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Wateringen 4: A Settlement of the Middle Neolithic Hazendonk 3 Group in the Dutch Coastal Area

The well-preserved remains of the Middle-Neolithic Settlement Wateringen 4 give detailed information of a hitherto unknown early phase of coastal occupation, prior to the well-known sites of the Vlaardingen Group. This Middle-Neolithic site of the Hazendonk 3 Group was inhabited around 3500 cal BC. It is concluded that the site was probably occupied on a year-round basis; foraging and farming were both important.

1. Introduction D.C.M. Raemaekers

1.1. History of the research

Until recently, the remains of the Middle Neolithic B Vlaardingen Group constituted the earliest known evidence for the presence of Neolithic man in the Dutch coastal area. The absence of older occupation remains was attributed to the dynamic nature of the coastal area: it was believed that any older occupation remains would either have disappeared owing to erosion or they would have become buried beneath thick deposits, precluding their recovery (Louwe Kooijmans 1993, fig. 6.11). This view could still be maintained in 1993, when remains of the Middle Neolithic A Hazendonk 3 Group came to light on the slopes of two dunes during large-scale infrasctructural work in the municipality of Rijswijk (province of Zuid-Holland). These dunes had first been covered with a layer of sediments with a total thickness of approximately 3.5 metres, after which, in the Iron Age, large parts of this layer had been eroded by a creek system known as the *Gantel* (Hessing 1994a, 415; Koot 1994, 15-23).

However, this traditional view had to be abandoned when the RAAP foundation discovered the Wateringen 4 site in the course of a coring campaign commissioned by the provincial authorities of Zuid-Holland to evaluate the archaeological remains in an area where a road was to be constructed (fig. 1). The RAAP's analysis revealed the presence of a soil in the top part of a dune, which was interpreted as a prehistoric 'culture layer', possibly dating from the Neolithic or the Bronze Age. RAAP recommended digging a trial trench to determine the character and age of the site (Kolen/Bosman 1992, 24).

The ROB (*Rijksdienst voor het Oudheidkundig Bodem-onderzoek*, the Dutch State Service for Archaeological Investigations) then dug a trial trench into the dune. This trench yielded pottery sherds, fragments of bone and burnt flint artefacts, which were dated to the Middle Neolithic A Hazendonk 3 period (Hessing 1994b, 437). The unexpected discovery of these well-preserved Middle Neolithic remains was cause for an extensive excavation, which was carried out by the IPL (*Instituut voor Prehistorie, Rijksuniversiteit Leiden*, Institute for Prehistory, Leiden University). The IPL conducted this investigation out of scientific interest, but also because it was able to start the excavation of the site within a short space of time.

1.2. The excavation

The high groundwater level and the considerable depth of the archaeological remains (down to two metres below the surface) necessitated the installation of a drainage system. To minimise the costs involved in installing this drainage system, core samples were first collected within a grid of ten-by-ten metres to determine the optimum location for the drains. The outcome of this coring campaign was a detailed map of the fossil dune surface, indicating the thickness and extent of the find layer and the presence/absence of charcoal, on the basis of which the drains were subsequently installed. This enabled us to excavate the top of the dune, where the find layer was thickest and contained the most charcoal, and large parts of the dune's slopes.

The road construction work was scheduled to begin after eight weeks, and it could not be postponed. We therefore decided to excavate the site on a large scale by shovel, without using sieves, in units of one square metre, to minimise the amount of administration. Most features were discovered in the last weeks of the excavation, so an excavation on a smaller scale would have led to a better understanding of the peripheral parts of the settlement site, but the centre of the settlement would not have been excavated. Stratigraphic sequences were observed in the slopes on both sides of the dune (see below). Here the finds

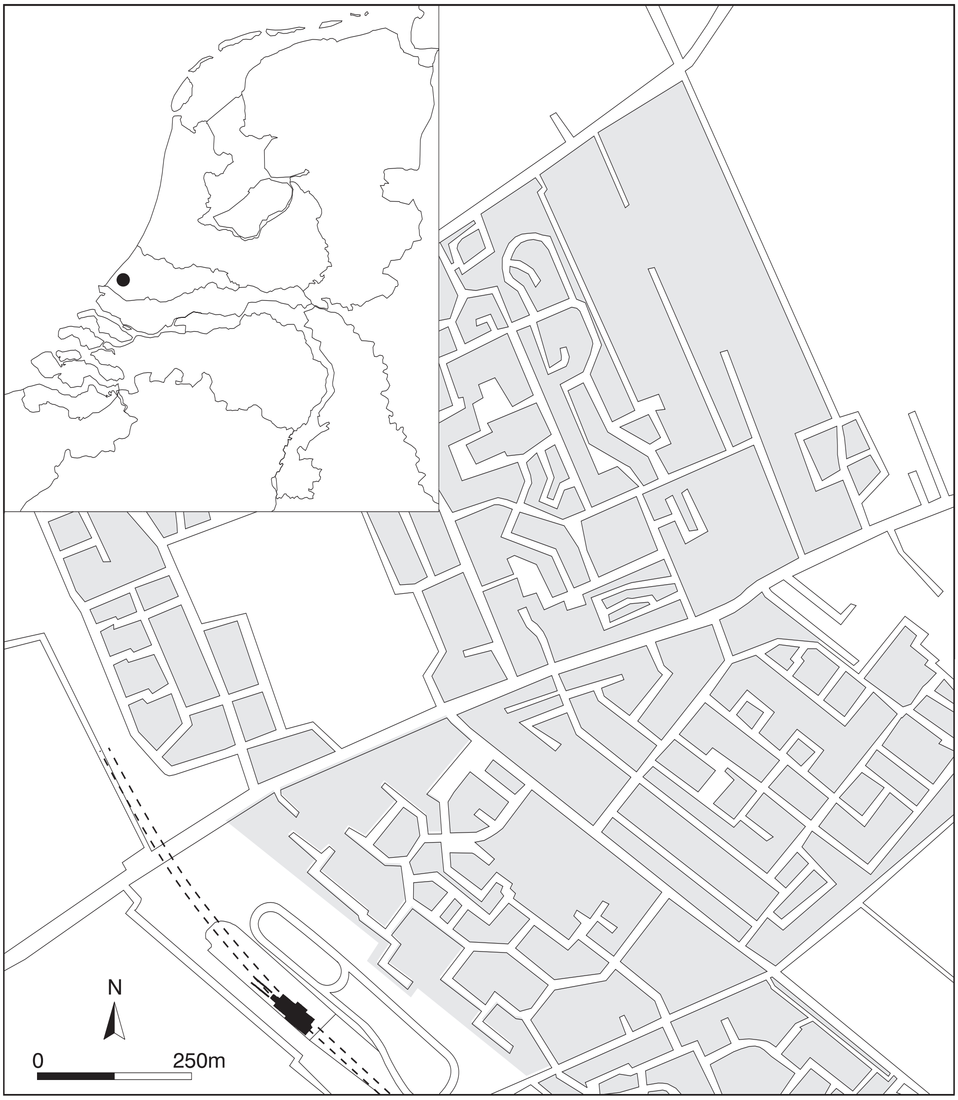

Figure 1. The situation of the Wateringen 4 excavation in relation to the planned road (double intermittent lines) and the built-up area of the town of Wateringen (solid grey). The field boundary is indicated as well.

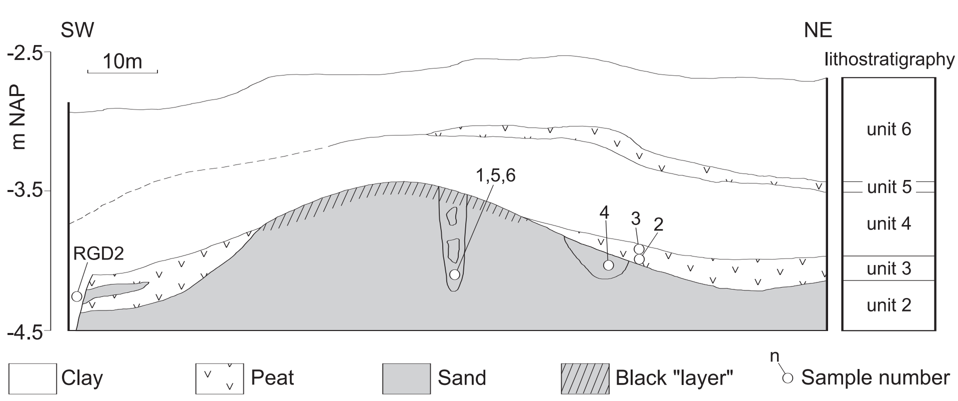

Figure 2. Schematic cross-section of the Wateringen 4 site. Only the excavated part of the dune is depicted. Sample numbers refer to ^{14}C samples.

