gracilis Panz.	1	.	.	.	.	1
Geotrupidae						
Geotrupes spiniger (Marsh.)	5	.	.	.	.	.
Scarabaeidae						
Onthophagus taurus (Schreb.) or illyricus (Scop.)	1	.	.	.	.	.
Aphodius consputus Creutz. or prodromus (Brahm)	1	.	.	.	.	.
Aphodius foetidus Hbst.	1	.	.	.	.	.
Aphodius spec. (a)	2	.	.	.	.	.
Aphodius spec. (b)	3	.	.	.	.	.
Aphodius spec.	.	.	.	1	1	.
Anomala dubia Scop.	1	.	.	.	.	1
Phyllopertha horticola (L.)	1	.	.	.	1	.
Hoplia philanthus Füssl.	.	.	.	1	2	.
Chrysomelidae						
Chrysolina fastuosa (Scop.)	.	.	1	.	.	.
Chrysolina spec. (other species)	.	.	.	.	1	.
Phyllotreta nemorum L.	.	1	.	.	.	.
Longitarsus spec.	1	.	.	.	.	.
Altica spec.	1	.	.	.	.	.
Curculionidae						
Sitona spec. a	1	.	.	.	.	.
Sitona spec. b	1	.	.	.	.	.
Ceutorhynchus erysimi (F.)	1	.	.	.	.	.
Nedyus quadrimaculatus (L.)?	.	.	1	.	.	.
gen. indet.	.	.	.	.	.	1
Sum MNI Coleoptera	145	13	33	52	72	34
Heteroptera						
Corixidae indet.	.	.	.	.	.	1
indet.	+	+	+	+	+	.
Anoplura & Mallophaga	–	–	–	–	–	–
Siphonaptera						
Pulex irritans L.	.	.	2	.	.	.
Diptera						
Scathophaga stercoraria L. (adult)	1	.	.	.	.	.
Musca domestica L. (adult)	.	.	1	.	.	.
other Diptera (adults)	+	.	+	.	.	+
Nematocera (larvae)	+	.	.	.	.	+
Brachycera (pupal remains)	+	+	+	.	+	+
Lepidoptera						
mandibles of larvae, indet	+	.	.	+	+	+
Trichoptera						
Larval frontoclypeus, indet.	1	.	.	.	.	.
Hymenoptera						
parasitic wasps, ants, etc, indet.	+	+	+	.	.	+
addenda:						
perisarc Hydrozoan polyp	.	.	.	.	.	1

26.2 Glossary of scientific, English and Dutch names of insects mentioned in the text.

scientific	English	Dutch
Coleoptera	beetles	kevers
Carabidae	ground beetles	loopkevers
Odacantha melanura (L.)		rietloopkever
Dytiscidae	predatious diving beetles	waterroofkevers
Hydraenidae	minute moss beetles	waterkruipers
Hydrophilidae	water scavenger beetles	spinnende watertorren
Histeridae	hister beetles/Steel beetles	spiegelkevers
Silphidae	carrion beetles	aaskevers
Blitophaga opaca (L.)	beet carrion beetle	doffe bietenaaskever
Ptiliidae	feather-winged beetles	haarvleugelkevers
Staphylinidae	rove beetles	kortschildkevers
Creophilus maxillosus Mannh.	hairy rove beetle	grauwe aaskortschild
Pselaphidae	short-winged mould beetles	knotskevers
Elateridae	click beetles	kniptorren
Buprestidae	jewel beetles	prachtkevers
Heteroceridae	variegated mudloving beetles	oevergraafkevers
Latridiidae	plaster beetles	gegroefde schimmelkevers
Coccinellidae	lady birds	lieveheersbeestjes
Anthicidae	ant-like flower beetles	snoerhalskevers
Geotrupidae	(dung beetles)	mestkevers
Geotrupes spp.	dor beetles	
Geotrupes spiniger (Marsh.)		doornmestkever
Scarabaeidae	scarab beetles	bladsprietkevers
Aphodius spp.		veldmestkevers
Phyllopertha horticola (L.)	garden chafer	rozenkever
Anomala, Hoplia spp. etc.	chafers	
Chrysomelidae	chrysomelids	bladhaantjes
Phylloterta nemorum L.	turnip flea beetle	grote gestreepte aardvlo
Curculionidae	weevils	snuittorren
Siphonaptera	fleas	vlooien
Pulex irritans L.	human flea	mensenvlo
Diptera	true flies	vliegen en muggen
Scathophaga stercoraria L.	yellow dung fly	strontvlieg
Musca domestica L.	house-fly	huisvlieg
Nematocera	midges	muggen
Brachycera	flies	vliegen
Lepidoptera	butterflies and moths	vlinders
Trichoptera	caddisflies	schietmotten/kokerjuffers

Part IV

Synthesis

27 Schipluiden: a synthetic view

Leendert Louwe Kooijmans

The local group at the Schipluiden site consisted of four households, together comprising around 25 persons, who lived on the dune on a permanent basis. For the procurement of stone and flint they were dependent on contacts with a hinterland in the south and the east. They did not have all the required wood species at their disposal either. A broad range of tools and other utilitarian objects were produced and used at the site. Most of the activities can be assigned to the men or the women in the group.

The first pioneers who arrived at the dune settled in an unusual coastal landscape that was from time to time flooded during marine ingressions. Their subsistence strategy was based on the exploitation of a broad spectrum of natural resources in different ecozones, some in winter, others in summer, combined with stock keeping and cereal cultivation.

To be able to describe how the local community functioned we must regard it as part of the regional group that exploited this region and the surrounding area. Approached from this angle, the community's way of life proves to have been far less agricultural than is suggested by the large numbers of bones found at the site. It is instead a good example of an extended broad spectrum economy. The isotope signal of the human skeletal remains shows that aquatic/marine resources were of substantial importance. Schipluiden can be seen to represent a late stage in the very gradual, step-by-step neolithisation process, with many elements recalling the preceding Mesolithic and the Swifterbant culture.

Man and materials

27.1 The local group

27.1.1 Complete households

The site's first occupants settled not on the dune itself, but at its foot – behind the dune, viewed from the water courses. This particular spot may have been selected out of a need for shelter in the open landscape. A number of open clusters of postholes on that side of the dune testify to small houses that were used for a relatively short length of time. The first unlined wells were dug there, too, in this first occupation phase. On the other side of the dune waste produced in butchering was dumped in the tidal creek. Occupation soon moved to the top of the dune, most probably due to floods – in the flat landscape the 1.5 metres' height of the dune meant the difference between a dry yard and wet feet.

The dune was occupied by complete households, *i.e.* men, women and children. This is first of all evident from the analysis of the human skeletal remains, which, besides men, were found to represent children aged between 2 and 8 and probably also one woman. It should be borne in mind that the archaeological population does not constitute a representative sample of the original population. The underrepresentation of women and children will be due to differences in the treatment of the deceased. The attested minimum number of 17 individuals is less than 10% of the deceased one would expect for a population of 4-5 households in around two centuries.

A second argument for assuming the presence of complete households on the dune is the broad range of artefacts made of a wide diversity of materials that were manufactured and used at the site. Pottery was made from local clays, tools of flint, stone, bone and antler were made and repaired on the dune. The activities that can be inferred from the typology of those tools and from the analysis of the use-wear traces observable on them represent the full range of activities of normal households. All this is characteristic of a base camp.

This conclusion is further supported by evidence relating to subsistence. The exploitation of the great diversity of food sources available in the site's immediate and distant surroundings is likewise characteristic of a basic function within a wide territory (see section 27.8).

27.1.2 Size of the group: four households

The area of the entire dune was in all the occupation phases organised as a settlement site. This is primarily evident from the fact that waste was dumped around the entire circumference of the dune in every phase. Only the evidence relating to the disposal of waste in phase 1 is not entirely complete. In phases 2b and 3 the dump zone shrunk somewhat along the southeastern edge of the dune because the rising groundwater led to a reduction in the area suitable for occupation. In each phase the daily activities extended into the plain and (later) the swampy zone surrounding the dune, in phase 2a even over a distance of at least 20 metres.

Thousands of postholes show that the entire top part of the dune, from the southwestern to the northeastern end, was intensively used. Four clusters were distinguished on the basis of the clustering of the holes of the thickest posts; they are assumed to represent individual yards. Diffuse clusters in the southeastern dump zone corresponding to these yards lead to the conclusion that the local community living on the dune – from phase 2a onwards at least – consisted of four or five households, *i.e.* around 25 persons. In this respect this local group does not – or at least not demonstrably – differ from the Late Mesolithic group that is assumed to have lived at the almost 2000 years earlier site of Hardinxveld. The greater size of the Schipluiden site will be attributable to the fact that this settlement was occupied on a permanent basis, and a much larger range of activities were carried out there.

27.1.3 A permanent settlement

One of the most important questions that must be asked when dealing with settlements dating from a period in which people began to exchange a mobile existence for a more settled way of life is whether the settlement was occupied on a permanent basis. Generalising the conclusions obtained for Hardinxveld we assume that people in the preceding Mesolithic exploited a large territory in different seasons from different camps, which were all strategically chosen with a view to the specific seasonal activities. An important characteristic of the Neolithic way of life, besides the adoption of crop cultivation and stock breeding, is also the investment of ever more effort in the construction of settlements – in the building of larger houses and storage facilities and in the creation of permanent fields. The maintenance required by those structures and the necessary tending of the crops will have made a fixed settlement perhaps not immediately necessary, but certainly desirable.

A first argument in favour of permanent occupation is the construction and maintenance of sturdy houses and a settlement layout based on their yards. Unfortunately we were unable to make out any house plans at Schipluiden, but we consider the dimensions of the postholes and their linear arrangements good arguments for interpreting the clusters as representing the sites of small, well-built rectangular houses like those at Wateringen 4 and Ypenburg (Raemaekers *et al.* 1997; Koot *et al.* in prep.). The postholes moreover imply a high degree of continuity: new houses were each time built at the site of a former house. The phasing and spatial patterns of the southeastern dump zone show that the sites of all the houses remained unchanged and the dune was divided into fixed yards. This fixed layout of the entire area was at some time accentuated by the construction of a fence that enclosed the entire site. This implied a substantial communal effort.

A formal cemetery of the kind found at Ypenburg (Koot/Van der Have 2001; Koot *et al.* in prep.) would have been a strong argument in favour of permanent site use, but the absence of such a cemetery is not an argument to the contrary. This difference with respect to Schipluiden does in our opinion not imply a functional difference between the settlements, but more a difference in the occupants' preferences and their urge to express their collectiveness. The selective burial of certain members of a community and differentiated treatment of the deceased are more in line with a permanent than a temporary settlement.

Besides these spatial arguments there are also material ones. The diatom research showed that all the pottery was made from estuarine clays, and was therefore most probably locally produced. There is no evidence of any import from a different ecological zone. The fact that people did not always use the best and most suitable wood species to make certain objects, for example axe hafts, but instead less appropriate, or even inferior, regionally available wood also implies close ties between the occupants and the surrounding region. This is something we wouldn't expect in the case of a community that regularly moved around within a larger annual territory.

Additional evidence of year-round presence at the site is provided by the results of the various biological analyses (section 27.8) in the form of indications of activities in specific seasons: fishing in the estuary and cereal cultivation in summer, the gathering of wild fruit in late summer and autumn, the hunting of swans, geese and ducks and the collection of shed red deer antler in the winter half of the year.

There is one comment that should be made in this context and that is that the occupants kept digging new wells on the northwestern side of the dune in the earliest occupation phases. Those wells are assumed to represent *ad-hoc* responses to unpredictable, incidental marine ingressions in those early days. An alternative interpretation would be that these wells reflect seasonal use of the site, with a new well being dug with each visit to replace the former that had filled up during the community's absence. This might be a realistic option for phase 1, about which comparatively little is known, but it is incompatible with the abundant evidence of year-round presence in phase 2a.

27.2 Tools and activities

At sites with normal, dry conditions the preserved material culture is usually limited to flint, stone and pottery, but thanks to the good preservation conditions in the wet peripheral zone of the dune and the fills of the features we have at Schipluiden also a sample of artefacts made of more perishable, organic materials: bone, antler, wood and even plant fibres. This makes us realise that the ratios of excavated artefacts manufactured from the various raw materials are exclusively determined by the chances of those artefacts' survival, and tell us nothing about the artefacts' original importance to the occupants. The discovered artefacts made of organic materials, especially those of wood, are to be seen as the proverbial tip of the iceberg – they provide only a glimpse of a much more varied spectrum. A good indication of the important roles of fibres, skins and wood are the frequencies of use-wear traces on the flint, stone and bone tools. Use-wear traces, rejected waste and semi-finished artefacts enable us to reconstruct the production processes of certain categories of artefacts and identify the tools that were employed in them.

27.2.1 Raw materials

Most of the required raw materials were provided by the local vegetation, fauna and soil, but certain essential materials were not to be found in the region. Some of them could be procured via expeditions. Only special types of flint and stone, axe blades and pyrite will have been obtained via social networks.

In the days of the Schipluiden settlement there were no large deciduous trees in the Delfland region: no oaks, ashes, limes, elms or yew. The need for wood of those species had to be met via import. Ashes probably grew fairly close by, in the forests aligning the major rivers or else on river dunes such as those of Hillegersberg (20 km) or Nieuw-Lekkerland (30 km). The same holds for oaks, which were in the Neolithic generally used for the manufacture of dugout canoes. The closest sources of yew were probably the sandy soils of the province of Noord-Brabant (>40 km). The distances concerned could be covered in expeditions of one or a few days. As far as the beautifully shaped ash paddles and the ash 'canoe partition' are concerned, there are two options: they were either made at the site using imported wood or they were obtained as finished artefacts through exchange. The scarce pieces of unworked ash and yew wood constitute an argument favouring the first option.

The sources of some of the other materials are still unclear. The main type of flint used as a raw material – rolled flint pebbles – could primarily derive from the Pas de Calais (200 km) coastal area, and the same holds for the jet, for which a primary source in that same region, near Boulogne-sur-Mer, is known. The two materials may however have been transported northwards by marine currents and have been picked up closer by, for example along the beaches of Flanders, the jet possibly even on the beach of Delfland itself. Small vein quartz river gravels, flat quartzite pebbles and even amber may have been washed out of the subsoil and picked up on the beaches, too. Two problems are that insufficient observations have been made in natural exposures of ancient beach deposits to verify the occurrence of such materials, and that present-day beach finds do not provide a reliable frame of reference for the past due to various contaminations and a higher sea level. Large pieces of selected types of stone, pyrite, axes and large flint tools were certainly imported from distant sources. Dependence on long-distance social exchange for such high-quality materials and artefacts is not specific to this site, but indeed inherent to the Neolithic in general, and not only that of this delta area. The combination of a simple flake industry based on readily available small pieces of flint and large artefacts made of 'exotic' flint has been observed at the other Hazendonk sites, too, and that is a good reason for assuming that the rolled flint pebbles of Schipluiden were also collected by the occupants themselves, not too far away from their settlement.

27.2.2 Tool manufacture

Axes

Axes were perhaps the most valued possessions in view of their distant origins. Most are made of flint; fragments of axes of other types of stone (quartzite) are much less common. The axes may have been imported as semi-manufactured objects and polished at the settlement or they may have been obtained as complete, finished artefacts in the exchange network. What we do know for certain is that damaged and blunt axes were sharpened at the site using grindstones of quartzite or quartzitic sandstone. The axes will have had a long life and were used until they were completely exhausted. A few small, almost totally worn axes were found in the dump zone. It is not very likely that they are representative of the tools used by the dune's occupants. Strenuous chopping work, certainly the felling of trees for house construction, will have called for axes that were a good deal heavier than the recovered small specimens. Some surviving fragments show that the occupants indeed also had larger, heavier axes. We have moreover found some handles of axes of such a larger size.

Flint flake and blade tools

Crude flint, usually in the form of river gravels, but also broken axes, was knapped at the site using a simple, usually hard flaking technique. The flakes were used to make arrow points, scrapers, drills and strike-a-lights, but most were only retouched or were used without further flaking. The occupants also imported larger retouched blade and flake tools. The flint tools were mostly used directly for processing soft materials such as skins and plant fibres, and to a much lesser extent for carving bone and wood. A few flint artefacts that were used for cutting silicious plants show the typical 'sickle gloss' formed in harvesting cereals.