Sample number	Groningen number	Material	Years BP
1	GrN 20.614	charcoal	4880 ± 50
2	GrN 20.718	peat	4670 ± 70
3	GrN 20.719	peat	4780 ± 40
4	GrA 913	bone	4610 ± 70
5	GrA 887	charcoal	4740 ± 40
6	GrN 21.109	charcoal	4840 ± 50
RGD1	GrN 21.599	shell	5460 ± 40
RGD2	GrN 21.600	shell	4900 ± 30

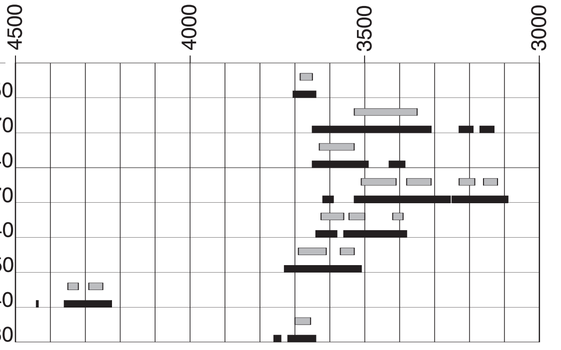

Figure 3. The ^{14}C dates of Wateringen 4. The sample numbers refer to the numbers in the text. The calibrated dates are given with 1σ (grey lines) and 2σ (black lines) ranges.

were collected per stratigraphic unit. On top of the dune, however, the finds were collected per square.

Most features came to light after the find layer had been dug away. They were all drawn and sectioned. Some features were not clearly visible at this depth, probably owing to homogenizing effects of soil formation. Therefore another layer of 10-20 cm was removed with the aid of a mechanical shovel. This led to the discovery of about 20 more features, including the northern half of a house plan (Raemaekers 1997).

2. Geological context — M. Verbruggen

2.1. Lithostratigraphy

Several deep borings and two trenches revealed six lithostratigraphic units at depths of between 1.4 and 8.2 metres below NAP (see fig. 2). The lowest unit (Unit 1) consisted of calcareous, well-sorted, flat-bedded, fine-grained sands alternating with layers of clay with thicknesses of up to 2 cm. The layers contained many lenses of mollusc shells (*Macoma balthica*) that had been washed together.

Unit 2 consisted of well-sorted unstratified fine sands. The top of this unit showed a dune morphology. About a hundred borings revealed two SE-NW oriented ridges with widths of 80 and 20 metres respectively, with a shallow depression in between. The area of the broadest and highest ridge was excavated; no occupation remains had been found on the second ridge during the coring campaign. Two types of soil were observed in the top part of Unit 2. Type 1, a dark grey A1 horizon, was observed beneath Unit 3 and in large lumps of sediment found in the unlined wells that had been dug into Unit 2. Type 2, a black, 10-cm-thick A horizon, had developed on the higher parts of the sand ridge (see below).

Unit 3, a thin layer of peat, had formed in the depression between the two ridges and the dune's southeastern slope. A clear distinction could be made within the peat between a dark brown lower part with recognisable plant remains and a black upper part without recognisable plant remains. The finds from the lower and upper parts of Units were collected separately. At the northeastern slope, the upper part of Unit 3 is named Unit 3a, the lower part is designated Unit 3b, while at the southwestern slope these parts are designated Unit 3c and Unit 3d respectively.
The sand above the area where the black upper part of the peat layer wedged out was also black; this discolouration extended to 10 centimetres above the peat. No features extended through Unit 3. A lamina of sand with the same characteristics as the sediment of Unit 2 was observed within Unit 3 (see fig. 2).

Unit 4, an approximately 30-cm-thick layer of clay, lay on top of Unit 2 and Unit 3. To the east of the ridge this clay layer was at least 80 cm thick (see fig. 2). There the boundary between Units 3 and 4 was very sharp.

Unit 5 (a thin layer of peat) and Unit 6 (a disturbed layer of clay) formed the top of the sequence.

2.2. Chronology

Eight ^{14}C samples were taken in order to date the sediments and the period of occupation. Figure 3 presents the sample numbers, ^{14}C ages, GrN and GrA numbers and calendar age ranges. Sample RGD 1, which was taken by the RGD (Geological Service of the Netherlands), consisted of shells of *Macoma balthica*. As it was obtained from about 60 cm beneath the top of Unit 1 it yielded a date for the period of sedimentation of this unit.[1]

Samples 1, 4, 5 and 6 were taken in order to derive dates for the period of occupation. Samples 1, 5 and 6, which were obtained from the fills of some unlined wells on the flanks and top of the sand ridge, consisted of charcoal. Sample 4, which consisted of bone, was obtained from the fill of a watering place in the flank of the ridge, beneath the peat layer.

Samples 2 and 3 came from the bottom and top of the peat layer, respectively.

Sample RGD 2 was taken for the purpose of dating Unit 4. The sample was found to consist of shells of *Scrobicularia plana*. Since no archaeological remains were encountered in the sediments next to the ridge, the site must have been abandoned by the time that the sedimentation of Unit 4 started.

The uncalibrated ^{14}C dates presented several interpretation problems. In the first place, the two ^{14}C dates obtained for the peat layer appeared to be in reverse order. Secondly, the dates suggested that the site was inhabited both before *and* after the formation of the peat (see samples 1 and 4), whereas the archaeological evidence points to a single habitation phase (see below).

However, all this changed when the ^{14}C dates were calibrated with the aid of the CAL20 program (Van der Plicht 1993) to obtain calendar age ranges. The calibration curve was smoothed by choosing a sample time width of 60 years for charcoal and peat (Mook 1983); the curve was not smoothed for molluscs and bone. It was decided to use the full sequence of all the calibrated ^{14}C ages as a basis for interpretation instead of rejecting one or more dates for the sake of arriving at a 'convincing' interpretation.

When we consider the full calendar age ranges of the two peat samples, the ^{14}C ages are not necessarily reversed. The peat growth may have started shortly after 3650 BC[2] and ended before 3400 or even 3500 BC (see the calendar age range of sample 3) – in other words, the period of peat growth may have lasted only 150 to 250 years. In the section, the peat layer was found to wedge out and come to an end at the point where it met the fairly steep slopes of the dune (see fig. 2). This implies that the base of the peat is diachronous, which could mean that on the higher parts of the dune peat growth started even later than 3600 BC. The calendar age range of sample 4, starting around 3600, supports this view.

The ^{14}C dates obtained for samples 1, 5, 6 and 4 suggest dates of about 3700 and 3100 BC for the beginning and end of the period of occupation, if we take into account the extreme ages of the ranges of 6 and 4. The calendar age ranges of samples 3 and RGD 2 however shorten this time span to 3700-3400 BC (fig. 3).

An interesting question from an archaeological viewpoint is whether the calendar age ranges leave open the possibility of a single occupation phase of a short duration (say 50 years). If we agree that this would mean that the calendar age ranges of samples 1, 4, 5 and 6 would then have to show only one chronological overlap, then the answer is yes: the date of 3625 BC ± 25 falls within all the ranges. If we accept that a ^{14}C date obtained for charcoal provides an indication not of the time when the charcoal was produced (*i.e.* the time of occupation), but of the time when the wood still formed part of a tree (which is always an unknown number of years earlier), such a short occupation phase can be placed anywhere between 3625 and 3400 BC.

2.3. THE EVENTS

The lithostratigraphic evidence and the eight ^{14}C dates enable us to reconstruct the events that took place before, during and after the occupation of the sand ridge (fig. 4).

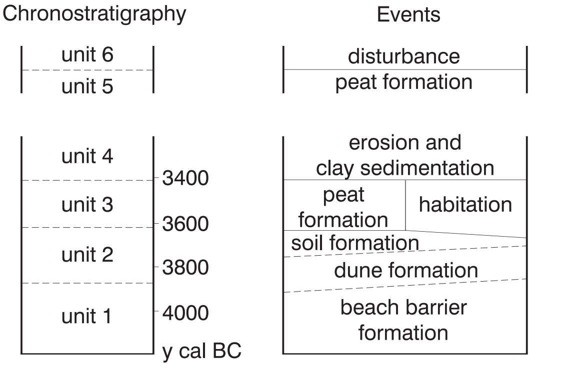

Figure. 4. Schematic representation of the chronostratigraphy and events at Wateringen 4.

Unit 1 formed around 4000 BC. Similar sediments have been extensively studied by Van der Valk (1992) at a location only 4 km to the east of Wateringen 4 (Rijswijk A4 temporary exposure, Unit 3a). Van der Valk interpreted those sediments as beach barrier deposits.[3]

Low dune ridges were later formed on top of the beach barrier.[4] Some soil formation must have taken place before the dune was occupied; see the description of Unit 2.

Around 3650 BC peat began to grow in the depression between the two dune ridges. Around this time, or at the very most 200 years later, people settled on one of the dune ridges. In the section, the bottom of the unlined well lies at a greater depth than the base of the peat, which means that the wells must have contained water. If we consider the fact that water tables beneath dune ridges like that of Wateringen 4 are often convex, the water in the well may have been 40-50 cm deep. Interesting in this context is that there was a small marsh near the dune. Perhaps the prehistoric settlers were attracted to this site because they knew that the marsh implied the availability of fresh water inside the dune.

Peat growth continued throughout the period of occupation. After the site had been abandoned, possibly around 3400 BC, a black soil developed in the higher parts of the dune ridge, as a result of a rise in the groundwater level. Around 3350 BC part of the eastern half of the dune was affected by erosion, after which marine sediments were deposited all-over the dune ridge.

3. Features D.C.M. Raemaekers

3.1. POSTHOLES

A total of 97 postholes were recorded, the majority of which lay on top of the dune (fig. 5). As these features were discovered only after the find layer had been removed, their exact depths had to be determined by calculating the difference between the height of the dune surface above the features and the bottom of the posthole sections. The

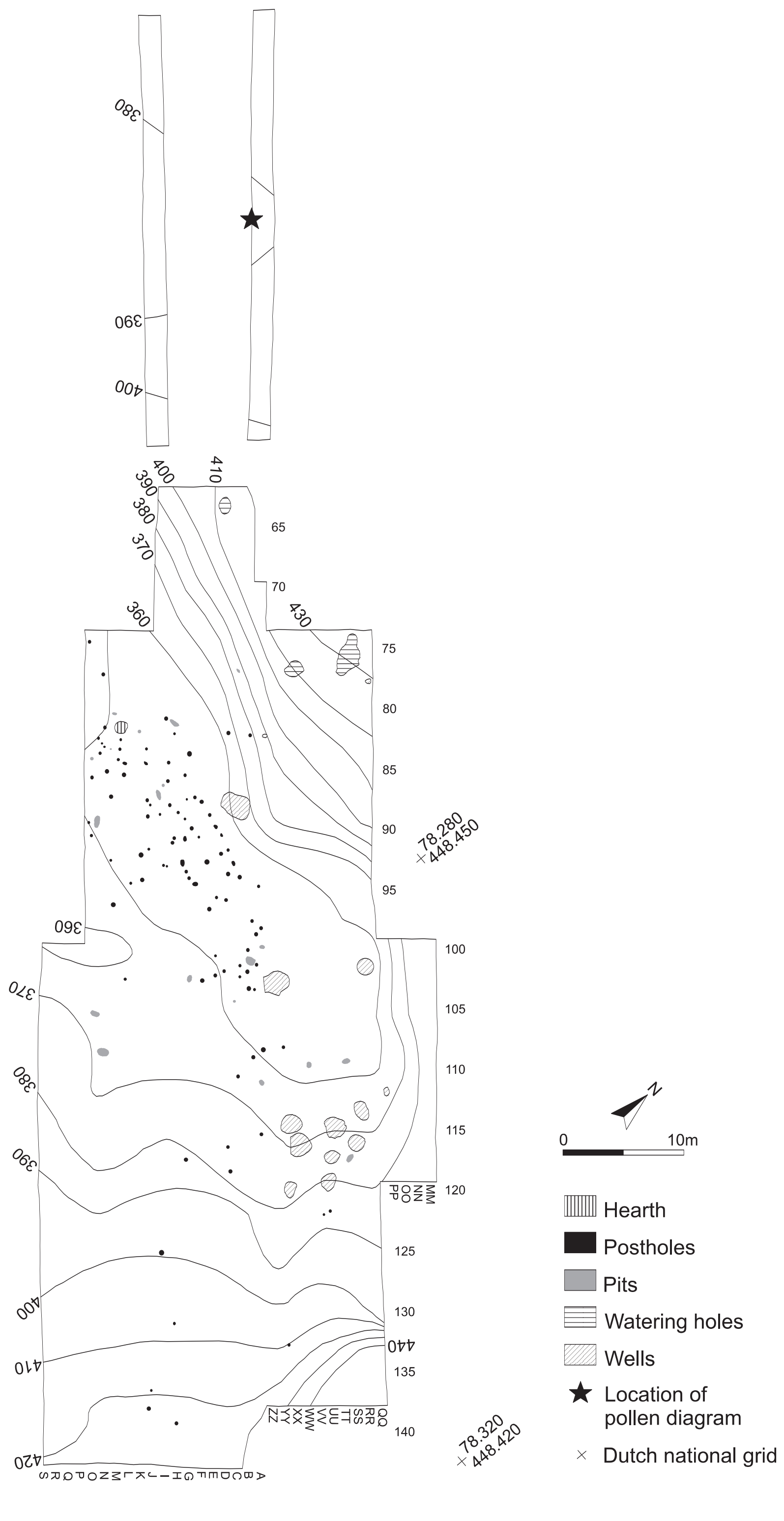

Figure 5. The excavated area of Wateringen 4, the different categories of features and the contour lines of the dune in cm below N.A.P. The position of the site in the Dutch national grid is also indicated.

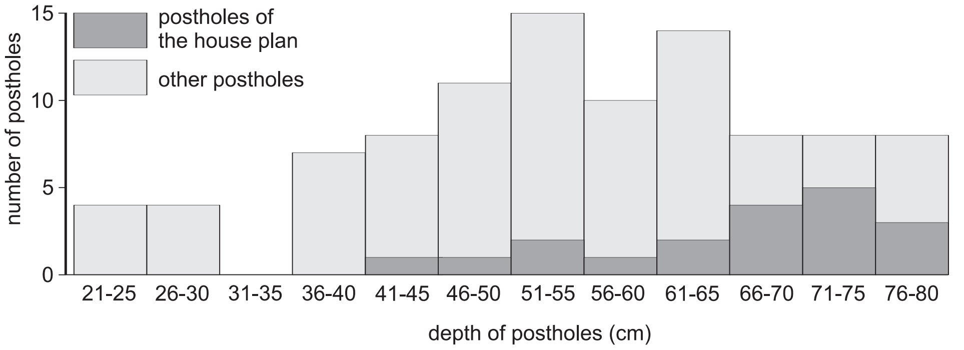

Figure 6. The depths of the postholes. The postholes ascribed to the house plan are indicated separately.