Many flint tools originally had a handle, as can be inferred from typical microscopic hafting traces and tiny remains of the tar that was used to hold them in place. Unique to the Netherlands is a crude piece of birch tar that was probably mixed with bee's wax.

Stone

Stones were often used in a crude form, as cooking or hearth stones. Other apparently unworked stones appear to have been selected mainly on the basis of stone type, shape and dimensions for use as querns, grindstones or hammer stones, the latter for example for knapping flint and stone, breaking open bones or roughening querns. Besides two small, complete specimens, several dozen fragments of querns of a coarse-grained quartzitic sandstone and granite were found, plus a few rubbing stones. The micro-wear and phytolite analysis showed that some of the stones were used for grinding cereals. Like worn, broken axes, exhausted grindstones were also used for producing flakes.

Most stone tools were recovered in the form of fragments that could not be refitted, so we may assume that many have disappeared without trace. They may have been crushed for use as temper in the pottery or they may have been secondarily used, for example as net sinkers or for securing fish traps and then have been lost off-site.

Bone and antler tools

As in earlier and later times, metapodia were usually selected for the manufacture of bone tools. This is not only a tradition, but also a rational preference, metapodia being the most compact, straight types of bones. This 'metapodial tradition' comprised an entire toolkit of chisels and awls, which were finished and sharpened with grindstones. Awls were used predominantly for processing fibres and skins, chisels for woodworking. Alongside this systematic production line we also observe evidence of a more opportunistic use of suitably shaped bone splinters.

Red deer antler beams were in the Neolithic used mainly for the manufacture of axes and axe handles; the tines were used predominantly as awls and punches. This was the case at Schipluiden, too. The occupants used both gathered shed antler beams and the antler of shot animals. The antler was divided into parts by roughly breaking it or carving transversely all the way round it. Strips were also cut longitudinally from the beams using the groove-and-splinter technique, but the end products of this technique were not found at the site and are not known from elsewhere either. This technique was very popular in the Upper Palaeolithic and Early Mesolithic, but was rarely used in the Neolithic. For Neolithic examples of its use we must turn to Switzerland (Cortaillod culture) and the Hebrides (Oban culture), where it was in both cases used for the manufacture of harpoon points.

Tool marks show that flint implements were used in these different forms of bone and antler processing, but oddly enough virtually none of the tools in question were identified in the use-wear analysis, in spite of the fact that the traces concerned are readily identifiable. This could mean that fairly inconspicuous flakes were used for this purpose, or that bone and antler processing was relatively rare.

Wood

Wood was an important raw material that was used for many different purposes. This is indirectly evident from the large numbers of axe fragments and pieces of grindstones found at the site. Large quantities of wood were required for building houses and fences and making fish weirs and so on. The sharpened ends of the fence posts show that the employed axes were most effective. Once a tree had been felled, its trunk was cleft tangentially or radially using wedges. Tangential cleaving may have been the first stage in the production of dugout canoes or it may have been used for producing posts and beams with square cross-sections.

In manufacturing artefacts from split wood and thick branches, the occupants used predominantly differently sized bone chisels, but also flint tools and heavy flakes of quartzite and quartzitic sandstone – the latter both for 'sawing' or carving and for sanding the carved wood. Some objects testify to great skill and workmanship in fine woodworking, such as two paddles, the axe handles and artefact no. 9411 of unknown function.

The diversity of wooden artefacts is greater than at any other Stone Age site in the delta area. All the artefacts except the axe handles seem to have been intended for hunting and transport. Besides objects that can be easily interpreted, such as paddles and a bow, there is also a series of mysterious objects for which we have no parallels and with which our imaginative powers are unable to associate a function. One of the objects could be part of a boat or a canoe, others could be parts of traps. Whatever those objects may be, the Schipluiden people did evidently not make exclusively simple implements, but also more complex, composite pieces of equipment consisting of several parts. The assemblage of wooden objects seems to represent a random selection of a multitude of artefacts.

27.2.3 Processing of soft materials

Flint flakes and tools were used mainly for processing soft materials such as skins and plant fibres.

Two unique pieces of fabric of thin willow bark fibres – or rather parts of fine basketry made using the 'looping-around-the-core' and a twining technique – and a find consisting of individual strips of hawthorn bark represent a group of materials that was originally very important but of which remains are rarely found. The finds in question are probably remains of mats and clothing. The high percentage of use-wear traces formed by silicious plants among the flint tools is an indication of the importance of this group of materials. In making the basketry, bone awls were inserted between the loopings to make openings through which the bark fibres could be drawn. Besides for these fine applications, plant fibres and bark were of course also used on a large scale for the manufacture of rope, (fishing) nets and traps, but no

Figure 27.1 Bird's-eye view of a reconstruction of the Schipluiden settlement in its natural surroundings around the middle of the occupation period. On the dune lie four small farms surrounded by yards and (hypothetical) kitchen gardens and enclosed by a fence. Outside the settlement crops are cultivated on the high salt marsh deposits in the beach plain and cattle are pastured. The open landscape is intersected by tidal creeks and dotted with dunes with a shrub vegetation. The coastline bordered by a row of low dunes is visible in the distance.

remains of such objects were found at Schipluiden. They have however been found at younger and older sites such as Hardinxveld, Bergschenhoek and Vlaardingen (Louwe Kooijmans 2001a, 1987; Van Iterson Scholten 1977).

No skins or hides were found, but we do have indirect evidence of them. In the first place in the form of cutting marks on bones associated with skinning and secondly abundant traces on flint tools, especially scrapers, indicating that those tools were used to scrape both fresh and dry skins. Holes were made in the skins with bone awls. A third source of indirect evidence consists of the ratios of different types of bones that imply that only the skin or fleece of some animals was brought back to the settlement. This holds for brown bear, at least some of the aurochs and lynx. We assume that the skins of most of the animals were used to make clothing and covers for benches, beds and the like.

We finally also have indirect evidence of the use of feathers. Some birds that are nowadays not considered to be game birds, such as white-tailed eagles and ruffs, may have been shot especially for their feathers, which were very suitable for use in arrows or for decorative purposes.

27.2.4 Special activities

Ornaments

Crude pieces of jet and small pieces of amber were at the site turned into beads using flint drills and knives, which show distinct traces of this activity. Things did not always go as intended, which led to interesting evidence of the manufacturing process.

Fire

Pieces of flint – both intentionally shaped artefacts and pieces that happened to have a suitable shape – were used as strike-a-lights in combination with pyrite and – presumably – punk powder, as is beautifully attested by the exceptional grave goods found in burial 2.

Pottery

Pottery manufacture proves to have been an entirely independent activity. The pots are simple, bucket-shaped vessels of crude workmanship, formed from thick coils of clay. The outside of the pots was sometimes 'decorated' with fields of impressions made with the fingertips or objects. The fields are devoid of any patterns, serving merely as a form of roughening of the surface. Two variants of pottery were produced: a slightly thinner ware that was tempered with crushed shell and shows little decoration and a slightly thicker variety that was tempered with ground quartz and was more frequently decorated. The first variant gradually went out of use in the course of the occupation period.

The diatom research showed that the pottery was made from local clays. The tempering with crushed shell is a distinctive technical feature and the almost complete absence of linear decoration a distinctive stylistic feature. The use of ground quartz and – less often – quartzite or granite as tempering material is surprising in this environment in which stone was rare or even completely absent. Quartz gravel may however have been collected on the beach. So all in all, the pottery was certainly locally produced.

27.3 Division of tasks in the local group

In fairly non-complex communities such as that of Schipluiden each household was self-sufficient, although there were of course also activities demanding a collective effort, such as the construction of houses. There was at most some specialisation on an *ad hoc* basis, associated with special, individual skills. In principle, all activities within each household were divided on the basis of age and sex, according to the group's traditions. There were on the one hand a number of 'rules', *i.e.* common, stereotype divisions of tasks, but on the other there was also quite a bit of cultural variation, often emphasised by anthropologists. The archaeological record offers no indisputable clues as to the allocation of tasks, so no concrete statements can be made and no assumptions can be verified. It is nevertheless challenging to speculate about how the activities at Schipluiden may have been divided so that all the members of the community contributed the effort of which they were organisationally and physically capable. We will in the following restrict ourselves to the various craft activities. The tasks associated with subsistence will be discussed later in this chapter.

The four households functioned together as a single unit. As far as the earliest phases (1/2a) are concerned this is evident from the clustering of wells along the northwestern periphery of the dune, which were evidently a collective source of water for the entire group. For the later occupation phases (2b, 3) it can be inferred from the fence that enclosed a large part, if not all, of the dune and of which large stretches were in the course of the occupation period replaced on several occasions. The construction of houses will, in view of the required manpower alone, have implied work for the entire group.

There will also have been household-specific and individual activities. The skeletons of the adult males systematically show evidence of the heavy work they did during their lives. That heavy work will have included the felling of trees, strenuous woodworking, the construction of houses and fences and the manufacture and maintenance (polishing) of axes. Flint and stone knapping are likewise generally regarded as typically male tasks. This means that the flint tools that the women required for their tasks were also provided by the men. The wooden implements used for hunting and fishing, ranging from canoes to traps, will also have been made by the users themselves. In practice this means that all fine carpentry was men's work, including the production of the required tools, in particular the bone chisels and quartzite flakes. We assume that the manufacture of fish traps, including the production of the required rope by twisting fibres, also belonged to the male domain, as did the making and repairing of nets – they are all activities for which the required skills were needed at the place of action, far away from the settlement. Growing boys would help the men and in doing so learn the skills they would later need themselves.

The preparation of food – from grinding and crushing to cooking – and the time-consuming manufacture of clothing and other fabrics from fibres and skins are typical female tasks. To this may presumably be added pottery production as a domestic activity: it was an independent activity for the benefit of specific women's work – the preparation of food. The women will have had at their disposal flint flakes and scrapers, bone awls, querns and the hammer stones needed to roughen them, plus stone for grinding into pottery temper. The women may have made their bone awls themselves. They will of course have involved the young girls in their work, getting them to help them so that they would learn the skills in the process. It is not certain who made the jet and amber beads and whether the failed beads are to be regarded as the products of children's efforts; from the viewpoint of the learning process this is indeed an attractive interpretation, but it does not agree with the presumed value and scarcity of this material.

Figure 27.2 Artist's impression of the Schipluiden settlement. Visible in the foreground is a muddy trampling zone at the foot of the dune, along which the occupants are building a fence to keep the cattle outside their settlement. In the distance are other low dunes whose vegetation includes the juniper shrubs that yielded the wood for the fence posts.

The grave goods from burial 2 finally show that the making of fire was probably surrounded by an aura of magic and was probably a privilege of the leader of the household. Main-taining the cooking fires will however have been an everyday activity, for which the women and children gathered the required firewood.

27.4 The wider social group

The sources of the raw materials and stylistic features show us to which wider community the Schipluiden occupants belonged. That was primarily the Hazendonk group in the rivers area, within which the stone procurement took place. Like the occupants of all the other Hazendonk sites, the Schipluiden community had contacts in a southerly direction, extending to the south of Belgium, via which axes and large flint blade tools were obtained.

27.4.1 Raw material lines (fig.27.3)

The occurrence of special mineral raw materials needed for the manufacture of essential artefacts is often restricted or even very localized, so they usually had to be imported from other areas. Such 'raw material lines' reflect the areas and the communities with which contacts were maintained. Those contacts may have comprised expeditions by small special task forces or direct or indirect exchange relations. Sometimes statements can be made about such contacts on the basis of the nature of the materials, the distances that had to be covered and the distribution pattern relative to the source. In the Lower Rhine Basin it is however often difficult to identify sources due to a shortage of references in the form of material studies based on sound evidence, the absence of specific distinctive features of some types of stone and the materials' scattered distribution in

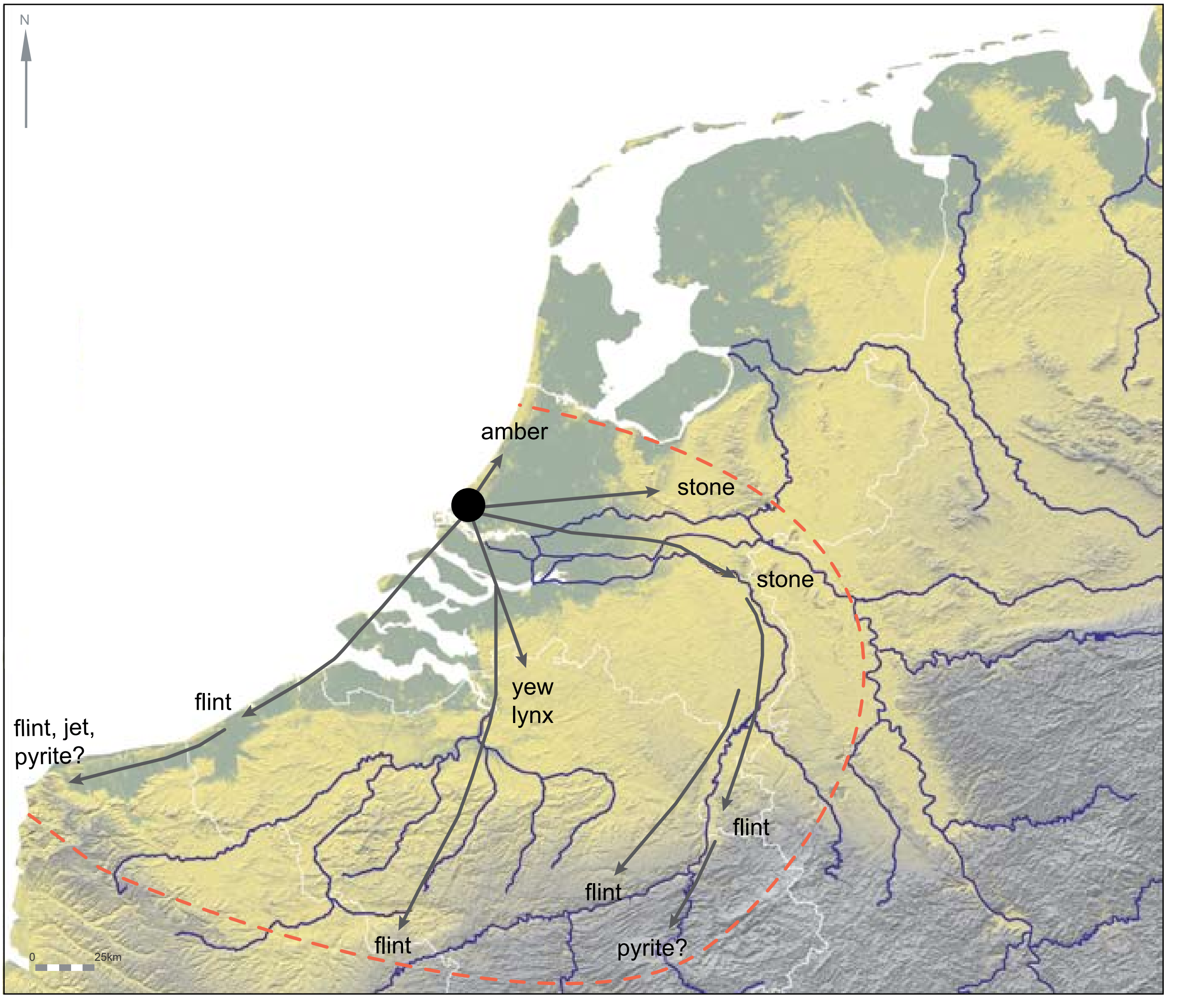


Figure 27.3 Contact lines of the Schipluiden occupants based on the origins of materials that were not locally available. The lines reflect the occupants' interaction sphere, which coincided largely with the distribution area of the Hazendonk pottery style group, but extended as far as the Michelsberg area in a southerly direction.

secondary contexts as a result of transport by rivers and marine currents.

All this is particularly true of the delta area, where stones do not occur naturally or are very scarce. In the Delfland region some commonly used wood species were moreover unavailable.

The largest distances, of roughly 200 km, were covered for the procurement of flint axes and blades and blade tools made on mined flint from central Belgium, what is known as Belgian flint and flint from the well-known mines of Obourg. The pyrite nodules used with the strike-a-lights probably came from the same general direction, either from the Ardennes or from Pas de Calais. As the material concerned was fairly prestigious and was obtained via contacts that extended far into the area of a substantially different cultural tradition, we in this case assume a combination of mobility of the Schipluiden occupants and exchange.

The most prestigious artefacts known from this period that are assumed to have been distributed via exchange in long-distance networks – jadeite axes from the western Alps and blades of Romigny-Léhry flint from the Reims area – are absent at Schipluiden, but then we would of course not expect to find such objects in the dump zone of a simple domestic site.

While the flint was obtained from the south, the larger pieces of other types of stone most likely came from sources in the east, namely the Meuse gravels. The sources in question cannot be specified any more precisely than 'somewhere between the ice-pushed deposits near Rhenen and the terrace gravels in the surroundings of Venlo', which lay some 80-150 km away. This holds for the quartzite and sandstone that were used to make grindstones, hammer stones and querns, but also for the pieces of granite and other igneous and metamorphic rocks that have no counterparts in the northern erratic material.

27.4.2 Stylistic affinities (fig. 27.4)

So the lines of contact of the occupants of the Schipluiden dune extended in an easterly and a southerly direction, covering distances of 100 and 200 km, respectively. They correspond to cultural relations, based on similarities in stylistic features of the pottery and flint implements, respectively.

The Schipluiden occupants formed part of a simple, but original ceramic style group which we have termed the Hazendonk group after the pottery recovered from level 3 of the Hazendonk site (Louwe Kooijmans 1974, in press a). This is a phenomenon in the southwestern interaction zone of the late Swifterbant communities of the Dutch/northern German plain and the Michelsberg culture in the loess zone to the south of it. The Hazendonk group covers only a small style area, most prominent in the Dutch rivers area from the coast up to Nijmegen and with a series of small assemblages in the Limburg Meuse valley. The boundaries to the south and to the north are both ill-defined.

On the basis of its simple coil construction and coarse temper, the pottery is assumed to have been derived from that of the Swifterbant culture. It is certainly in no way related to the high-quality thin-walled Michelsberg ware. At some sites in the east a Michelsberg-like component in the assemblages testifies to southern contacts, but this is not the case in the west (delta area). The material culture, and therefore also the people, are consequently unmistakably regional in character. The lines via which stone was supplied to Schipluiden coincide precisely with this pottery province.

The entirely individual pottery style was combined with a southern, Michelsberg-inspired component in the flint artefacts, in which a dominant local river-gravel flaking industry was always combined with the import of larger, more prestigious tools made on large blades and flakes of mined flint. This is something we see in all the Hazendonk find assemblages. They comprise thick, triangular arrow points that are asymmetrical when viewed from aside, leaf-shaped points, large 'horse-shoe scrapers' and pointed blades that were used as piercers and reamers. The typical Belgian Michelsberg flake axes are absent, but that could be due to the late phase in the Michelsberg chronology. This absence is countered by an unusual type of 'tanged' scraper that is unknown in the Belgian Michelsberg assemblages. So the Schipluiden people did not indiscriminately take over or import the entire tool spectrum, but indeed selected what suited them most, showing a certain degree of material expression. Viewed on the basis of their flint, the Schipluiden people did not form part of the Michelsberg culture, but they did have close connections with it.

A third 'stylistic' feature is the distinctive burial posture with the strongly flexed, probably bound, legs, for which no native precedents are known and which appears to have been derived from an as yet poorly known Michelsberg tradition.

27.4.3 Cultural geography

Thanks to a new comprehensive study of the Michelsberg culture in Belgium (Vanmontfort 2004) and additional information on the Netherlands (Verhart 2000; Schreurs 2005), the German Rhineland (*Untersuchungen* 1971-1982; Amtmann/Schwellnus 1987) and Westphalia (Eckert 1986; Knoche 1997) we now have a better view on the cultural patterns in the Lower Rhine Basin (Lüning 1967; Vermeersch 1987; Vermeersch/Burnez 1998). From Pas de Calais to the Münster Basin and in the Lippe region the Michelsberg culture, represented by settlement sites and a large number of enclosures, was clearly restricted to the clay and loess areas, including the sandy clay parts of Belgium. In Belgium two large, separate distribution areas can be distinguished – one in the Dender and Scheldt area and the other covering the entire part of central Belgium and extending in an easterly direction up to Hesbaye, which seems to be devoid of sites of this culture. The sites in South Limburg seem to be the westernmost of the Michelsberg cluster of the adjacent Rhineland. In areas of flint and chalk, flint mines were dug (*e.g.* Spiennes, Jandrin-Jandrenouille, Rijckholt) or flint was exploited at the surface.

The question always was how far the culture area extended across the sandy soils in a northerly direction, and whether its northern limit may even have lain in the Netherlands. A number of findspots are known in those northern areas – Aalter, Antwerp, Zwijndrecht, Lommel, Dilsen – but they yielded only isolated pots of this culture. The most probable interpretation of these finds is that they are objects that were exported to the north and were there deliberately deposited in burials. It is less likely that they represent actual expansion of the Michelsberg communities. Michelsberg settlement sites, which are readily identifiable by their characteristic flint industry, are completely absent on the sandy soils of

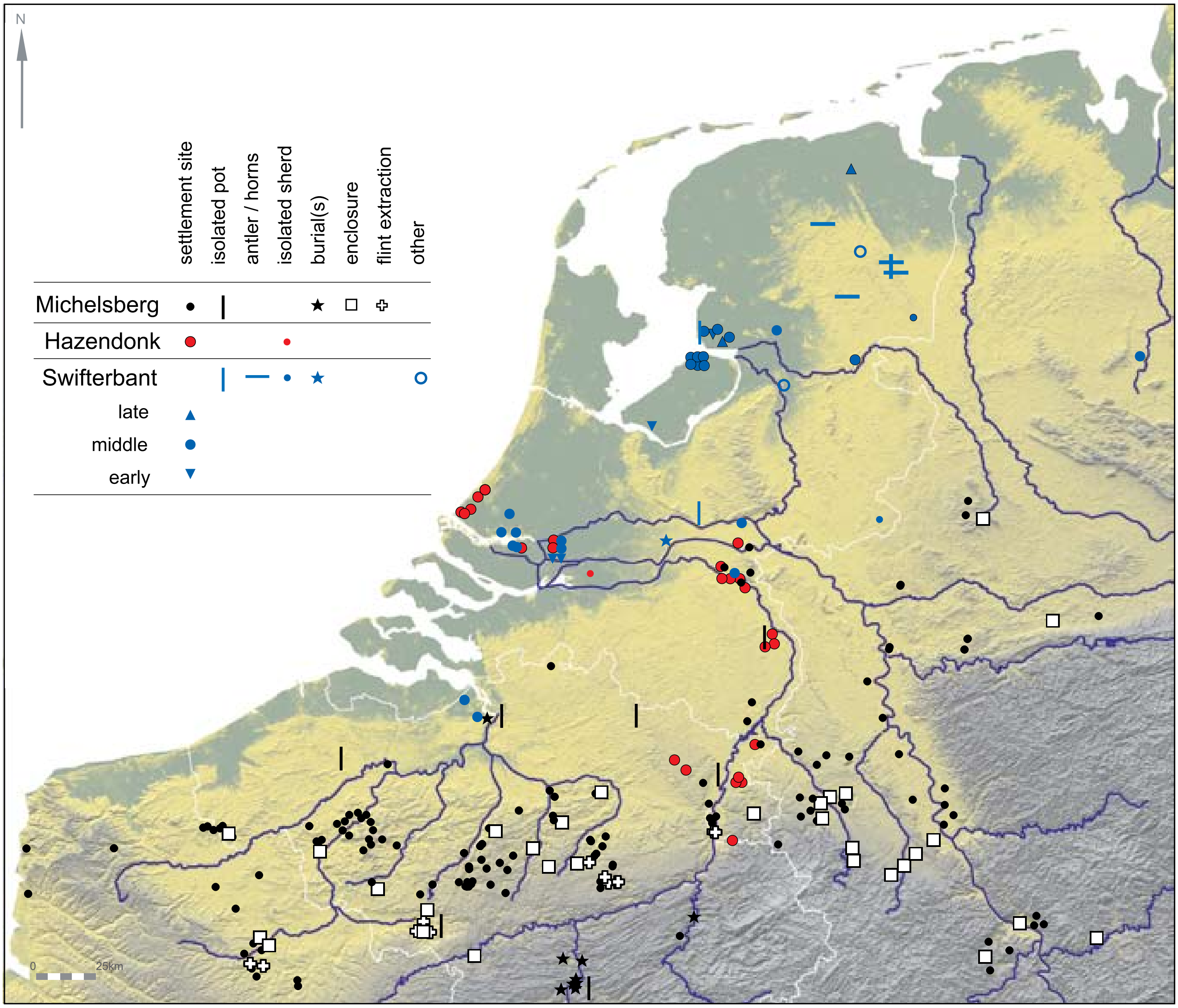


Figure 27.4 The Lower Rhine Basin showing sites of the Michelsberg culture, the Swifterbant culture and the Hazendonk group around 4300-3400 cal BC. The distribution of the sites shows that hilly areas were avoided. The density of the sites is not related to the original occupation density, but largely associated with preservation conditions and the intensity of research. The Hazendonk group evolved around 3700-3600 cal BC in the southwestern part of the late Swifterbant culture, under the influence of contacts with Michelsberg communities. Michelsberg seems to be confined to the loess zone, but dispersed small flint assemblages (not mapped) and a few isolated more or less complete Michelsberg pots have been found to the north of that zone. The status of this zone (and the southern limit of Hazendonk) is as yet unclear. The Meuse valley however seems to have been an important contact route.

Main data sources:

Michelsberg: Lüning 1967; Eckert 1986; Knoche 1997; Vanmontfort 2004; Verhart 2000; Toussaint 2002

Swifterbant: De Roever 2004; Raemaekers 1999, 2003/2004

Hazendonk: Louwe Kooijmans in press a; Amkreutz/Verhart in press

depositions: Ufkes1997; Prummel/Van der Sanden 1995; Van der Sanden 1997 northern Belgium and the southern part of the Netherlands. Conversely, settlements of the Swifterbant culture have meanwhile been found as far south as in the environs of Antwerp (Melsele, Doel). And both the import of southern pottery (Blicquy at Hardinxveld-De Bruin; Michelsberg at the Hazendonk site, Rössen and Bischheim at Hüde I) and the burial of complete pots (Bronneger, Hardinxveld-De Bruin, Urk-E4) are now known from a number of Swifterbant sites. All this implies that only the very ends of the southern contact lines of the Schipluiden occupants – and of the Hazendonk group in general – extended up to the edge of the Michelsberg world, where (by chance?) the most important flint mines lay.

An exception is the Meuse valley in Limburg, where a series of assemblages of flint tools made according to the typical Michelsberg tradition testifies to occupation. Some of those assemblages are associated with both Michelsberg and Hazendonk pottery (Verhart 2000). Even if we make allowance for the relatively high intensity of research in this area, the Meuse valley stands out as a zone of intensive north-south contacts – a corridor via which mined flint at least, if not other commodities, too, found its way northwards.

The Michelsberg world with its large enclosures and deep flint mines contrasted markedly with the world of the semi-agricultural occupants of the lowlands, and not only in the people's way of life, but also in population density.

27.5 Symbolism/symbolic acts

Although daily life must have been full of significant rituals, we have only a very limited impression of them via the settlement archaeology and only few or no relations are observable between the various phenomena. Most acts with a symbolic significance will have left behind no traces in the material remains of the human activities. Even so, we have at Schipluiden come across several artefacts and other evidence which we assume to have a symbolic connotation.

27.5.1 Treatment of the deceased

There is evidence of differentiated treatment of the deceased. One of the households formally buried some of its deceased: a number of men whose advanced age may have granted them a special position in the community, and two children. The strike-a-light that accompanied one of the men is an exceptional grave good that may have several meanings: it may be an indication of the *persona* of the deceased or the material expression of the people's ideas about the afterlife. The highly flexed burial posture, with the legs presumably bound together, also appears to reflect views on the power of the ancestor's spirit, which had to be curbed. It is a new burial posture whose significance was derived from the southern Neolithic. Usually, however, the deceased were subjected to a treatment aboveground, which sometimes led to the dispersal of skeletal elements and their incorporation among the settlement refuse.

27.5.2 Artefacts

Some puzzling wooden artefacts with which we are unable to associate a function on the basis of analogies need not necessarily be viewed in a cult context. There is in this field still a substantial shortage of material knowledge.

This does not hold for the curious antler beam sharpened on two sides (no. 4263.1), which was roughly shaped, but not finished and certainly not used. No comparable artefacts are known from the large Mesolithic and Neolithic assemblages from the Lower Rhine Basin, or indeed from elsewhere. It may simply be something that was produced by someone fiddling around with a tool, but it could also represent a serious effort to create an exceptional object, with the option of a symbolic use.

Jet and amber beads have incidentally been found as grave goods, in particular at Ypenburg and Swifterbant-S2. They may be – modest – indications of the personal identity of the deceased, but it is possible that some special value or power was (also) assigned to them. Amber had a special significance throughout the entire late part of prehistory. Sometimes jet replaced amber in this respect; this was for example the case in northeastern England in the Beaker period.

27.5.3 Dogs

Most remarkable is the systematic deposition of remains of dogs. Dogs were apparently sometimes killed with a blow to the head, after which the head was discarded separately from the body; after some time the (incomplete and disturbed) remains of the carcass were buried. This suggests some form of ritual butchering and loss of the affection evident from the formal burials known from earlier times, for example at Hardinxveld-Polderweg (Louwe Kooijmans 2001a). This may be associated with the change in the position of dogs at the transition from hunting to farming. What precisely happened to those dogs at Schipluiden and why – with what intentions – completely eludes us, but the acts must have been meaningful to the people who performed them.

27.5.4 Cattle

On one occasion, fairly early in the occupation period, but certainly not at the beginning, the remains of three heads of cattle were deliberately deposited in a small pit, which we have termed a 'deposition pit' (feature 12-48; section 22.3.7). The remains derived from two juvenile-adult animals (older than 24 months) and a juvenile. The latter was killed when it was between 5-6 and 7-10 months old, that is – assuming it was born around the end of April – between the end of September and the beginning of March, in late autumn or winter, which is the period in which we would expect animals to have been slaughtered. Evidently three heads of cattle of different ages were killed and butchered on the same occasion and a (relatively small) proportion of their bones was deliberately deposited in a small pit along with – most remarkable in view of what has been said in the preceding section – one of the complete, smashed dog skulls. The bones are mainly parts of the skull, vertebrae and parts of the pelvis; parts of the legs are somewhat underrepresented. The deposition pattern closely resembles that of the dog remains, except that, unlike with the dogs, this type of deposition was a once-only occasion. It is in accordance with the wider custom of the deposition of (parts of) animals in the Neolithic, other examples of which are aurochs crania and red deer antlers that were found in the province of Drenthe, a deposition made in phase 3 at Hardinxveld-De Bruin (Louwe Kooijmans 2001b, 91, 274 and fig. 8.7) and peat depositions known from Denmark (Koch 1998). The Schipluiden deposition is difficult to interpret. Its composition is more indicative of slaughtering waste than of remains of some special meal.

27.5.5 Birds

It is fairly unlikely that certain birds were hunted primarily for their meat; in these cases the motive was probably some assigned meaning or prestige. This holds first of all for birds of prey, in particular the white-tailed eagle, which is virtually always represented in Neolithic assemblages of a certain size. A more functionalistic interpretation is that those birds were shot to obtain feathers for use in arrows. The fact that hardly any remains of waders were identified, except the ruff, may imply that these birds were selectively shot, specifically for the coloured feathers sported by the males in the brooding season. The same explanation has elsewhere been put forward for remains of the great spotted woodpecker (Van Wijngaarden-Bakker *et al*. 2001a, 222).

27.5.6 Conclusion

We have only an anecdotal understanding of the spiritual world of the dune occupants. The burial rite implies a distinct interpretation of the afterworld. The manipulation and deposition of dogs and incidentally cattle can be viewed in a more general deposition tradition that is regarded as a form of communicating with higher powers, the spirits of nature and ancestors.

Ecology and subsistence

27.6 The genesis of Delfland

27.6.1 The Rijswijk-Zoetermeer beach plain

During the period of occupation the coastal landscape changed drastically. Crucial in its development was the equilibrium between the supply of sediments (sand) from the sea on the one hand, and on the other the area available for accommodating those sediments in the tidal basins behind the beach plain. That area constantly increased due to the rise in sea level (fig. 27.5).