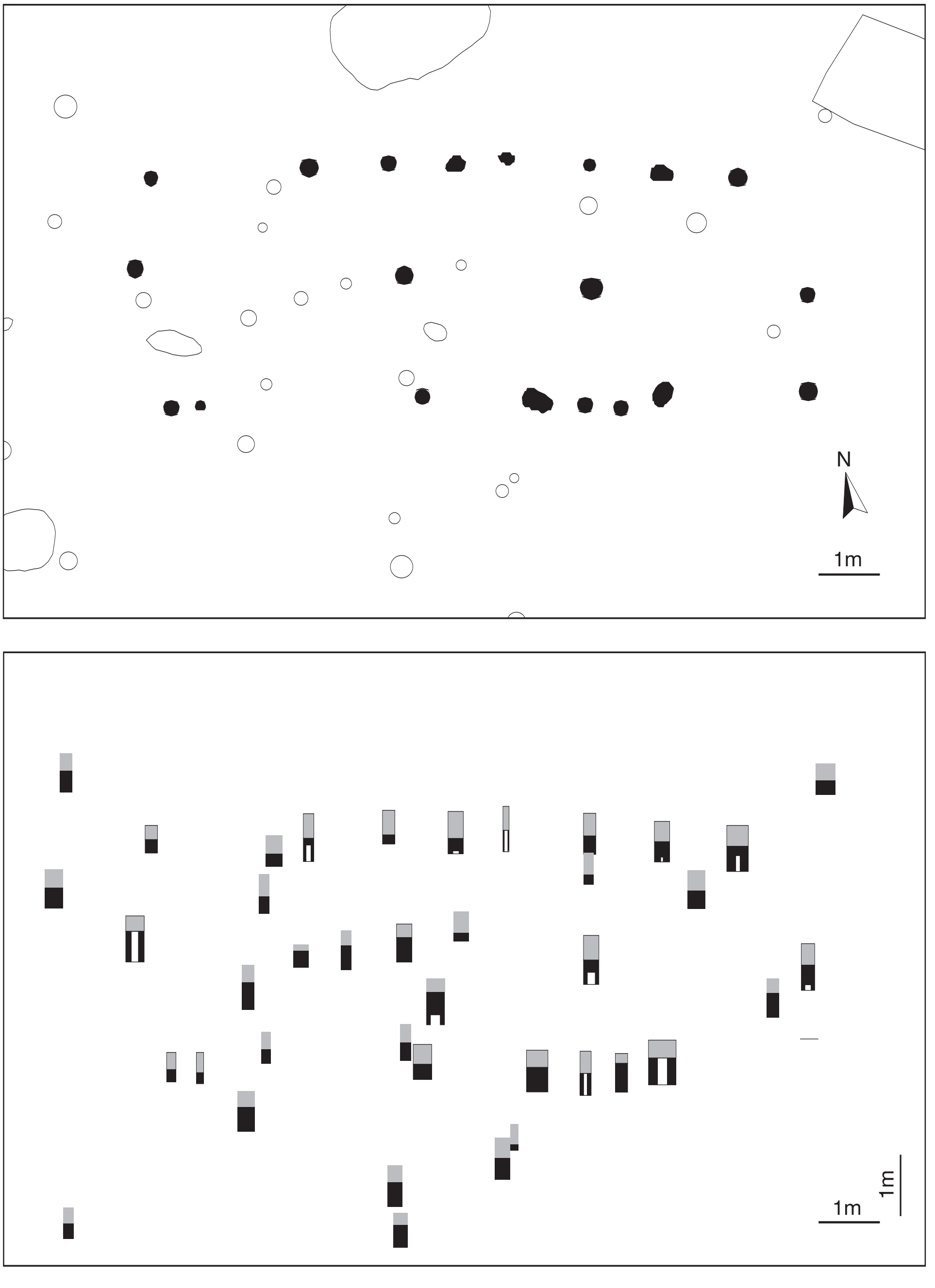

Figure 7. The house plan. In the top part of the drawing the postholes ascribed to the house plan are shown in black; the depths of the postholes are indicated in the bottom part. The remains of the wooden posts are indicated in white. The grey parts correspond to the thickness of the black layer (see the text). The postholes ascribed to the house plan are outlined in black.

maximum depth of the postholes was found to have been 80 cm (Lawende 1995, 26-29; see also fig. 6).

A configuration of nineteen postholes observed on top of the dune constituted the plan of a two-aisled house with a length of 10.9 m and a width of 4.1 m (fig. 7). As post-*Bandkeramik* Neolithic house plans are very rare in the Netherlands, the house plan will be discussed in detail below. The configuration was interpreted as the plan of a house on the basis of the following evidence:

- the use of different kinds of wood for different structural parts, *i.e.* *Alnus* for the central posts and *Juniperus* for the wall posts (see section 5);
- the observation that the central postholes were somewhat broader and deeper than the wall postholes. This suggests that the house had a saddle roof (Huijts 1992: 21);
- the presence of the two aisles and the size of the plan. The few other house plans from this period known in the Netherlands are also two-aisled and of a similar size. Good examples are the plans of the Vlaardingen Group at Haamstede-Brabers (plan 1 (9.10 × 3.50/3.80 m) and plan 2 (7.50 × 3.90 m); Verhart 1992, figs 10-13), and the house plan of Vlaardingen (western levee (9.70 × 5.30/5.80 m); Glasbergen *et al.* 1961, fig. 31);
- the situation of the features on top of the dune. This was the driest part of the dune, which will moreover have afforded a good view over the surrounding area;
- the orientation of the plan relative to the dune's contours;
- the overlap with the distribution of the finds (figs 26, 29, 33). This suggests that the structure was a centre of activities.

The majority of the postholes that still contained the remains of wooden posts form part of the reconstructed house plan. This suggests that the absence of wood in the other postholes on top of the dune is not attributable to preservation conditions. It is more likely that the posts that once stood in those holes were deliberately removed, possibly for use in a later structure. That would mean that the plan formed by the postholes containing the remains of wooden posts represents the last structure to have stood on the excavated part of the dune top.

When the posts of the earlier structures were removed and reused or burned, the empty postholes were filled with sand. The fills of these holes consisted of humic topsoil or the non-humic sand that surrounded the posthole. In the latter case it was of course impossible to distinguish visually between the fill of the posthole and the surrounding sand. The large number of postholes without remains of wooden posts suggest that there were more structures on top of the dune than that discussed above.

3.2. Unlined wells

In addition to the postholes, the excavators observed a second group of features. This group consisted of fourteen similar features with diameters between 45 and 257 cm (average 152 cm), depths between 58 and 103 cm (average 78 cm) and primary fills consisting of thin lenses of non-humic and slightly humic sand combined with a few lumps of sand showing traces of soil development (see fig. 8). These features yielded very few finds.

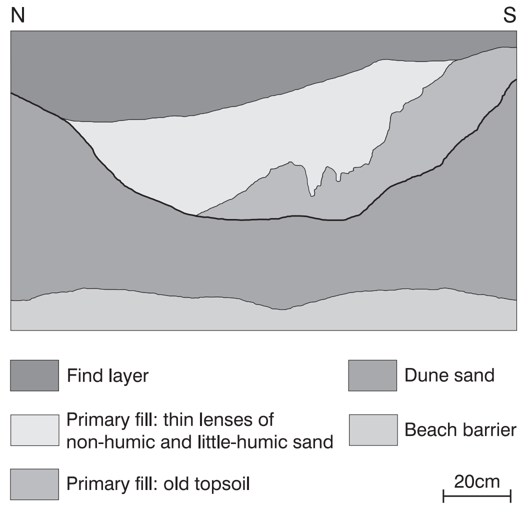

Figure 8. Schematic representation of an unlined well (UU119).

In the dune stratigraphy exposed in the section the soil horizon was obscured by the black discolouration; it was attested only in the fills of this second group of features and beneath the layer of peat. All these features contained lumps of this soil, which means that the pits must all have been dug some time after the formation of the dune. This is further supported by the ^{14}C dates for the formation of the dune and the occupation, which show a clear hiatus of several hundred years.

The combination of very few finds and a fill of slightly humic and non-humic sand implies that the pits became filled with sand shortly after they had been dug. This rapid infilling makes it likely that the features represent unlined pits that were dug down to beneath the groundwater level; such pits will have had unstable walls, which will have caved into the pits within a short time. That would explain the presence of the sand lenses and the lumps of sand showing traces of soil development. In section 2 it was already observed that the pits probably extended to beneath the groundwater level.

We may assume that these pits were dug for the purpose of obtaining water. An argument favouring this interpretation is the absence of intersections, which would have made the walls of the unlined wells even less stable, causing them to cave in almost immediately. After the unlined wells had filled up, depressions remained in the surface of the dune. These depressions indicated the positions of earlier wells and could be avoided when digging new wells. Concentrations of charcoal were found in two of these depressions (SS102 and UU115; see fig. 5).

The distribution of the unlined wells is shown in figure 5. The majority of the wells were situated near the peripheries of the settlement area as inferred from the distribution of the finds. Nine of the fourteen wells were concentrated in a small area to the east of the top of the dune. This area yielded fewer finds than would have been expected on the basis of the altitude of the dune surface; compare figures 18, 26, 29 and 33. It may well be that the occupants deliberately kept this area free of refuse to avoid polluting their drinking water.