Around 4900 BC the rise in sea level decreased to 30 cm per century, the basins filled up and the tidal inlets gradually closed. Until a few centuries before the first occupants' arrival the Delfland region consisted of an open coastal plain of sand banks and beaches on which sand was deposited in pace with the rise in sea level. Around 4350 BC an established coastline ultimately developed in the form of a low coastal barrier that more or less coincided with the course of the present-day A4 motorway. That coastal barrier was regularly flooded, during which overwash deposits were laid down behind it. In front of the barrier a broad, uninterrupted beach plain evolved and in the north (near Zoetermeer) a broad tidal gulley penetrated far inland. This gulley was later to fill up with sediments, too. Together, all that sand is referred to as the 'Rijswijk-Zoetermeer sands'. The molluscs found in our drill cores (chapter 16) point to a marine environment, a tidal flat area with a good connection to the open sea. There are no good present-day parallels for this landscape; it is most closely approximated by the eastern part of the coast of the Waddenzee, between Simonsplaat and Rottumeroog.

27.6.2 From beach to salt marsh

In spite of the continuous rise in sea level the beach plain was constantly raised, to above the average high tide. The clay content of the deposits gradually increased and the landscape evolved into a salt marsh plain. The formation of the 1.5-metre-thick layer of high tide and salt marsh deposits (Units 40-26-19) must have taken several centuries. It is hard to conceive how it may have taken place without a protective coastal barrier in the west.

To the south this new coastal area bordered a broad estuary, in which both the Meuse and one of the branches of the Rhine flowed into the sea. From this southern estuary, the sea, but also the water of the rivers, at high tide had access to the hinterland via widely branched tidal creeks, which led to the deposition of fine-layered clays.

In the vast, 3-km-wide plain the old beach sand was in some parts blown onto the salt marsh deposits, leading to the formation of flat, low dunes, one of which was that of Schipluiden, which was formed at the time of the deposition of the clay of Unit 26. Basing ourselves on the currently available evidence we assume that there were at least fifty of such dunes dispersed across the plain, which are now completely hidden from sight, buried beneath later deposits.

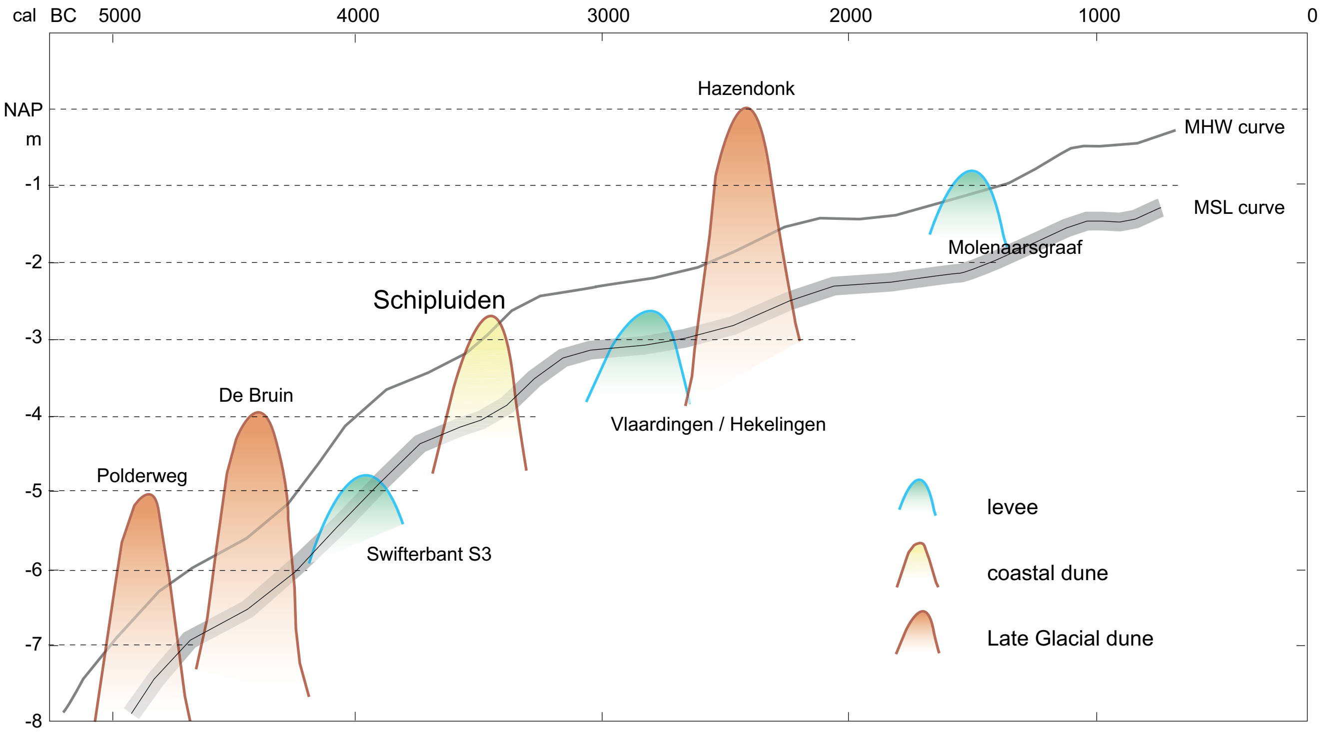


Figure 27.5 Curves representing the rise in Mean Sea Level (MSL) after Van de Plassche 1982 and the Mean High Water (MHW) at an assumed tidal amplitude of 2 m with some prehistoric settlements in the low-lying parts of the Netherlands projected on to them. The last occupation phase of the late glacial river dunes is indicated. The low coastal dune that bore the Schipluiden settlement lay within the former tidal range, but apparently somewhat protected and out of reach of daily marine ingressions.

27.6.3 *Palaeogeography: four ecozones*

Four ecozones can be distinguished in this new coastal landscape. First of all there was the coast in the far west. Next came a broad sedimentation plain and further east was the periphery of the reed swamps and alder carrs that extended several dozen kilometres in an easterly direction. In the south this regular zoning was interrupted by the Rhine/Meuse estuary. This estuary is to be seen as a wide tidal inlet with sand flats into which flowed the tidal creeks of a system that extended far into the delta plain and absorbed saltwater at high tides. The Schipluiden dune lay at the eastern periphery of the sedimentation plain, 3 km from the coast and 10 km from the tidal inlet (fig. 27.6).

27.7 The changing conditions in the plain surrounding the dune

Whereas the geography of Delfland as a whole did not change demonstrably during the relatively short period for which the Schipluiden dune was occupied, the old beach plain did undergo a major ecological transformation which – oddly enough – seems to have had little influence on the occupants' way of life. From phase 1 until phase 3 very little changed in the ratios of hunting and stock farming and in the exploited natural resources.

27.7.1 *Sources*

The major changes that took place in the landscape and the environment of the settlement and its surroundings during the period of occupation are known to us in great detail thanks to the palaeogeographical and palaeoecological studies carried out in our project (chapters 14-25). The water regime and the salinity are now accurately known thanks to the outcomes of the diatom and mollusc studies, supplemented with the information obtained in the studies of the fish and insects. The interpretations of the vegetation are based on three pillars. The first comprises the results of the study of the botanical macro-remains, which provide a detailed picture of the local vegetation within a radius of a few hundred metres. The wood and charcoal analyses meanwhile yielded information on the tree and shrub vegetation in the site's wider surroundings, to which the analysis of the insects added a few further specifications. The pollen research, finally, yielded

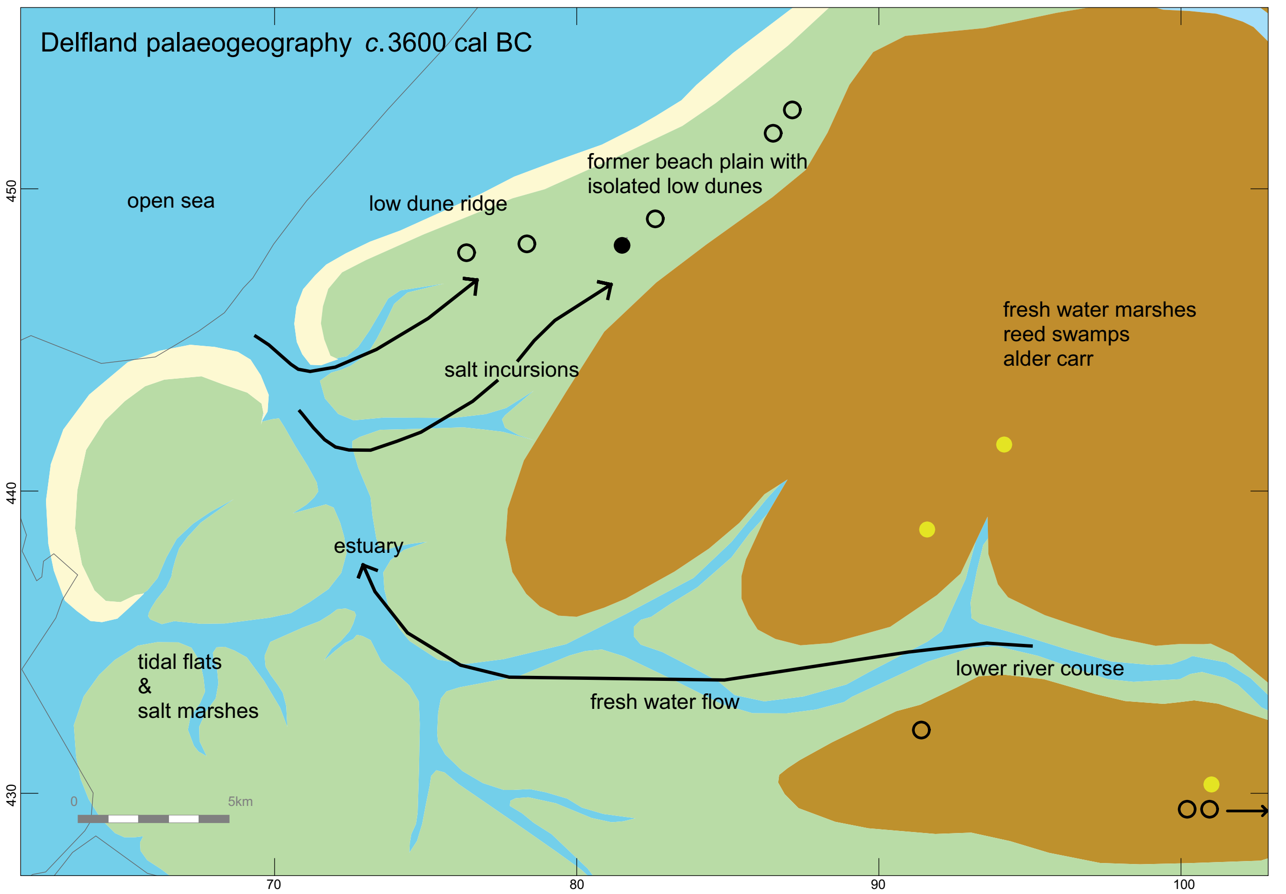


Figure 27.6 Palaeogeography of Delfland and the Meuse estuary around 3600 cal BC showing the settlements of the Hazendonk group. Schipluiden is indicated by a solid black symbol; some late glacial dune tops (so-called *donken*) are shown in yellow.

a somewhat less detailed regional survey. The diatoms, insects and background fauna tell us all about the local conditions at the site itself with respect to issues such as moisture, flooding and hygiene.

The detailed data on the conditions in the individual phases are particularly important for our understanding of the extent to which people were determined to remain at their settlement and adapt their way of life if necessary.

27.7.2 Changes in the landscape

The various studies revealed a number of trends in the development of the landscape. The diatoms, the seeds and the pollen point to an indisputable change from a salt marsh landscape proper with brackish to saline conditions in the earliest occupation phase to freshwater conditions in the last phase. The main turning point of this change occurred in phase 2b. Evidence of marine ingressions in the earliest occupation phase is provided by remains of many young herrings and smelt that were found in the fills of two early wells along with remains of common gobies and (three-spine) sticklebacks – the fish were trapped in the wells when the seawater retreated. The same saline conditions are reflected by the salt-loving to salt-tolerant insect fauna of the remarkable low-lying ‘deposition pit’.

Figure 27.7 Aerial photo of the De Kwade Hoek nature reserve on the coast of the island of Goeree. This is one of the few parts of the Dutch shoreline where the coast is being expanded seawards. In this case the expansion may be a consequence of the Delta Works. A beach plain has been cut off from the open sea by a newly formed row of dunes and has evolved into an area of natural grass- and reedlands. It is a rare small-scale present-day reference for the large-scale landscape development along the Delfland coast *c.* 3600 cal BC.

Figure 27.8 Low salt marsh in the De Kwade Hoek nature reserve. Glasswort *(Salicornia europaea)* can be seen in the foreground. Sea aster *(Aster tripolium)* grows on the higher salt marsh in the background, behind the gulley. This landscape illustrates the environmental conditions during the first stage of occupation at Schipluiden (phase 1).

An important question is whether there was a tree and shrub vegetation. For the information required to answer this question we must first of all turn to the samples of wood, in particular the wood that was used to build the fences around the middle of the occupation period. To enable the construction of a single fence with a length of around 300 metres that enclosed the entire settlement, the site's surroundings must around the middle of phase 2 within a short space of time have supplied stakes with a total length of 2000 m and an average cross-section of 6 cm: juniper, apple, hawthorn and sloe wood from shrubs on nearby dunes (a *Rhamno-Prunetea*) and alder wood from carrs (an *Alnetea glutinosae*). So the vegetation consisted of more than the odd spindly tree, and indeed comprised substantial groves including as remarkable elements juniper shrubs. Finds of numerous carbonised sloe stones and apple pips imply that sloes and crab apples grew here and there on the dune slopes. It is doubtful whether there were any deciduous trees 'proper' in this area – at most perhaps a few spindly oaks, ashes or elms, but certainly no sturdy trees. Only alders, and probably also willows could grow to a cross-section of more than 50 cm.

In the course of the occupation period the area was flooded less and less often, the area surrounding the dune emerged from the water more frequently and for longer stretches of time (as shown by the diatoms) and there was a hiatus in sedimentation. These developments are associated with the formation of the Voorburg-Rijswijk coastal barrier, 3 km west of the site, which prevented the seawater from penetrating far into the area at high tide, leading to a local fall in the average high-water level. This is a stereotype landscape development observable at all occupation sites on delta deposits, also in later times (Louwe Kooijmans 1974, 57). In the long term this effect was however countered by the continuously rising sea level, which caused the level of the groundwater behind the coastal barrier to rise, too, resulting in increasingly swampy land and ultimately the development of lush, wet grass- and reedlands of the kind that are today to be found on a much smaller scale in the Kwade Hoek beach plains

Figure 27.9 View of De Kwade Hoek from the row of dunes on the landward side.

closed off from the sea on the island of Goeree in the province of Zeeland (figs. 27.7-10). The formation of a steadily growing layer of reed peat followed by sedge peat ultimately made the site unattractive for occupation, and it was abandoned around 3400 BC.

These few centuries between 3700 and 3400 BC constitute an important episode in the development of the Delfland landscape, which saw the transition from a period of coastal conditions that had lasted for more than a thousand years to the evolution of the typical Holland peat landscape that was to remain undisturbed by large-scale ingressions for three millennia.

It would seem that after abandoning their settlement, the occupants continued to use the site for some time as a base camp for expeditions, in particular for hunting red deer (see section 22.7). Even after it had changed into a large peat bog, the area will have remained attractive for its abundance of waterfowl and fish. This can be inferred from a cluster of 25 wooden posts that were driven deep into the peat, down into the underlying dune, around 2300 BC. The aim of these posts eludes us due to the absence of associated finds. All we can venture to say is that it had something to do with an off-site activity.

27.7.3 Conditions at the site

The uninterrupted use of the site for occupation over a long period of time led to the formation of a black occupation layer. The colour is caused by fine charcoal dust; the entire site was indeed found to be covered with a veil of charcoal particles. Nothing comparable is known from later sites with similar conditions, such as the Bell Beaker settlements in the Alblasserwaard area. It implies some special burning activity whose aim at present eludes us. The charcoal could represent the burning of vegetation or remains of open fires that were washed or blown across the site. Interestingly, a similar ‘burnt layer’, only without any significant archaeological remains, was found on another small dune in the vicinity of the Schipluiden settlement. That dune was used but not occupied.

The many pits that we have interpreted as ‘unlined wells’ testify to frequent problems with the supply of freshwater. This was also observed at the other settlements found in this region, with the only difference that the field of wells at Schipluiden implies a particularly high intensity of use. It is surprising that this site was selected for such intensive occupation.

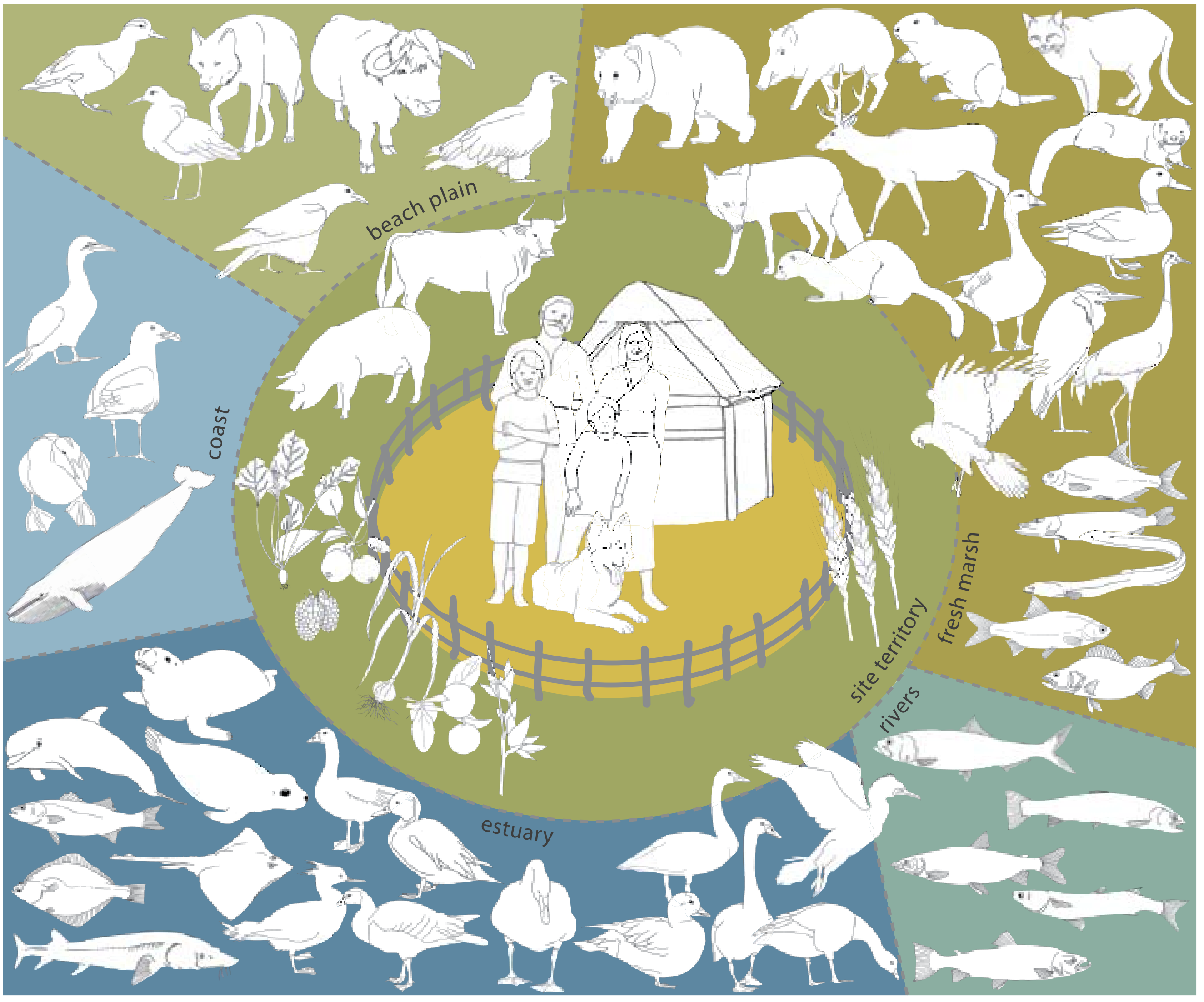
Figure 27.10 Natural grassland, rich in reed, has developed in a more sheltered part of the former beach plain, where the formation of fen peat has started. The earlier row of dunes, covered with dune shrubs, is visible in the background. This landscape illustrates the environmental conditions during a later stage of occupation at Schipluiden (phases 2-3).

Dung beetle remains found in the fill of one of the wells show that conditions in parts of the settlement site must have been fairly unhygienic, and that cattle roamed freely among the houses in the phase before the erection of the fence. The same was observed at Wateringen 4 (Raemaekers *et al*. 1997, 150). It is interesting to see that a later well was dug in an area with much cleaner conditions. Domestic flies and human fleas show that there were unpleasant sides to life, too.

27.8 Subsistence

The dune occupants' subsistence system was based on two pillars: farming – both livestock and arable farming – and a broad exploitation of the various ecological zones in the surrounding landscape. This system is known as an 'extended broad spectrum economy' – the Mesolithic basic system combined with new Neolithic elements. The exploitation of a broad diversity of food resources, in the immediate vicinity of the settlement and at a greater distance from it, is the opposite of what we would expect to find at a special activity site, and confirms the site's function as a basic settlement within a wide territory.

It is difficult to assess the relative importance of the different activities, as the only remains available for such assessments have undergone various formation processes. The only two activities we can reliably compare are stock farming and the hunting of large mammals. The problem of distinguishing between remains of pig and wild boar could thankfully be satisfactorily solved thanks to the abundance of remains of the two species and the availability of sufficient discriminating bone dimensions. Both the numbers and the weights of the bones show that stock farming was in all the phases more important than hunting, though the cattle did become a little less important in the course of the occupation period. It will be argued below (section 27.12.5) that the many mammal bones found at the site represent only a limited proportion of the consumed food.



See section 27.12.4 p. 509

Figure 27.13 Socioeconomic model of the semi-agricultural community of Schipluiden. The most important element is the domestic space, with the farmstead at its centre, closed off from its surroundings by a fence. The dog is considered a member of the household, in a long tradition going back to Mesolithic times. Around this domestic space lies the part of the beach plain over which we assume the occupants enjoyed exclusive rights of use. In this zone crops were grown, cattle were pastured, pigs were herded and plant food, firewood and construction wood were collected. Beyond was the uncultivated wilderness comprising different ecozones, of which in particular the freshwater marshes and the (Meuse) estuary were collectively exploited with the occupants of nearby settlements. Not included in the model are the background fauna and some of the identified bird species. Each species is illustrated only once, in its most characteristic biotope, but it was of course not exclusively restricted to that biotope.

Illustrated are:

site territory:	cattle, pig, sea beet, sloe plum, sand leek, sea club-rush, crab apple.
beach plain:	garganey, ruff, carrion crow, wolf, aurochs, white-tailed eagle.
fresh water marsh:	brown bear, wild boar, beaver, wildcat, red deer, marten, fox, otter, greylag goose, mallard, grey heron, crane, marsh harrier, bream, pike, eel, rudd/roach, perch.
rivers:	salmon, sea trout, whitefish, allis/twaite shad, thin-lipped grey mullet.
estuary:	grey seal, bottle-nosed dolphin, common seal, bass, roker, flounder, sturgeon, white-fronted goose, pintail, goosander, barnacle goose, mute swan, wigeon, Bewick's swan, whooper swan, brent goose, cormorant
coast:	gannet, great black-backed gull, eider, whale sp.

So, in spite of the changing environment, no clear trends are observable in the subsistence system in the 250 ± 50 years for which the site was occupied. A few comments should be made here. From phase 2b onwards the number of swans and geese killed decreased substantially whereas even more ducks were shot. A possible explanation for this is that the geese's stopping places had come to lie further away in the less accessible parts of the estuary. It would also seem that young cattle were no longer slaughtered in phase 3. The apparent increase in the importance of red deer hunting in phase 3 at the expense of stock farming cannot be explained on the basis of changes in diet. A more likely explanation is that the abandoned settlement was used as a hunting base where certain parts of shot red deer were left behind and became mixed with the refuse of phase 3.

27.8.1 Stock farming

The domestic animals kept by the dune occupants were first of all cattle and secondly pigs, but oddly enough no sheep or goats. The cattle will have been pastured in the plain, but they also regularly roamed close to and even in the settlement, as can be inferred from coprolites of the cowpat variety and dung beetles recovered from one of the wells. We therefore assume that the fence was intended to keep the cattle out of the settlement, and that the broad trampling zone was created by cows behind the fence (of which no postholes were however found in that zone).

With a withers height of 118-129 cm the cattle were of the same size as those in the subsequent centuries, and distinctly smaller than aurochs, from which their remains can be readily distinguished. The animals were taken to the settlement to be slaughtered. Animals of all ages were slaughtered: a quarter in their first year and 40% not until after 3 to 4 years. A find of apparently deliberately deposited remains of three heads of cattle – two adults and one juvenile – in a small pit suggests large-scale slaughter, and hence a slaughtering season and measures for preserving the meat. The waste produced in butchering (the bones at least) was usually however dumped at the swampy periphery of the settlement.

The weight percentages suggest that cattle supplied about half of the meat consumed – a little less towards the end of the occupation period. The spectrum of the animals' ages at the time of death does not in any way suggest that the animals were kept for their milk. The analysis of remains encrusted on the pottery sherds did not provide any evidence of the use of milk either.

Pigs were kept in much smaller numbers. Domestic pigs had a distinctly smaller withers height than wild boars (66-72 cm as opposed to 81-89 cm). There is only a small overlap between the ranges of bone measurements of the two species. Pigs were likewise slaughtered at varying ages: 35% in their first year and a quarter not until after 3 years. It is not clear where the pigs were kept – in the yards or outside the settlement. No pig droppings were found among the coprolites, and the biotope in the dune's immediate surroundings was not particularly suitable for pigs.

27.8.2 Arable farming

The consumption of cereal was demonstrated for all phases at Schipluiden by the presence of carbonised grains of emmer and six-rowed naked barley in almost all the samples. The samples also all contained threshing remains – both chaff and rachis internodes – implying that the cereal was at least threshed at the site, during which the grains were released from the ears, after which the rachis internodes, spikelets and chaff were removed. This will according to the Neolithic tradition have been done on a daily basis, according to the occupants' needs, before the grinding. The quern fragments, the phytolite analysis of those fragments and the carbonised remains of food all point to the consumption of cereals.

If all the arguments in favour of permanent occupation by complete households are correct, it is likely that the cereal was grown close to the site itself, in spite of the specific conditions and the regular flooding with saltwater, certainly at the beginning of the occupation period. There are two botanical arguments for this. The first is the presence of threshing remains of naked barley, the second the systematic association of carbonised cereal with carbonised seeds of plants characteristic of high-lying salt marshes. On the basis of the latter argument it is assumed that the crops were grown in the high parts of the surrounding salt marshes. The fact that the floods will have occurred mainly in autumn and winter makes it likely that the cereal was a summer crop that was sown in spring. The crops may however also have been grown on (parts of) small dunes in the surrounding area.

27.8.3 Hunting and fishing

From the recovered remains and the assignment of the identified animal species to the various ecological zones in the research area we may infer a multitude of activities in all the ecozones, both in summer and in winter. Only the coast seems to have been visited fairly rarely, even though it lay only 3 km from the settlement. The odd seal and birds such as gannets and great black-backed gulls may have been shot there. A whale vertebra found at the site will derive from an animal that was washed ashore. The only possible conclusion is that the foredune did not play an important part in the occupants' subsistence strategies.

Hunting

By far the most important hunted wild animals were red deer and wild boar. We assume that the red deer in particular were attracted by the vast grasslands of the old beach plain. The wild boar's preferred habitats will have been the shrubs and the swamps. Antler beams with part of the skull attached and the absence of juvenile remains imply that the red deer were hunted at least from September until February, and that the hunting season probably closed for spring and summer. Nothing can be said about the wild boars as remains of domestic piglets and juvenile wild boars cannot be distinguished from one another. From time to time a roe deer or an aurochs was shot, too.

The hunters went on expeditions into the swamps to the east of the settlement to set traps for beavers and otters. In the case of these species, too, juveniles were released. This form of hunting is traditionally associated with winter, but no concrete seasonal evidence was found at Schipluiden.

Small and large predators other than otter were virtually not hunted. Only the fleece of a shot brown bear was taken back to the site. The recovered remains of lynx are assumed to imply the import of skins from outside the region. The odd seal and bottle-nose dolphin may have been caught in fish weirs in the estuary.

Fowling

The killed birds were almost exclusively waterfowl, in particular ducks, more specifically mallard. In the winter the estuary was ideal for this activity. There, geese will have every day flown to and fro between their foraging areas in the plain and their sleeping places on the open water. There, too, were large groups of ducks that spent the winter in this area, such as mallards, goosanders, teals and pintails. In the summertime ducks will most likely have been hunted in the swamps, where greylags and cranes will have bred, too. As several studies have shown that open water was scarce in the plain, it is unlikely that fowling took place there. Nevertheless, birds may have been shot there, too.

Fishing

Fishing focused on sturgeons and flounders in the estuary and on eels and Cyprinids in the freshwater of the swamp. Sturgeon fishing was a summer activity, which probably involved the use of large fish weirs as attested at Vlaardingen and Hekelingen for the subsequent Vlaardingen group. Eels were probably caught with traps.

Some 'saltwater fish' (roker and bass) were caught in the estuary and migratory fish proper (salmon, whitefishes, allis shad/twaite shad) may have been caught in courses of the major rivers a little further upstream. Some of those fish may have been caught along with sturgeon in the large fish weirs in the summer.

27.8.4 Gathering

We have on the whole a fairly poor understanding of the gathering of plant food as only seeds of fruit and shells of hazelnuts were recovered. The most conspicuous plant food remains at Schipluiden are large quantities of sloe stones crab apple pips. They are followed at a great distance by seeds of rosehip, blackberry and dewberry. Remains of hawthorn, red dogwood, elder and juniper were also found in small quantities. Hazelnuts, which are very common (for easily identifiable) at most sites, were quite rare at Schipluiden, but the remains that have survived date from all the phases.

Electron-microscopic and gas-chromatographic analyses revealed remains of other species at Schipluiden, notably sea beet, wild onion and tubers of sea club-rush. They probably represent important sources of food of which remains are however rarely recovered and identified. The actual spectrum of exploited plants will certainly have been much larger and will have included wild vegetables like *Chenopdium* species, orache/seablite (*Atriplex*/*Sueda*) and wild celery *(Apium graveolens)*.

27.9 Storage and preparation of food

Carbonised sloe stones were found all over the site, but also burnt complete sloes. Carbonised halved apples with curled edges are typical of a burnt supply of dried sloes and apples, and an important indication of the storage of supplies for the winter. The combination of a large quantity of sloes combined with fish remains at the bottom of the 'deposition pit' (12-48) implies a form of preservation under water, which at the same time improved the flavour of the sour sloes.

Chemical analysis and SEM photographs of carbonised remains tell us something about the form in which the food was consumed. Tubers and leaf vegetables were mixed into a pulp or mush. Cereals were crushed and boiled with water to obtain a gruel. The crushing may have been done with 'hammer stones' or wooden pestles and mortars. Cereal was also ground on small portable querns, but considering that only a small number of such implements were found this was obviously not common practice.

Carbonised remains encrusted on some of the pottery sherds show that the pots were used not only for boiling water, but also for cooking various foodstuffs. The chemical and microscopic research revealed various components: remains of seeds (sea aster, seablite), emmer, vegetable oil (possibly of rapeseed or red dogwood) and animal or vegetable proteins, in varying combinations.

No evidence of baked farinaceous food (bread) was found among the carbonised remains and no evidence of the use of milk among the remains encrusted on the sherds. The research did not help us any further in interpreting the strongly deviating ^{15}N and ^{13}C values, of both the encrusted food remains and the bones of the people who consumed the food. These values clearly point to a substantial freshwater fish component in the diet.