The largest and deepest unlined well lay on top of the dune, near the house plan. If the prevention of pollution was indeed a consideration, it is unlikely that this well was in use at the same time as the house, for the large number of finds discovered in and around the well implies that the water would then have been polluted. It is equally unlikely that the well was dug at a later date, because the period of occupation is believed to have ended with the abandonment of the last house discussed above. This is further evidence suggesting that the site was already occupied before the latter house was constructed.

3.3. Watering places

Three features observed in the peat-covered northern slope of the dune differed from the above group of features in terms of their sizes (lengths of 160, 160 and 335 cm), their depths (64, 51 and 90 cm, respectively), their peaty fills and their shapes (length-depth ratios), see fig. 9. The position of the features, in the wettest (= deepest) part of the excavated area, suggest that the features represent watering places. The large amounts of bone found in the features' fills indicate that the watering places were later used for a different purpose, probably for the dumping of refuse. The two easternmost features yielded the remains of dung beetles, which are generally assumed to constitute sound evidence for the former presence of animal dung.

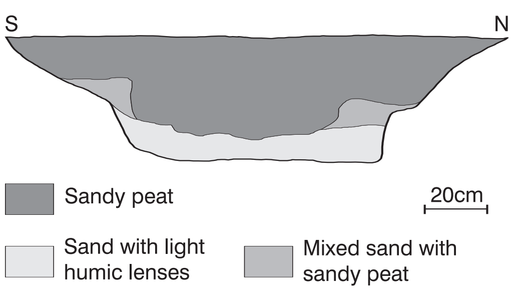

Figure 9. Schematic representation of a watering place (XX77).

3.4. Pits

The second largest group of features comprised the features of nineteen pits with diameters between 39 and 97 cm (average 61 cm), depths between 31 and 67 cm (average 42 cm) and uniform fills of grey, slightly humic sand. Like all the other features, these pits yielded few finds. The pits were all situated near the top of the dune, in contrast with the unlined wells. The pits' function is unknown.

3.5. The hearth

Some seven metres from the western side of the house plan the excavators found a circular feature with a diameter of 150 cm and a depth (reconstructed) of 56 cm. The feature's flat bottom was covered with a 5-cm-thick layer of large fragments of charcoal, followed by a 10-cm-thick layer of dune sand (see fig. 10). This feature was interpreted as a hearth. The sand may have been used to extinguish the fire after use. This is the only true feature of a hearth found at the site. In addition, layers of charcoal were found in two of the depressions that remained after the collapse of the unlined wells.

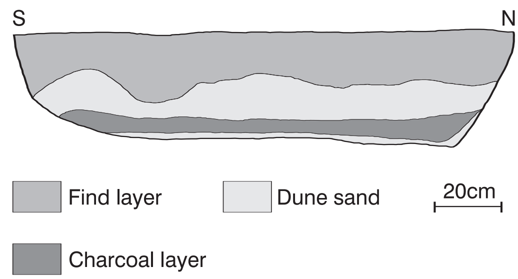

Figure 10. Schematic representation of the hearth (L82).

3.6. Conclusions

The analysis of the features' shapes, sizes, fills and spatial distributions showed that they represent postholes, unlined wells, watering places, pits and a hearth. The features' distributions reflect a spatial differentiation of activities: the majority of the postholes, the pits and the hearth were concentrated on top of the dune, whereas the wells and the watering places were situated mostly on the slopes.

The length of the period of occupation is probably best estimated on the basis of the evidence provided by the features. All the wells were found to contain lumps of sand mixed with soil. This means that the first occupants must have arrived a few hundred years after the formation of the dune. The assumption that earlier structures stood on the dune before that represented by the reconstructed house plan implies that the site was occupied for at least two house generations. At least one of the wells is datable to this earlier occupation phase.

4. Former vegetation and food plants C.C. Bakels

4.1. Methods

It was decided to recover the botanical remains from the find layer by means of interval sampling. Initially, 5-litre samples of black soil were taken from every other square along four lines running parallel to the long sides of the main excavation trench, at intervals of eight, and in one case six, metres (*cf.* figs 11-16). Unfortunately, the southeastern tip of the excavation area was not sampled. Whenever features came to light beneath the black layer, they were sampled too. The samples were taken from lumps of the old land surface incorporated in the features, from the primary and secondary fills of various features, from some of the postholes and from the hearth.

However, after some time we found that we had collected such vast quantities of soil that it would be impossible to analyse all of the samples. As the soil contained both carbonized and uncarbonized plant remains, large-scale flotation was out of the question. All the samples had to be hand-sieved and hand-sorted. The finest mesh used was 0.5 mm. To limit the amount of work, the investigation was therefore largely restricted to squares lying five metres apart and the sample size was reduced to three litres.

It was decided also to perform some pollen research. For the latter purpose a section in one of the trenches was sampled (see fig. 5). The section showed a peaty sediment with a thickness of about 10 cm, the lateral continuation of the black layer mentioned above (Unit 3). The peat lay on top of the sandy subsoil and was covered by clay. Archaeological finds showed that the layer dated from the period of human occupation. The sample was taken from a point lying 50 m from the centre of human activity: the top of the low dune. Two pollen spectra were counted, one from the bottom and one from the top of the peat.

4.2. Reconstruction of the former vegetation

Some results of the identification and counting of the seeds preserved in the soil samples are presented in table 1. They are representative of all the analysed samples. The taxa have been arranged according to the environments in which they most probably grew. The first two rows indicate how they were preserved. Most of the uncarbonized remains were of species with decay-resistant seeds. The original number of plant taxa will hence have been greater. Nevertheless, the encountered plants probably represent the former vegetation fairly accurately.

As carbonized remains have in one way or another been handled by human beings, it is always best to reconstruct former vegetations from the evidence provided by waterlogged remains. Of course, there is always the possibility that some waterlogged remains selected for analysis have been dislocated by human beings, but this is assumed to be of only minor influence on the results, especially in the case of herbs. As will be pointed out below, it is very unlikely that the remains from the Wateringen site had been dislocated by other agents, such as water.

The best sources for the reconstruction of the environment are the samples from the squares. They represent a vegetation *in situ*.

The first question that had to be answered was whether this vegetation corresponds to the vegetation during the period of human occupation. This was investigated by comparing the evidence from the squares with information obtained from the lumps of old land surface found at the bottom of some of the unlined wells. Those lumps were found to contain remains of the same species as also encountered in the samples from the squares. The composition of the primary and secondary fills of the pits showed that the vegetation underwent very few, if any, changes during and after the period of occupation. The seed bank may theoretically have contributed components of an older, different, vegetation (Cappers 1995), but no clear indications of this were found in the analysis of the counts. Therefore the evidence provided by the uncarbonized remains from the squares was used to reconstruct the former environment.

The groups of plants presented in table 1 were combined with the dune's former relief, three excepted. The remains of 'cultivated plants' were all carbonized. The only true waterplant, *Ceratophyllum demersum*, was represented exclusively in samples from the features interpreted as wells; it was not encountered in the samples from the squares. *Potamogeton* sp. also grows in marshes. The samples from the squares moreover contained no remains of plants from trodden ground, such as paths.

The first group of plants which apparently covered a fairly large area is that of riparian plants; see figure 11. The figure is based on the presence/absence of the taxa, because no additional information was obtained in a quantitative analysis of the data. The plant communities in question covered the lower part of the terrain, roughly the part below the −380 cm contour line. This part of the settlement's surroundings was probably wetland. There were no large expanses of open water.

Figure 12 presents the remains of plants classified as species favouring marshy areas. They were encountered in the same areas as the riparian plants, but also higher up the dune, up to the −360 cm contour line. One of the species encountered most frequently is *Eupatorium cannabinum*. As already pointed out above, this does not necessarily mean that this was a dominant species, for it may simply be the

Table 1. The plant species represented at Wateringen 4 and examples of the contents of individual samples. W=waterlogged, C=charred; in individual samples, charred remains are indicated by an *; the other remains are waterlogged finds. +: <10, ++: ≥10 but <150, +++: ≥150.
1-6 are samples from features, 7-9 are samples from squares. 1=UU119, 2=YY120, 3=C88, 4=UU115, 5=YY120, 6=C88, 7=G120, 8=G110, 9=G76.