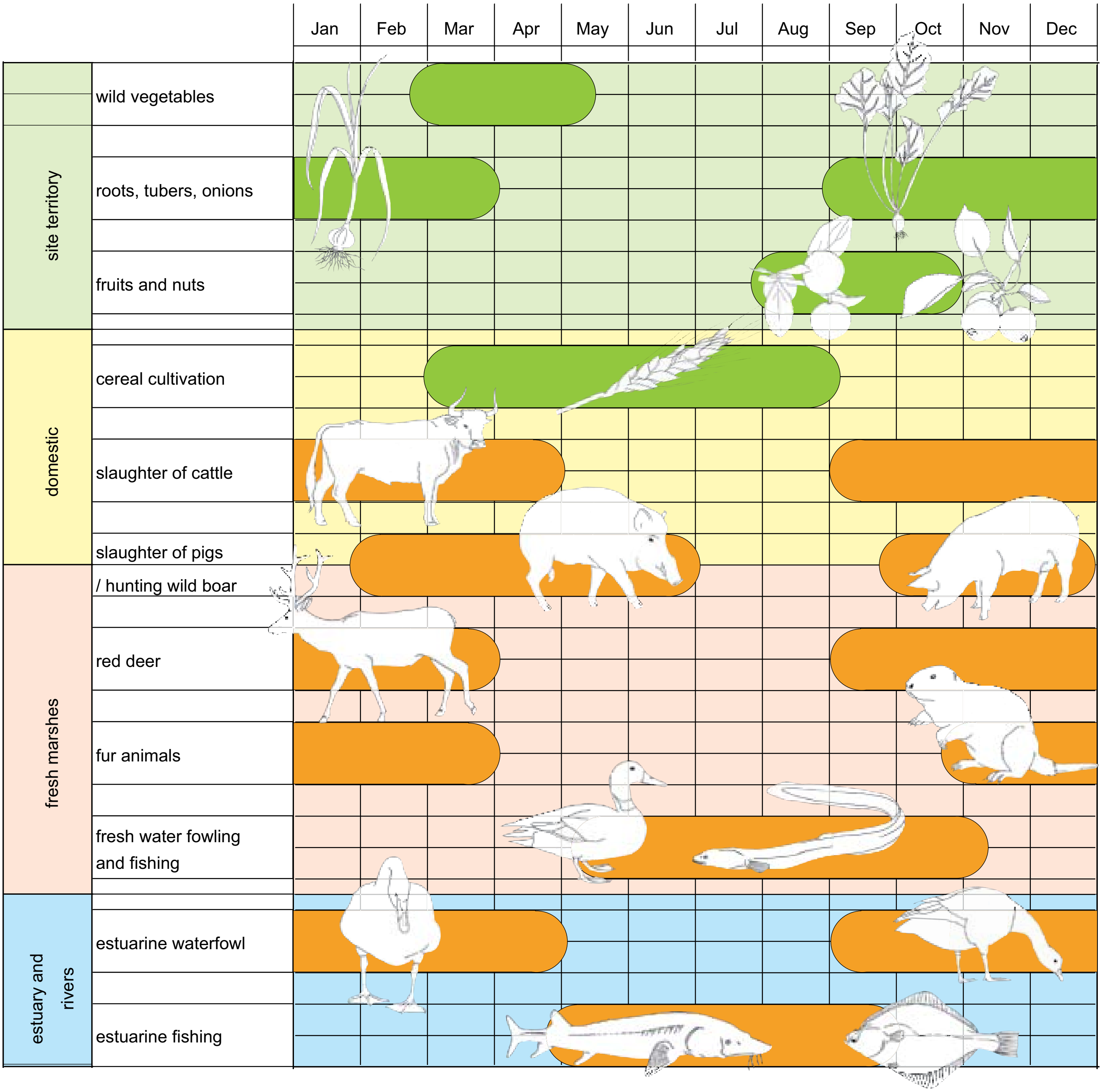


Figure 27.11 The various subsistence activities arranged according to season on the basis of the results of the different biological analyses; an integration of figures 19.14, 22.16, 23.13 and 25.13. A distinction has been made between plant food (green) and animal food sources, interpreted as representing predominantly the domains of women and men, respectively. In addition, four zones have been distinguished: a central domestic sphere, the site territory and two more distant zones, the freshwater marshes and the estuary with the lower river courses. Note that some seasonal indicators suffer from rather large margins of error, especially the slaughtering of pig and cattle; it is not certain to what extent this was confined to a specific season.

A regional perspective

27.10 Dates and phases

27.10.1 Dates

The settlement is culturally characterised by the exclusive presence of Hazendonk 3 pottery and the absence of elements of both the preceding 'Swifterbant' and the succeeding 'Vlaardingen' cultures. The Hazendonk group has been dated to around 3700-3300 BC, roughly the middle of the 4th millennium BC.

^{14}C dates tell us that Schipluiden was occupied from around 3630 to 3380 BC, *i.e.* within the aforementioned period. The two ranges however have margins of error, as a result of which the length of the occupation period cannot be determined with any greater precision than 130 to 370 years. The main cause of this uncertainty are two substantial wiggles in the calibration curve. Another confusing factor is that potentially informative samples (remains encrusted on pottery and human bones) systematically yielded too old values due to nutritional effects, and could therefore not be used to obtain accurate dates.

27.10.2 Duration of the occupation

For our interpretation of the occupation we need a more accurate determination of the length of the occupation period than is provided by the ^{14}C dates. There is a second source of information to which we can turn and that is the curve representing the relative rise in the average sea level (Van de Plassche 1982, 86).

The sedimentation levels in the sheltered conditions of the Schipluiden dune can be more or less equated with the average sea levels. The measurements of -4.50 m NAP/3630 cal BC and -3.70 m NAP/3400 cal BC at the beginning and end of the period of occupation (chapter 2) coincide precisely with the curve. Assuming an average rise in sea level of 27 cm/century, this 80 cm rise in water level moreover implies a duration of around three centuries. This shows that the probabilities of the extreme values of the ^{14}C dates – both the low and the high ones – are indeed low. On the basis of these considerations we assume that the site was occupied for 250 ± 50 years. This duration is important for our interpretation of the (permanent) character of the settlement and (the absence of) economic and cultural changes. We are dealing not with a given moment in a transformation process, but with a system that remained stable for many generations.

27.10.3 Phases

The only information that can be used to divide this occupation period into phases is provided by the stratigraphy of the aquatic deposits covering the flanks of the dune in which finds were incorporated. On the basis of in particular the stratification on the southeastern side of the dune three phases can be distinguished, the middle one of which can be divided into two. Phase 1 is separated from the beginning of phase 2 by a hiatus in the deposition of refuse on the southeastern side of the dune, but this does not necessarily imply a hiatus in occupation. The magnitudes of the error margins of the dates in relation to the duration of each of the phases however make it impossible to estimate the lengths of the individual phases.

27.11 The occupation

27.11.1 The beginning

By the time the first occupants settled on the dune the new landscape had existed for quite some time. The poorly developed podzol soil shows that the dune had had a vegetation cover for some time and had to some extent undergone eluviation by rainwater penetrating into it. In this period marine influence will still have been too strong to allow permanent occupation. A series of sites (Schiedam, Bergschenhoek, Rotterdam-CS, Rotterdam-Zuid) demonstrate that people of the preceding Swifterbant culture practised hunting and fishing in the coastal swamps in these days and they probably did become familiar with the region, for example via hunting expeditions and later, when conditions improved, by pasturing their cattle there. But to actually settle in this coastal region was an entirely different matter, and must have been quite an adventure. It is after all unlikely that people will have settled in an unknown area in an unreliable situation.

What made this area so attractive? That must have been the large areas of grassland that were ideal for pasturing cattle. This grassland will have been an unusual biotope, certainly in this area's wide surroundings. Such biotopes will in those days have been relatively rare in these densely forested parts. Something must have made the site itself extra attractive, too, considering the intensity and duration of the occupation. That may have been its situation in this particular ecotone – the transitional area between the plain and the swamps – and/or perhaps the presence of a second dune in its immediate vicinity that could be used for growing crops and/or as a refuge for the cattle in the event of floods. There were however no simple, dry access routes. People will have had to drive their cattle across either the peatland or the estuary to reach this new area, which was rather isolated in an environmental, and possibly also social respect. We therefore assume that several groups of a comparable size settled in this area more or less simultaneously.

27.11.2 Two centuries of permanent occupation, 3600-3400 BC

The local group consisted of four households, together comprising around 25 persons, who lived on the dune on a permanent basis. For the procurement of stone and flint the people were dependent on contacts with a hinterland in the south. Certain wood species required for various purposes were not available in the site's immediate surroundings either. But otherwise the dune's occupants could manage very well with the locally available resources and raw materials.

Subsistence was based on an extended broad spectrum economy. The exploitation of different ecozones around the site by means of gathering, fishing and hunting in different seasons was combined with cattle and pig farming and cereal cultivation.

In spite of the drastic environmental changes, the occupants managed to survive at this site for two to three centuries.

All this has already been summarised in greater detail in the previous 'Man and materials' and 'Ecology and subsistence' parts of the synthesis. This final part focuses on the organisation and functioning of the regional group of which the Schipluiden occupants formed part.

27.11.3 The end

The rising water level, the transformation of the ancient beach plain into a vast fen marsh and the gradual 'submersion' of the dune ultimately made the site unfit for further occupation. The settlement was abandoned and the occupants moved elsewhere. They may have continued their way of life unchanged at a site somewhere at the periphery of the belt of coastal barriers that had by this time become much broader and covered with low dunes all along the coast between Loosduinen and Voorschoten. Settlements of the Vlaardingen group are known from the latter area. They are of a slightly later date, following a hiatus in finds of one to two centuries in which the Hazendonk-Vlaardingen cultural change took place. The economy of the Vlaardingen communities along the coast was distinctly agricultural in character – with 90% domestic animal bones far more so than that of Schipluiden – and the livestock had by this time been expanded with sheep and/or goat. These people however also had southern contacts and indeed many other characteristics in common with the Hazendonk group: the import of flint axes from what is now Belgium, the use of broken fragments of those axes for the manufacture of flake tools, the manufacture of amber and jet beads, a lack of interest in the coast for the exploitation of resources and the apparent importance of sturgeon in the diet.

A remarkable increase in the average weight of red deer bones in phase 3 put us on the track of the deposition of large red deer foreleg bones in that phase, which we interpreted as an indication that the abandoned site was used as a hunting base by people living at a new settlement (section 22.7). The hunters will have consumed the forelegs at this camp and have taken the other parts of the butchered animals back to their settlement. But where that settlement was we don't know.

It is appealing to associate the as yet unexplained exceptional subrectangular hut plan on top of the dune with this later use of the site. The hut differed from the usual houses in its small dimensions (4 × 6 m) and light structure. Intersections tell us that the plan dates from a late part of the occupation sequence. A parallel is known from Vlaardingen. There, the feature of a fairly flimsy Bell Beaker hut measuring 3 × 7 m (Van Beek 1990,) is also assumed to represent a temporary shelter.

27.12 A SOCIO-ECONOMIC MODEL

27.12.1 Size of the regional group

The main area of focus is the former beach plain, which measured 5 × 20 = 100 km^2. The occupants of the Schipluiden dune did not live isolated in this plain, but formed part of a wider social community that included other, comparable groups with which they shared the exploitation of the plain. There will definitely be quite a number of settlement sites buried in the subsoil of this region beneath the 3 to 4 m of later deposits. A few have been discovered during public works. One of those settlements (Wateringen 4) was demonstrably occupied for a short length of time. Another (Ypenburg) seems to have been more intensively used, and ^{14}C dates prove that both were indeed occupied at exactly the same time as Schipluiden. Nothing can be said about the duration of occupation of the other two – Wateringse Veld and Rijswijk-A4. But altogether perhaps not more than 10% of the subsoil is known in sufficient detail. A rough estimate is that a total of 20-40 dunes must lie buried beneath those sediments, half of which will have traces of occupation. So there will certainly have been several contemporary settlements.

For our model we will work with an educated guess of five to ten settlements at a time, some of which will have been smaller than Schipluiden (such as Wateringen 4), and the odd one possibly larger (Ypenburg). We see Schipluiden as a particularly favourable site that was intensively used in its entirety, to far beyond the limits of the dune, for a long time – indeed for the entire period for which this area was fit for occupation. Assuming Schipluiden was occupied by 25 persons, the entire area will have had a population of between 100 and 200, or roughly 150 inhabitants/100 km^2.

We can compare the size of this group with earlier population estimations for the Netherlands as a whole (Louwe Kooijmans 1983, 1995). We assumed populations of roughly 2000 for the Mesolithic and 10,000 for the evolved Neolithic, *i.e.* 5 and 25 inhabitants/100 km^2, respectively, based on a total area of 40,000 km^2. When we restrict ourselves to land that was fit for occupation – and hence exclude the raised bogs and wetlands – these densities become twice as high: 10 and 50/100 km^2. These figures are considerably lower than the estimated population of 150 people for the Delfland microregion of 100 km^2. The Mesolithic figure implies that hunting large game in the coastal plain itself would have covered not more than the needs of 10 person-equivalents, while the Neolithic figure means that the coastal plain was relatively densely populated.

A third approach is based on ethnographic references to comparable communities living under comparable conditions (Binford 2001, 215). In the case of pure hunter-gatherers in the cool-temperate zone the maximum population density of hunters of exclusively large mammals is only 5 inhabitants/100 km^2. A dominant exploitation of aquatic (fish) or plant resources however allows much higher population densities, with maxima of up to 80 and 100 inhabitants per 100 km^2. So again the hunting of wild mammals will have accounted for only a very limited part of the overall subsistence basis in the case of Delfland. Other natural resources could have covered at most about half of the subsistence needs of the assumed population or approximately 75 person-equivalents.

27.12.2 Relative importance of different food resources

Two clues help us to estimate the importance of the different food resources in the overall subsistence system in the case of Schipluiden and the Delfland region. The first is the fixed ratio of domestic animals and large game (chapter 22), the second is the isotope ratio of the human skeletal remains (chapter 5).

It is usually rather difficult to assess the relative importance of food resources on the basis of archaeological remains due to the highly diverse formation processes that those remains may have undergone and the great differences in sampling techniques usually employed in their recovery. There is no relation between the importance of individual resources and archaeological visibility. This principle is well known, but insufficient allowance is usually (always?) made for it. The only exception concerns the relative importance of hunting and stock farming, assuming that the refuse of those two activities both underwent the same deposition processes. This however usually involves some technical problems such as the difficulty of distinguishing between domestic and wild pigs. At Schipluiden this problem could however be solved. Secondly, Antler and remains of dogs and fur animals must not be included in the assessments, because antler would result in an overestimation of red deer, dogs were not eaten and fur animals (except beaver) were no main food resource. In the case of Schipluiden this means that the assessment boils down to a comparison of cattle plus pig with red deer plus wild boar. This wild:domestic ratio is 35:65 based on the numbers of bones and 28:72 based on the weights of the bones. This difference is caused by the relatively small proportion of remains of domestic pig and the relatively large proportion of those of wild boar. In actual fact the figures should be converted to the weight of the meat, and then to

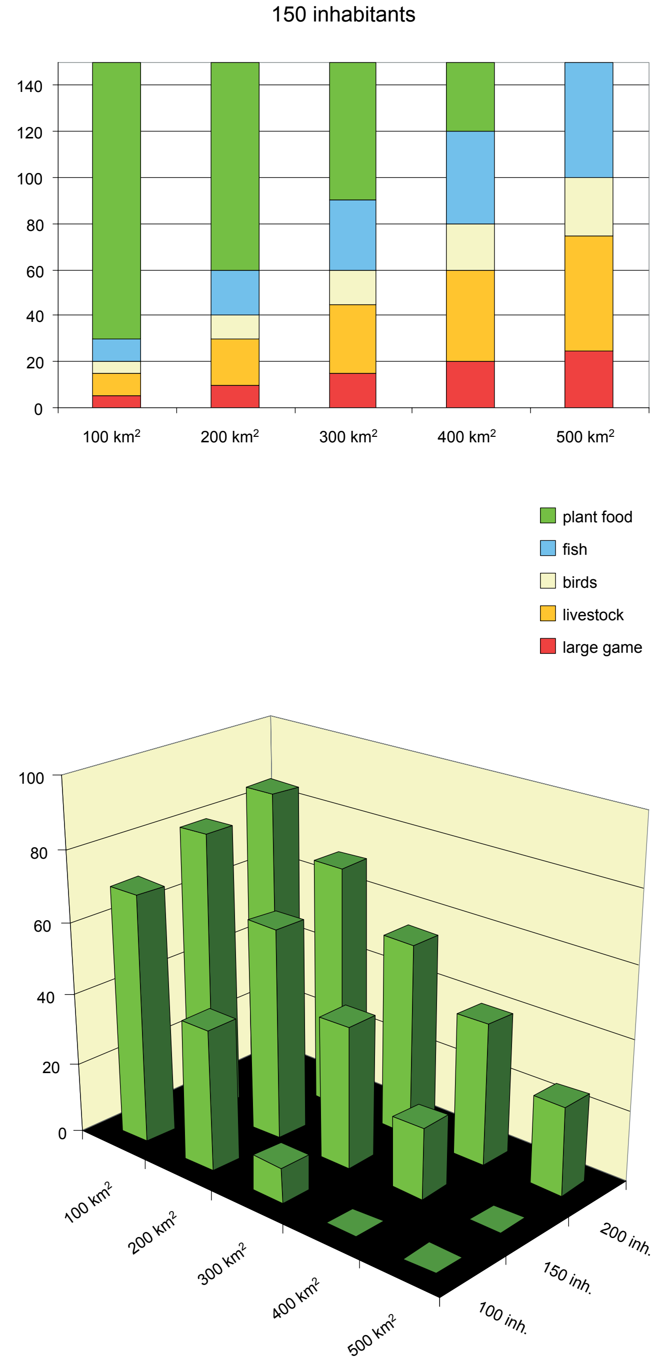


Figure 27.12 Calculation of the composition of the food package of the Neolithic community in the Delfland microregion. The calculations are based on the assumption that large game could support the equivalent of 5 inhabitants per 100 km^2.

a Calculation based on a population of 150 inhabitants and a group territory increasing from 100 to 500 km^2.

b Plant food as a percentage of the food package in relation to the number of inhabitants and size of the group territory.

the meat's caloric value. The caloric value of for example pigmeat is much higher than that of red deer or cattle meat, so such a conversion would be to the advantage of wild animals. Here we assume a ratio of 1:2.