	W	C	Old surface		Primary fill		Secondary fill		Squares		
			1	2	3	4	5	6	7	8	9
Cultivated Plants											
Hordeum vulgare		x	2*	–	–	3*	7*	4*	–	2*	–
H. vulgare, internodia		x	–	–	–	–	–	9*	–	–	1*
Triticum dicoccum		x	–	–	–	1*	2*	–	–	–	–
Tr. dicoccum, glume bases		x	–	–	3*	1*	1*	8*	–	–	–
Hordeum/Triticum		x	–	–	–	–	–	10*	–	–	–
Open Water											
Ceratophyllum demersum	x	x	–	–	–	1	2*	–	–	–	–
Potamogeton sp.	x		–	–	–	–	–	–	–	–	–
Riparian Vegetations											
Berula erecta		x	–	–	–	–	1*	–	–	–	–
Carex acutiformis	x		1	–	–	–	–	–	–	–	–
Carex riparia	x		–	–	–	–	–	–	–	–	–
Iris pseudacorus	x		–	–	–	–	–	–	–	–	–
Lycopus europaeus	x		+	–	–	–	–	–	2	–	–
Mentha aquatica	x		–	–	–	–	–	–	–	–	–
Scirpus lacustris ssp tab.	x	x	–	–	–	1	–	1*	–	–	–
Scirpus maritimus	x	x	–	–	1	–	–	1*	–	–	–
Marsh											
Brassica nigra	x	x	–	–	–	–	–	–	–	–	–
Eupatorium cannabinum	x	x	–	2	1	–	–	2	15	2	–
Euphorbia palustris	x		–	–	–	–	–	–	–	1	1
Lythrum salicaria	x		–	–	–	–	–	–	–	–	–
Solanum dulcamara	x		+	–	–	–	–	–	–	–	–
Stachys palustris	x		1	–	–	–	–	–	–	–	–
Thalictrum flavum	x		–	–	–	–	–	–	–	–	–
Ruderal Areas, wet											
Alopecurus geniculatus	x		–	–	–	–	–	–	–	–	–
Chenopodium glaucum/rubrum	x		–	–	–	–	–	–	–	–	–
Lychnis flos-cuculi	x		–	–	–	–	–	–	–	–	–
Myosoton aquaticum	x		–	–	–	–	–	–	–	–	–
Polygonum hydropiper	x		+	–	–	–	–	–	–	–	–
Polygonum minus	x	x	++	–	–	–	–	1*	–	–	–
Potentilla reptans	x		–	–	–	–	–	–	–	–	–
Ranunculus sceleratus	x		+	–	+	–	–	–	–	–	–
Ruderals/Weeds, dry											
Arctium sp.	x		–	–	2	–	–	–	–	–	–
Atriplex patula/prostrata	x		+	–	–	–	–	–	–	–	–
Chenopodium album	x	x	–	–	++	+	++	5	1	–	–
Chenopodium ficifolium	x	x	–	–	–	–	+	–	–	–	–
Polygonum convolvulus	x	x	–	–	+	–	–	–	–	–	–
Polygonum lapathifolium	x	x	–	–	++	–	–	1*	–	–	–
Solanum nigrum	x	x	–	–	1	+	–	–	–	–	–
Stellaria media	x		+	–	++	–	–	–	–	–	–
Urtica dioica	x		++	1	+++	+++	–	–	3	–	1

Table 1. (continued).

	W	C	Old surface		Primary fill		Secondary fill		Squares		
			1	2	3	4	5	6	7	8	9
Paths											
Plantago major	x		–	–	–	–	–	–	–	–	–
Polygonum aviculare	x	x	–	–	–	–	–	–	–	–	–
Wooded Areas											
Cornus sanguinea	x		–	–	–	–	–	–	–	–	–
Corylus avellana		x	–	–	–	–	–	–	–	–	–
Galeopsis bifida/tetrahit	x		–	–	1	–	–	–	–	–	–
Glechoma hederacea	x		+	–	–	–	–	–	–	–	1
Lapsana communis	x		1	–	–	–	–	–	–	–	–
Malus sylvestris	x	x	–	–	–	–	–	–	–	–	–
Moehringia trinervia	x		+++	15	2	+	++	7	1	++	24
Prunus spinosa	x	x	8-3*	–	–	–	3*	4*	–	–	–
Rosa sp.		x	–	–	–	–	–	1*	–	–	–
Rubus caesius	x		–	–	–	–	–	–	–	–	–
Sambucus nigra	x		–	1	–	–	–	–	–	–	–
Salt Marsh											
Suaeda maritima	x		–	–	–	–	–	–	–	–	–
Others											
Alnus glutinosa	x	x	–	–	–	1*	–	–	–	–	–
Brassica rapa	x		–	–	++	–	–	–	–	–	–
Bromus sp.		x	–	–	–	–	–	–	–	–	–
Carex sp.	x	x	–	–	–	–	–	2*	1	–	–
Galium aparine		x	–	–	–	2*	1*	4*	–	–	–
Galium cf. mollugo		x	–	–	–	–	–	–	–	–	–
Gramineae		x	–	–	–	–	–	–	–	–	–
Hypericum sp.	x		–	–	1	–	–	–	–	–	–
Juncus sp.	x		–	–	–	–	–	–	–	–	–
Phragmites/Poa sp.		x	–	–	–	1*	–	–	–	–	–
Poa sp.		x	–	–	–	–	–	–	–	–	–
Rumex sp.	x	x	++	–	2	–	–	–	–	–	–
Scrophularia/Verbascum	x		–	–	–	–	–	–	–	–	–
Silene sp.	x		++	2	–	–	–	–	–	–	–
Stellaria sp.	x		–	–	–	+	–	–	–	–	–
Vicia hirsuta		x	–	–	–	–	–	–	–	–	–
Vicia hirsuta/tetrasperma		x	–	–	–	–	–	–	–	–	–

species with the most decay-resistant seeds. In this particular case, however, this plant may indeed have been the dominant species. The tall forb *Eupatorium cannabinum* tends to dominate in comparable surroundings. Although it is commonly described as a plant favouring wet conditions, it also thrives in dry areas, in soils containing decomposing humus, for instance in calcareous dune environments. The same is true of *Solanum dulcamara*. The lower slopes of the Wateringen 4 dune may hence have been less 'marshy' than one would think.

A third category consists of plants which are nowadays found mainly in wet ruderal areas. As can be seen in figure 13, they show the same distribution as the marsh plants. These plants grow in soils with a high nitrogen content, which will have occurred naturally in this young environment.

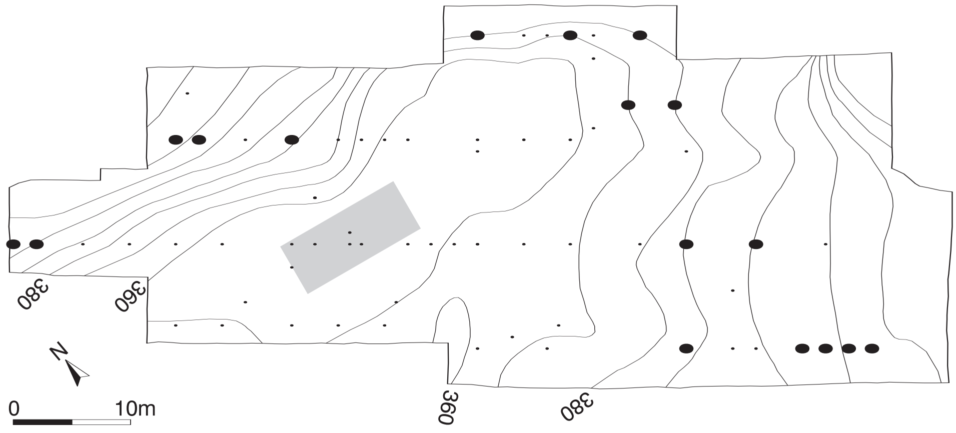

Figure 11. The presence/absence of remains of riparian vegetation in the sampled squares and the primary fills of the features. The large dots indicate the presence, the small dots the absence of remains in the samples. The grey area represents the house plan.

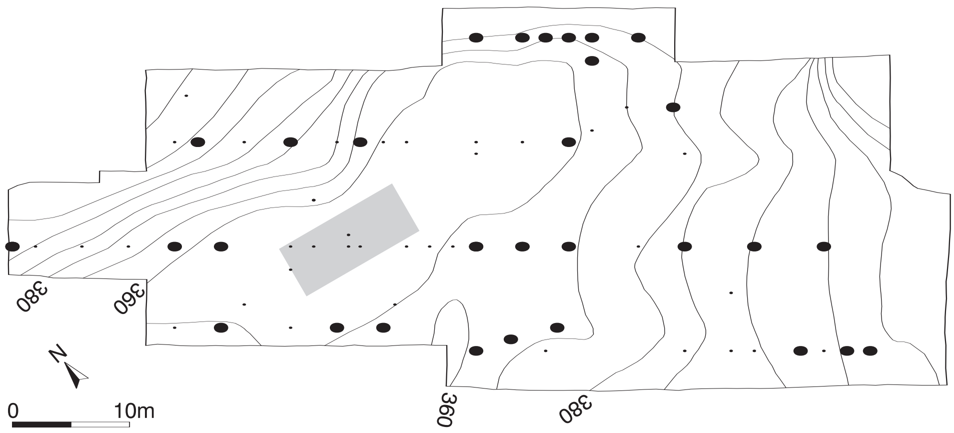

Figure 12. The presence/absence of remains of marsh vegetation. See also fig. 11.

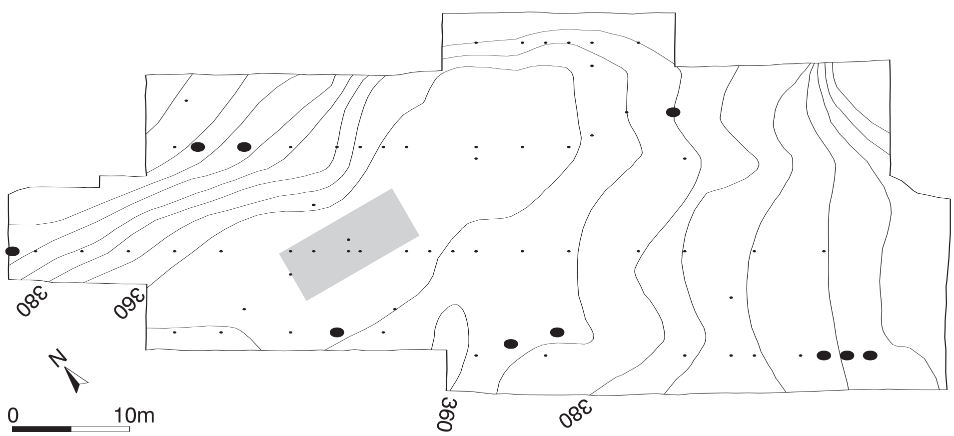

Figure 13. The presence/absence of remains of wetland ruderal vegetation. See also fig. 11.

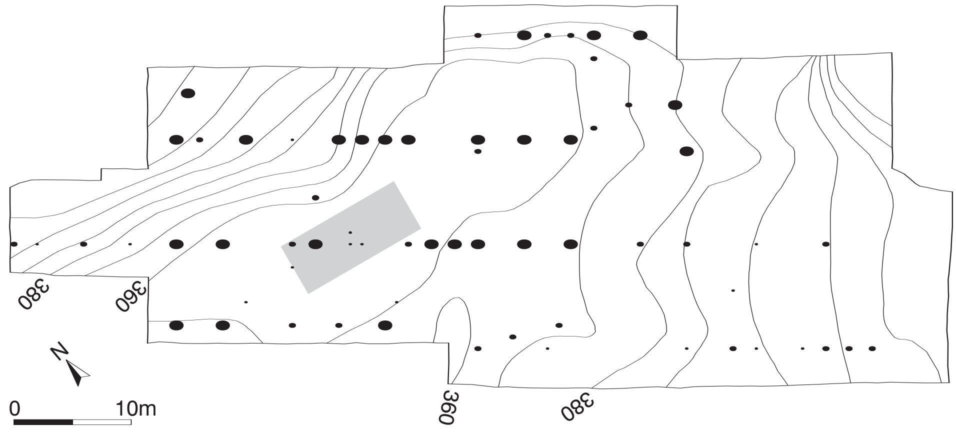

Figure 14. The presence/absence of macro-remains of thickets. The large dots indicate more than 10 remains, the medium-sized dots 1-10 remains, while the small dots indicate the absence of remains. See also fig. 11.

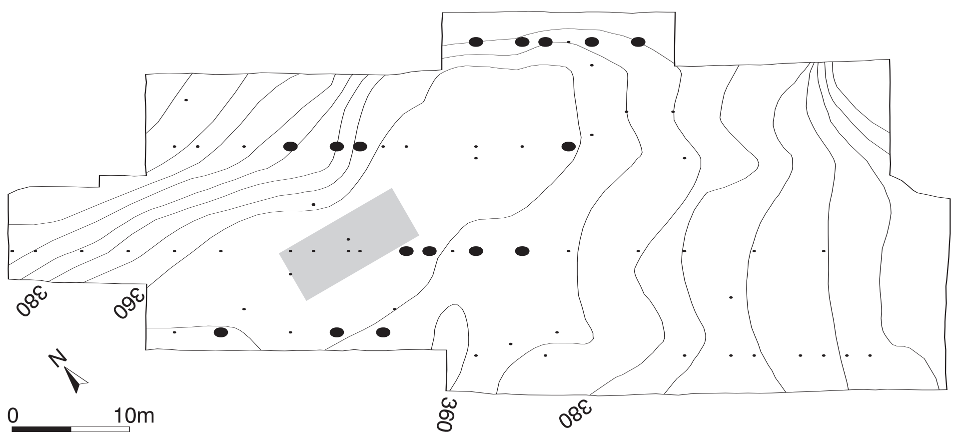

Figure 15. The presence/absence of plants typical of salt marshes. See also fig. 11.

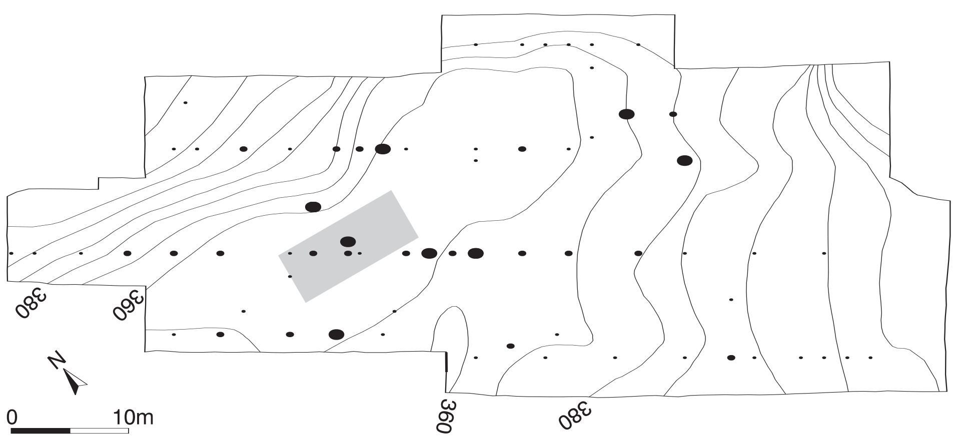

Figure 16. The presence/absence of cereal remains. The large dots indicate more than 1 fragment, the medium-sized dots 1 fragment, while the small dots indicate the absence of remains. See also fig. 11.

The results of the analysis show that the area surrounding the dune is best described as a marsh with a lush vegetation of tall forb species. Although the groundwater reached the surface in the lowest parts, and there must hence have been patches of open water (otherwise plants like *Potamogeton* sp. would not have grown here), there does not seem to have been an actual lake in the immediate surroundings, at least not within the excavated area. The water was fresh, as indicated by species like *Lythrum salicaria*, which do not grow in saline environments, but this may have been a fairly recent condition by the period of occupation. Most of the encountered plants tolerate saline or slightly saline conditions. Theoretically, the remains of these species may actually derive from the seedbank left by an earlier vegetation in a brackish environment, but as they were encountered in such high numbers in proportion to true freshwater species we may assume that the species in question formed part of the contemporary vegetation. All these species can grow perfectly under freshwater conditions. They may have colonized the area during a phase of brackish conditions and have continued to grow there when the environment underwent desalinisation.