The relative abundance of bones of waterfowl (chapter 23) and the more modest assemblages of fish remains (chapter 25) must together represent important sources of animal protein. This statement is based on the stable isotope analysis of the human skeletal remains. The results reveal a pronounced 'marine signal' and a freshwater reservoir effect in the ^{13}C values pointing to consumption of roughly 50% of the protein from these resources; these signals would be inexplicable if terrestrial mammals had played a greater part in the diet. This implies a domestic : terrestrial : aquatic ratio of 2 : 1 : 3 in our exploitation model.

The plant food diet (chapters 19 and 20) must have been varied, including cereals grown locally and fruits, berries, nuts, roots, tubers, onions and vegetables gathered as wild resources, though some may also have been cultivated in garden plots at the site. The relative importance of this part of the diet is however the great unknown and can only be estimated as the outcome of the model.

27.12.3 An exploitation model

The three main variables in our model are the number of inhabitants of the microregion, the extent of the surrounding ecozones exploited and the ratio of plant and animal food. The relations between these variables are illustrated in figure 27.12a. In the case of a population of 150 people the exploitation of the coastal plain alone results in an extreme proportion of plant food of 120 person-equivalents or 80%. Extending the exploited area with parts of the estuary and the fresh water marshes causes the value to decrease to less than 50% at 300 km^2, which can be considered a realistic score. The alternative combinations of 200 inhabitants exploiting 400 km^2 and 100 people exploiting 200 km^2 result in similar values (fig. 27.12b). We should realise that grazing of livestock and the use of the coastal plain in general will have had a negative effect on the stock of game, resulting in the use of an even wider region. Some Hazendonk sites along the lower courses of the main rivers, such as the recently discovered Barendrecht-Vrijenburg site and the Hazendonk itself, which lay 15 and 30 km, respectively, from Schipluiden, may have functioned as subordinate special activity sites of the Delfland people. The specialised faunal spectrum of the Hazendonk site (fig. 27.17; Zeiler 1997) is indeed indicative of such a function.

Binford (2001, 213) however argues that when mobile hunter-gatherers adopt a sedentary way of life we observe not only a 'dramatic increase' in the size of the 'ethnic group', but also a 'dramatic decrease' in the size of the 'occupied area'. We assume that the latter also holds for the hunting component of our semi-agricultural group, with Binford's 'occupied area' corresponding to our group territory (see section 27.12.5). It should be added that our calculations have a much smaller scale than those of Binford.

27.12.4 Site territory (fig. 27.13-14)

It is unlikely that the wider area was divided into separate territories, considering that both the Schipluiden and the Ypenburg occupants exploited all the different ecological zones. It is however plausible that each group enjoyed exclusive rights of use over the immediate surroundings of its settlement, within which it could meet its most common daily needs, by gathering wild fruits and firewood, obtaining wood for structural purposes, creating fields for its crops and possibly also pasturing its cattle – in other words its 'site territory'. How large this territory may have been depends on what activities we regard as territory-bound. It comprised part of the plain, including some of the dunes that lay in it. With a radius of 2 km the entire plain will have been divided between the settlements; with a radius of 1 km only a quarter of it.

Like artefacts and craft activities, subsistence-related activities will have been divided between the two sexes. In the traditional division of tasks, women's tasks are concentrated in and around the settlement, and the women's life takes place largely within the site territory. We assume that the Schipluiden women's tasks included the gathering of berries (in summer), fruits, nuts and tubers (autumn and winter) and the tending of the fields and kitchen gardens (spring, summer). Firewood will also have been collected in the site territory. These are the less prestigious – but very reliable, and therefore important – aspects of the subsistence system.

Many of the more strenuous activities involved in crop cultivation will have been carried out by the men (too). Their bones indeed show signs of frequent hard work. Those activities may have included opening up the land for cultivation and building fences round the fields, and activities such as tree felling, house construction and canoe manufacture.

Stock farming is generally assumed to belong to the men's domain. The cattle may have been pastured in the immediate vicinity of the settlement, and the pastureland may also have lain within the local group's territory. With a stock of ten heads of cattle per household and a stock density of one animal per 2 ha, the group will have needed 80 ha of grassland – an area that was readily available within the territory in the various alternatives, with due allowance for the territory's ecological differentiation.

27.12.5 Group territory

Outside the site territories there was presumably an area over which the entire community enjoyed collective rights of use. The estuary was evidently open to anyone for hunting and

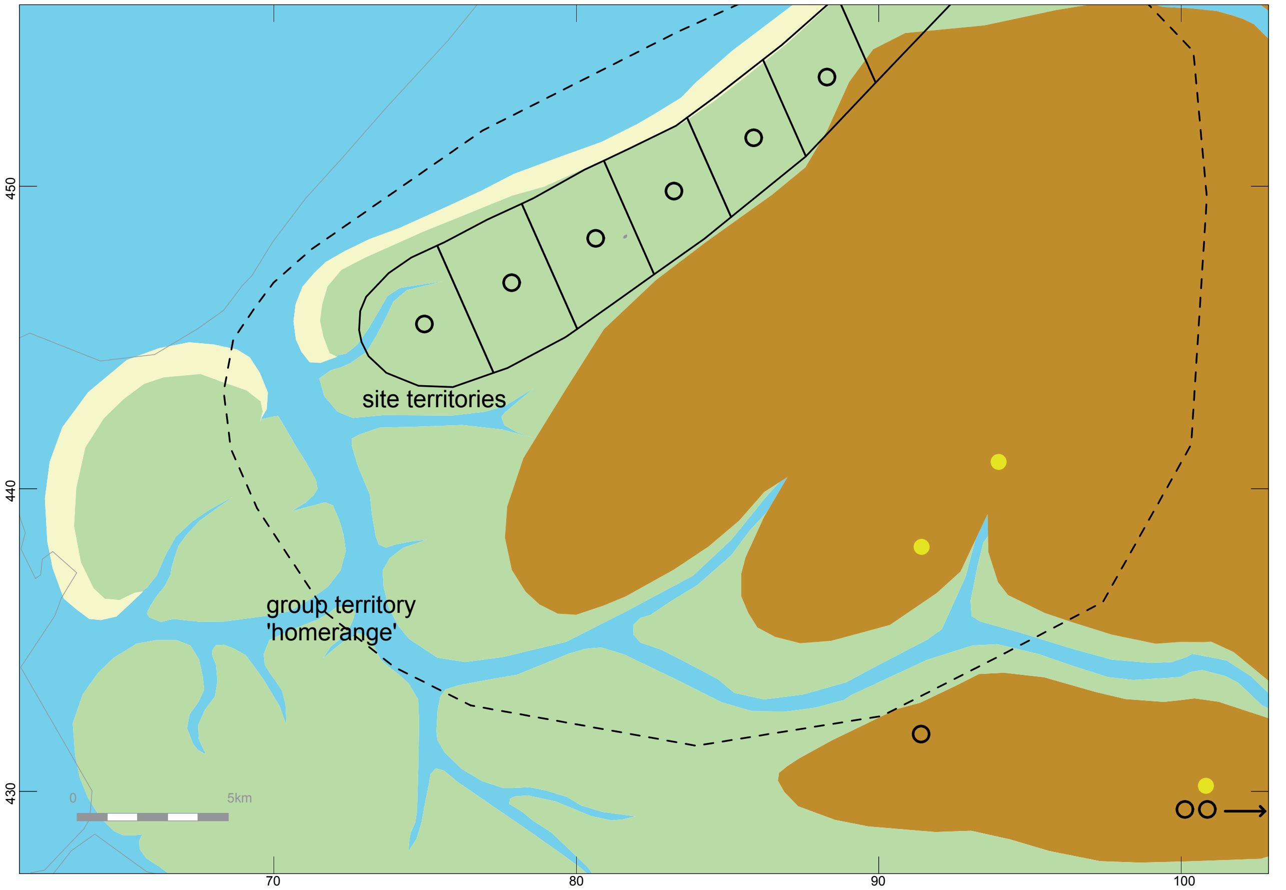


Figure 27.14 Spatial model of the Delfland microregion showing six contemporary settlements of four households each with site territories of at most 10 km² and a collective group territory that will have extended far into the freshwater marsh ecozone.

fishing, and the same holds for the vast swamps to the east of the sites. The hunting of large mammals may well have been a collective activity and the same may hold for the catching of large sturgeons and the construction and maintenance of the fish weirs used for that purpose. This wider area, which in actual fact comprised the whole of the 'Delfland' region including the peripheral areas, we could call the 'group territory' (fig. 27.13-14). The resulting model has much in common with that of the *Bandkeramik* in the south of the province of Limburg (Bakels 1978, 141), except that the Delfland community, being still strongly focused on natural food resources, will have exploited a much larger territory. We therefore prefer to use the term 'group territory' rather than 'home range'.

27.12.6 Interaction sphere

The Schipluiden occupants lived in this region on a permanent basis and lived off the rich diversity of food resources available in the region. They made pottery from local clays, which they tempered with (sea) shells and other materials. They also used the locally available wood species, even if they were not optimally suitable for the intended purposes. They however also maintained contacts with areas fairly far removed from their settlement, within a wide 'interaction sphere', via which they obtained certain essential raw materials that were not locally available. Those lines of contact extended in a southerly direction for mined flint, axes and pyrite, and in an easterly direction for stone (27.4.1).

With an assumed size of 150 persons, the regional group will have been smaller than the minimum assumed for an independent reproduction group, and external social and marriage relations will have been essential for its survival. If the group comprised more than 200 persons, it will have been potentially independent, but external contacts will still have been highly desirable.

Those contacts demanded extra efforts, because the Delfland occupation area was fairly isolated. The Meuse estuary complicated communication in a southerly direction while the peat bogs hampered communication with the east. Direct communication will have been possible only in a northerly direction, along the coast to the mouth of the Oude Rijn and from there along the river's banks towards the east. Communication will have taken place mainly across water. The sites on the river dunes in the Alblasserwaard area may (also) have had an intermediate function. There will however be other sites buried beneath sediments whose existence is unknown to us; fifteen years ago the sites in the Delfland region were indeed also still unknown.

What form this communication had is not clear. As far as the eastern relations, within the Hazendonk pottery style group, are concerned, human mobility is more likely than exchange, considering the modest nature of the materials concerned. If women were exchanged between the settlements, that must have taken place in the context of these contacts. The arguments for this are the assumption that the women made the pottery, and the originality and uniformity of the pottery throughout the entire Hazendonk style province.

The southern relations concerned more prestigious goods – axes, mined flint and pyrite – and the contacts extended into a zone with a different cultural tradition and organisation: the completely agricultural Michelsberg culture of the loess zone with its enclosures, flint mines and sophisticated pottery (fig. 27.4). In this case, too, the contacts may have involved a combination of mobility of the Hazendonk groups and exchange. Being fairly hard to find, pyrite nodules, for example, will have been appealing objects for exchange. The skins of the 'exotic' lynx will also have made perfect exchange articles for the products the delta occupants were able to supply, and the same holds for the beautifully designed paddles. Complete, or possibly semi-finished axes are likewise more in accordance with an exchange relationship than with free access to the flint procurement sites.

These southern networks are continuations of those of the preceding periods, as represented for the period 5500-4500 cal BC in the Hardinxveld sequence and earlier in the distribution pattern of artefacts made of Wommersom quartzite (Louwe Kooijmans 2001a and b; Gendel 1982).

27.13 Schipluiden's place in the neolithisation process (fig. 27.15)

Schipluiden provides a perfect impression of society 1500 years after the introduction of the farming way of life in South Limburg by the people of the *Bandkeramik* culture, 1000 years after the adoption of stock farming by the Swifterbant communities in the large northern plain, and 700 years after the first crops were sown in this area. It is a reference point for the advancing 'Neolithic' way of life, which had by this time become largely established in a material respect. Economically – in terms of subsistence – life was however still very much dependent on the old traditions of fishing and gathering.

Formally speaking it's quite straightforward: Schipluiden is a Neolithic settlement. The people used polished axes and made pottery; they lived in a permanent settlement, grew cereals and kept cattle. So all four criteria of the 'Neolithic package' are perfectly met. To this can be added the fact that, with a livestock farming:hunting ratio of 2:1, the subsistence system had evolved beyond Zvelebil's substitution phase (1986) and had reached his phase of consolidation of the neolithisation process (fig. 27.16). The deceased were moreover buried according to a new, Neolithic tradition, in one case (Ypenburg) even in a formal cemetery. So why not characterise the settlement as Neolithic and have done with it? Because we must also consider the following factors.

Besides showing all the aforementioned characteristics of the new way of life, the Schipluiden community was actually still strongly influenced by old traditions. We observe plenty of native elements that go back to the preceding Swifterbant period and even the Mesolithic; they make these people appear conservative. Those elements are first of all the pottery: the women stuck to the good old familiar techniques and didn't switch to making the elegant, varied Michelsberg types – quite the contrary: the robust bucket-shaped pots actually seem to be a reaction against those newfangled types!

Hearth pits have long been regarded as one of the most typical characteristics of the Mesolithic way of processing food. The sixty or so hearth pits found at Schipluiden show that this method was still very much alive here.

It is not altogether certain whether the groove-and-splinter technique of antler working should be traced back to the Mesolithic at Schipluiden. This is after all a typical *early* Mesolithic technique, used for the production of the barbed points of those days, which goes back to the processing of reindeer antler in the Magdalenian and the Hamburg culture. Its use in the Neolithic at sites far removed from one another in the Hebrides and Switzerland suggests reinvention of this technique, which was after all a fairly obvious processing method that moreover has a lot in common with that used for processing metapodia.

Far more fundamental is the subsistence system, which we have characterised as an 'extended broad spectrum economy' (Louwe Kooijmans 1993). The people settled at a site strategically positioned between different ecozones, which they exploited on a certain seasonal basis, with a readily identifiable division of tasks between men and women. This is all very 'Mesolithic'. The people lived in relatively small settlements, in groups of a few households, at sites surrounded by expansive areas of land over which they could claim rights of use without competition from other sites.

They also kept cattle and grew cereal, but the isotope signal of the human skeletal remains points to a considerable

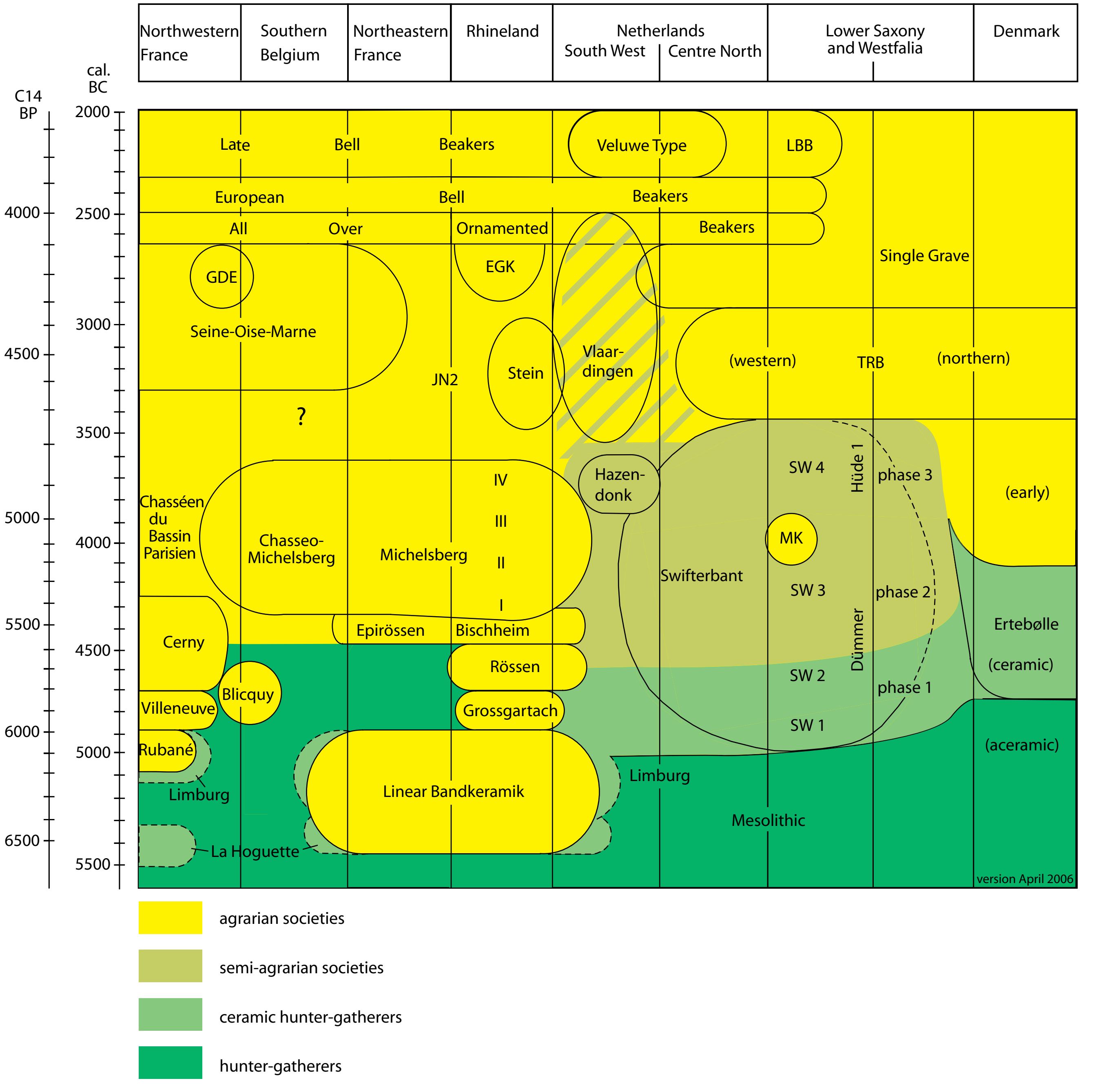


Figure 27.15 Chrono-geographical diagram of the Neolithic of the Lower Rhine Basin and adjacent areas, the colours indicating the stages of neolithisation. Update of a diagram originally drawn in 1974. Note how long the boundary between the agrarian societies and the foragers and semi-agrarian Swifterbant societies in the Dutch/North-German plain remained stationary. The Hazendonk group represents communities in this frontier zone at a stage when this distinction was about to dissolve.

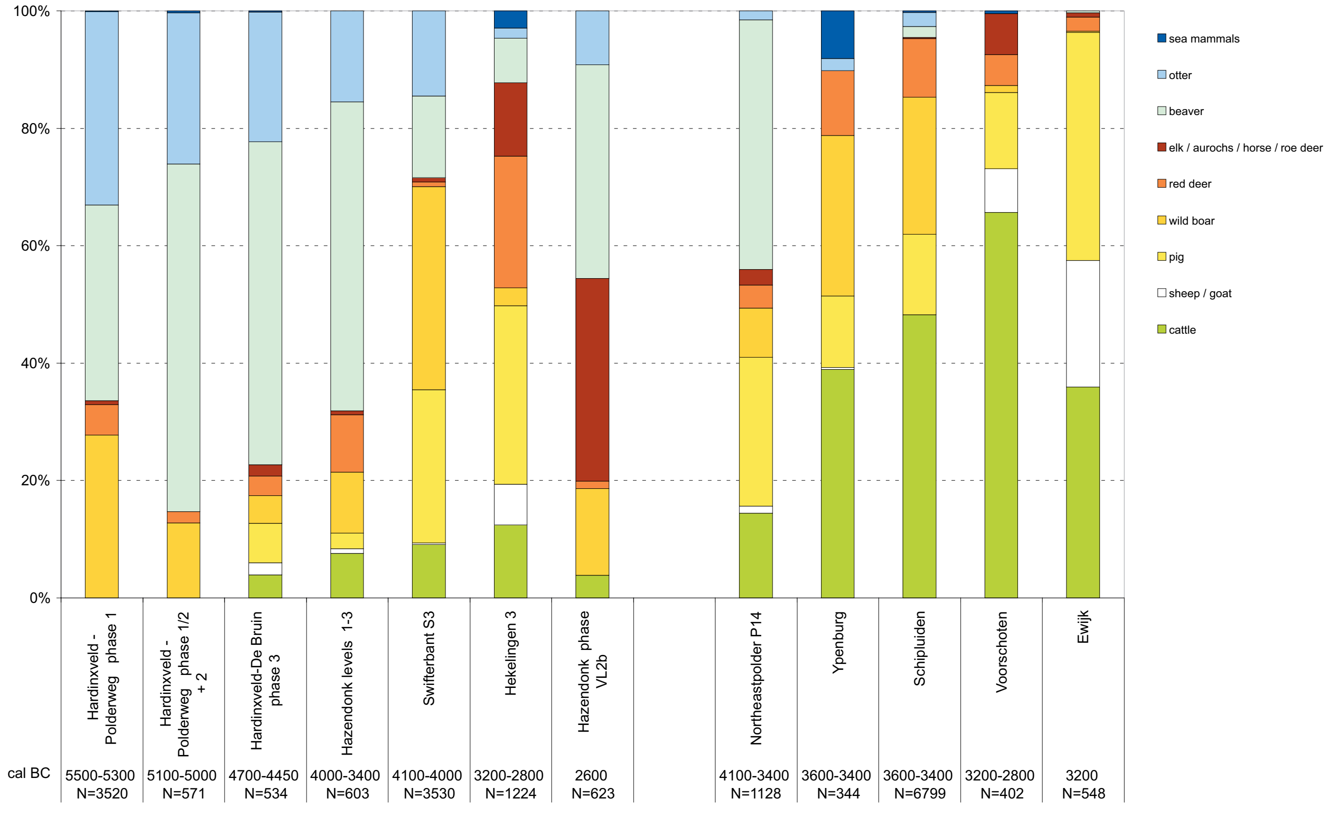


Figure 27.16 Faunal spectra of selected Late Mesolithic and Neolithic sites, 5500-3500 cal BC, in the Holocene sedimentation area divided into two groups: pure wetland sites on the left and agricultural settlements on the right. Both groups of spectra are presented in chronological order from the left to the right. Excluded are antler, dog and all fur animals except otter. Indeterminate pig/wild boar bones have been attributed to pig and wild boar on the basis of the ratio of the positive identifications. The same holds for cattle/aurochs bones.
Four factors are of importance in the interpretation of these data: the stage in the process of neolithisation, the ecozone in which the site was situated, possible differences in function of the sites in the former settlement system and seasonality. The left group is thought to more closely reflect the upland processes.

coastal	Schipluiden, Ypenburg, Voorschoten
rivers area	Ewijk
upland margin	Noordoostpolder P14
estuarine, fresh marshes	Hardinxveld, Hazendonk, Swifterbant, Hekelingen

After Louwe Kooijmans in press b. Data from Clason 1990; Gehasse 1995; Groenman-van Waateringe *et al*. 1968; Oversteegen *et al.* 2001; De Vries 2004; Van Wijngaarden-Bakker *et al.* 2001; Zeiler 1997.

aquatic component in the protein consumption, which makes us characterise the community as 'semi-agrarian'. The Schipluiden occupants were much less agricultural than would appear from the bone assemblage alone.

Looking at things from this perspective we also understand why the people decided to settle in an area surrounded by coastal swamps. The site must nevertheless partly have been selected on the basis of a need for good pastureland for the cattle. That was always a critical factor in the then still densely forested land. It remained an important consideration in the Late Neolithic and even in the Bronze Age, especially in the West-Friesland region and the rivers area. We assume that the cattle was not only of economic value, but also constituted a basis from which men derived their prestige. All this made Delfland a particularly attractive area for these people.

Schipluiden therefore provides a good impression of the very gradual process of neolithisation that seems to be characteristic of the Lower Rhine Basin and is epitomized by the Swifterbant culture. In this process, small groups of people – we should be thinking of several hundred rather than thousands – adhered to the traditional way of life for a long time and adopted the achievements of the Neolithic

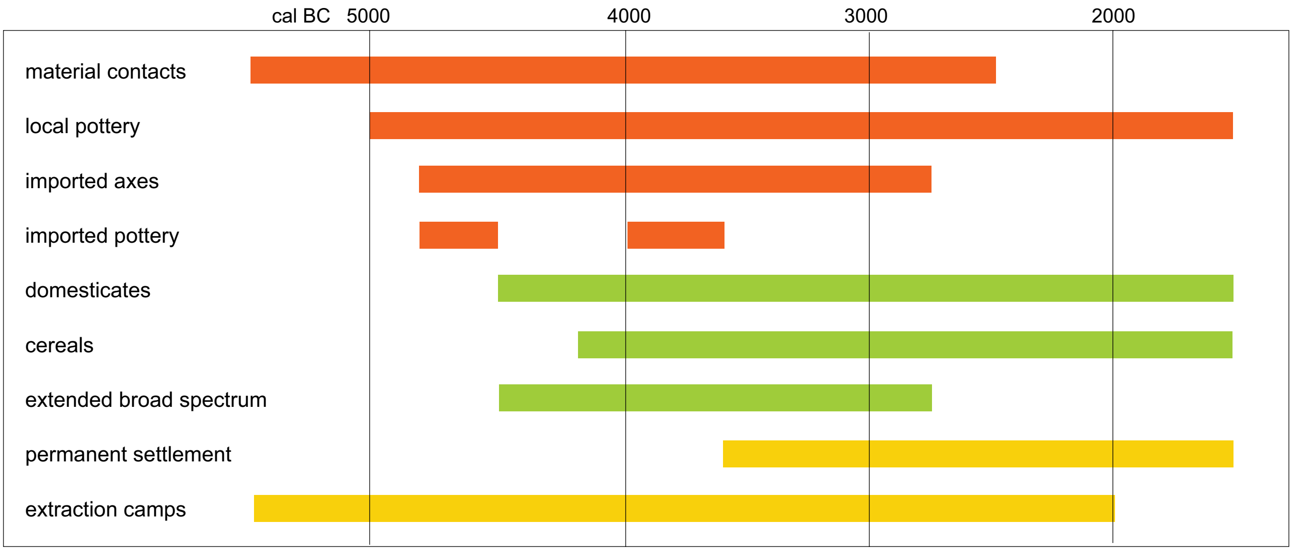


Figure 27.17 Graphic representation of the neolithisation of the Lower Rhine Basin. Technological aspects (red) preceded shifts in subsistence (green) and settlement system (yellow). The earliest archaeological evidence found so far may postdate the actual introduction of new elements. New research may yield earlier evidence. The exploitation of natural resources from special activity or extraction camps decreased through time, but did not end before the end of the Neolithic.

only step by step, almost imperceptibly. Settlements elsewhere – in the rivers area and on the southern sandy soils – may well have been more agricultural in character, as established for the later Vlaardingen culture on the Older Dunes and in the eastern part of the rivers area, but at present we have insufficient evidence to prove it.

Thus characterised, Schipluiden may hence definitely not be regarded as an average Neolithic settlement, typical of a much larger area. Further south, in the area of the Michelsberg culture, settlements will have been more agricultural and will have had much smaller territories. There, people will have needed a much smaller 'group territory' for the more restricted exploitation of natural resources. Social cohesion was instead expressed on a higher level by communal enclosures, which represent social and ideological alliances rather than communal rights of use of exploitation areas.

The subsistence system outlined for Schipluiden is not a unique development in the European Neolithic. It has also been encountered at sites with different conditions, where restricted landscape units with agricultural potential bordered a large irreclaimable wilderness. Examples of such sites are the Swiss lakeside dwellings, whose hinterland consisted of expansive mountain forests. At those sites the percentages of animals hunted in the different phases of the Neolithic vary substantially, from 10 to 90% (Wyss 1969, 122). At Arbon-Bleiche (3385-3370 cal BC) hunted and domestic animals were equally balanced, each represented by 50 percent by weight (Dreschler-Erb/Marti-Grädel 2004). At those permanently occupied lake dwellings equal proportions of wild and domestic animals remained quite common until well into the Late Neolithic Horgen culture.

The particular environmental situation and the associated research conditions make Schipluiden an anchor site for our understanding of the neolithisation process in the Lower Rhine Basin. Here, this process was evidently characterised by a gradual adoption of Neolithic elements over an exceptionally long time span, in which material innovations (pottery, flint, axes) largely preceded economic ones (arable and livestock farming), and the exploitation of natural resources remained important even in a highly advanced phase (fig. 27.17). It was a fairly exceptional and original trajectory in the mosaic of cultural change processes that together constituted the neolithisation of Western and Northern Europe.

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Laboratory for Artefact Studies	**7**.15, 17; **8**.5, 8; **10**.5, 9
Leendert P. Louwe Kooijmans	**1**.6-10; **2**.1, 2, 5, 6a, 8-10; **3**.21b, 22; **11**.17; **19**.13; **21**.6; **23**.5a; **26**.1; **27**.8-10
Nationaal Herbarium Nederland, Leiden	**19**.3a-d
Stichting Monument & Materiaal, Groningen, Jaap Buist	**25**.4
TNO-NITG, Utrecht	**15**.2-3
Zoölogisch Museum, Amsterdam	**26**.2b, 4, 5

SCHIPLUIDEN

The Schipluiden site is a unique document for a crucial phase in the neolithisation process of the Lower Rhine Area. The rescue excavation profited from available funding for a full recovery of the site by a large multidisciplinary team. The site dates to c. 3500 cal BC and was situated on a low coastal dune, now 3 m below sea level.

It was surrounded by a collective, multiple fence and dense post clusters indicate long-term habitation. Over a hundred temporary wells were a measure to ensure access to fresh water in the coastal environment. It shows us the first step to a year-round settled way of life, north of the Dutch loess zone. Exotic raw materials such as flint and stone, but also beads of amber and jet demonstrate wide connections, especially far to the south, into the Michelsberg culture area. A number of human burials and dispersed skeletal remains reflect a variety of mortuary practices.

The waterlogged condition of the site meant a wealth of preserved organic remains: spectacular wooden equipment, like paddles and axe hafts and even some fragments of woven fabric. Bones of mammals, birds and fish, molluscs, diatoms and insects, pollen and botanical macroremains inform us in detail on the Neolithic landscape and subsistence. It appeared that the inhabitants combined the 'new' husbandry and crop cultivation with the 'old' tradition of hunting and fishing in the various surrounding landscape zones.

All evidence together allows a detailed synthesis of a community in the delta environment on the threshold to a fully Neolithic way of life.

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