Elements associated with wooded areas are presented in figure 14. They comprise the remains of fruits and seeds of woody plants (with the exclusion of alder, *Alnus glutinosa*) and the herbs that may have formed part of the undergrowth. *Alnus* was excluded because its fruits and seeds were encountered only in the primary fill of watering place TT77. They may have been dumped in the pit by human beings. If alders had grown in the immediate surroundings of the site, their seeds would have been found in many more samples. The most common shrubs of which fruit and seed remains had been preserved were elder (*Sambucus nigra*) and sloe (*Prunus spinosa*). Although those fruits may also have been gathered elsewhere, it is very likely that the shrubs formed part of the local vegetation. A shrub vegetation is attested by the plant whose remains were most frequently encountered: *Moehringia trinervia*; its seeds were even the most numerous of all the Wateringen 4 seeds. This herb thrives beneath shrubs in relatively open stands, on sandy soils with high concentrations of decomposed organic matter that are neither too dry nor too wet. The second most common herb encountered on the dune was *Glechoma hederacea*, which favours the same conditions. Neither plant grows in brackish environments.

Some species, in particular *Moehringia*, were encountered in widely varying frequencies; that is the reason why their remains are expressed in classes in figure 14. As can be seen in this figure, the greatest quantities were found in the higher parts of the landscape. From this we may infer that the low dune was originally covered with an open shrub vegetation including elder and thorny elements, which bore a close resemblance to the type of vegetation commonly encountered on young dunes today. A striking difference with respect to present-day dune vegetations is however the absence of sea buckthorn (*Hippophaë rhamnoides*) in the Neolithic vegetation. The absence of remains of the fruits of this shrub could be attributable to preservation conditions, but if sea buckthorn had indeed grown on the dune, its pollen would have been represented in the pollen spectra and, as we will see below, this is not the case.

Another low tree whose fruit and pollen were not represented in the record is juniper (*Juniperus communis*). The fruit and pollen of this species survive only rarely. However, many remains of the worked and unworked wood of juniper trees were found during the excavation. The outer posts of the house, for example, were made of relatively stout juniper trunks (see section 5). Juniper may have grown in well-developed stands on the low dunes. Only few junipers are to be found on the Dutch dunes today, but in the past the species was fairly common. On the island of Texel, for instance, junipers were to be found in relatively dense stands until well into the nineteenth century.

The Neolithic occupants undoubtedly had to clear away some of the thicket before they were able to settle on the dune. The resultant clearance and its use will have stimulated the growth of ruderal herbs, most of which may even have been introduced by the occupants themselves. Only *Urtica dioica* may have been fairly common before their arrival.

The last category consists of plants typical of salt marshes. Only one species of this category was actually represented, namely *Suaeda maritima*. As can be seen in figure 15, the majority of the seeds of this species were found around the house plan. The plant is very much out of place in the reconstructed immediate surroundings: the salt marshes must have lain some unknown distance away from the dune. One explanation for the plant's presence in the site's botanical record could be that clay from the salt marshes was used to daub the walls of the house, although no remains of clay were found during the excavation. Another possibility is that the seeds were introduced by animals and were deposited in their dung; salt marshes are good pastures.

The analysis of the pollen from the peat in the trench contributed little towards the reconstruction of the vegetation. The macroremains found in the section (*Eupatorium cannabinum* and *Lythrum salicaria*) show that the organic deposit formed in the environment described above. The presence of some remains of foraminiferae in the lowest spectrum testifies to occasional flooding by salt or brackish water in the early phases of the deposit's formation. There were many more remains of these organisms in the top spectrum, indicating renewed influence of the sea.

The pollen spectra of the bottom and top samples are very similar. Pine (*Pinus*), presumably a long-distance element, is the dominant tree, which confirms that the landscape was indeed open. Oak (*Quercus*) is the most common sub-regional pollen type, followed by alder (*Alnus*). The other tree species represented are lime (*Tilia*), ash (*Fraxinus*), birch (*Betula*) and hazel (*Corylus*), but as they were all represented in percentages of less than 5% they cannot have grown in the immediate surroundings.

The herb spectra are dominated by Compositae tubuliflorae, as would be expected with *Eupatorium* being a prominent local herb. Gramineae (*Phragmites*?) and Cyperaceae (*Scirpus*?) are also well represented. The top spectrum shows higher frequencies of Chenopodiaceae and Compositae liguliflorae (*Aster tripolium*?), which may be attributable to the growing influence of the sea. The spores of Monoletae psilatae may have come from ferns that grew in the local marsh. The other species, which were represented in percentages of at most 1%, are *Artemisia*, *Polypodium*, *Euphorbia palustris*, *Filipendula*, *Polygonum persicaria*-type, *Urtica*, *Sparganium erectum*-type and *Calystegia/Sepium*. With the exception of the first two, they all formed part of the local marsh flora.

As already mentioned above, a conspicuous feature of the Neolithic record is the absence of *Hippophaë* pollen. Also remarkable is that the spectra show no dominance of alder (*Alnus*). This implies that no stands of alder were to be found nearby, which is rather surprising because, besides juniper wood, alder wood is the most common type of wood found on the site (see section 5). The inhabitants must hence have transported the wood over some distance. The same holds for the other resources that were gathered in woods. But the exact extent of the distance covered is unknown.

4.3. Cultivated and gathered plants

The remains of cultivated plants are restricted to naked barley (*Hordeum vulgare* var. *nudum*) and emmer wheat (*Triticum dicoccum*), of which both the kernels and the chaff were found. These remains, which were all carbonized, were encountered not only in the fills of various features, but also in the samples from the squares. As can be seen in table 1, these species were not represented in large quantities anywhere on the site, but the samples that were found to contain more than one fragment almost all came from the immediate surroundings of the house and the wells (fig. 16). It should be borne in mind that this charred material is very light and is easily blown about by wind. This explains why fragments of cultivated plants were found even in the marsh.

The evidence from Wateringen 4 confirms that emmer and naked barley were the main cereals grown in the Middle Neolithic. The same species were also found at the contemporary Dutch sites Hazendonk 3 and P14 (Bakels 1981; Gehasse 1995). The question is whether these cereals were grown locally. The local conditions certainly allowed their cultivation. The reconstructed local vegetation is indicative of rather rich and sufficiently moist sandy soils, which are very suitable for the cultivation of cereals. The only problem may have been the wind.

The weed flora associated with the cereals may be represented in the 'ruderals/weeds' category. A striking aspect of this category is the high percentage of carbonized remains. The plants may have become charred together with the grain. The weeds in the list starting with *Chenopodium album* and ending with *Solanum nigrum* are all common Neolithic weeds. Some of the plants listed under 'others', like *Galium aparine*, *Vicia hirsuta* and *Vicia hirsuta/tetrasperma*, were also quite common in the Neolithic. Today, most of these weeds are associated with summer crops, except *Vicia*, which is associated with winter crops. But we should be careful in drawing any conclusions from this as we do not know whether we may apply present-day conditions to Neolithic environments.

Another problem involves turnip (*Brassica rapa)*. We do not know for sure whether it was a wild plant or a crop plant (Brinkkemper 1991).

The occupants of the Wateringen site may have supplemented their diet with wild fruits, nuts and seeds gathered in the surroundings. As at other prehistoric sites, remains of hazelnuts (*Corylus avellana*), apples (*Malus sylvestris*), sloe plums (*Prunus spinosa*), rosehips (*Rosa* sp.), dogwood (*Cornus sanguinea*) and, less frequently, dew blackberries (*Rubus caesius*) were common finds (Bakels 1991). As already mentioned above, some of the fruits and nuts, such as the hazelnuts and the apple, cannot have been gathered in the immediate surroundings. But they are products that can be stored, hazelnuts as such and apples in dried condition.

Non-food plants were also gathered. The relatively high proportion of charred rush (*Scirpus* sp.) remains points to human use. The same holds for the reed (*Phragmites australis*) remains. The seeds of the latter plant were difficult to identify, but the carbonized stems were frequently encountered. The plants may have been used for basketry and thatching. Any remaining or decayed parts may have been put onto fires.

The spatial distributions of the carbonized and uncarbonized remains of the plants that were used by the occupants do not reveal any special activity areas. The assemblages from the primary and secondary fills of the pits and wells were the same as those from the adjacent squares, except for the fact that their densities were higher, perhaps because plant remains accumulated there, either by chance or because the occupants used the pits and wells for dumping the remains in question. There is only negative evidence

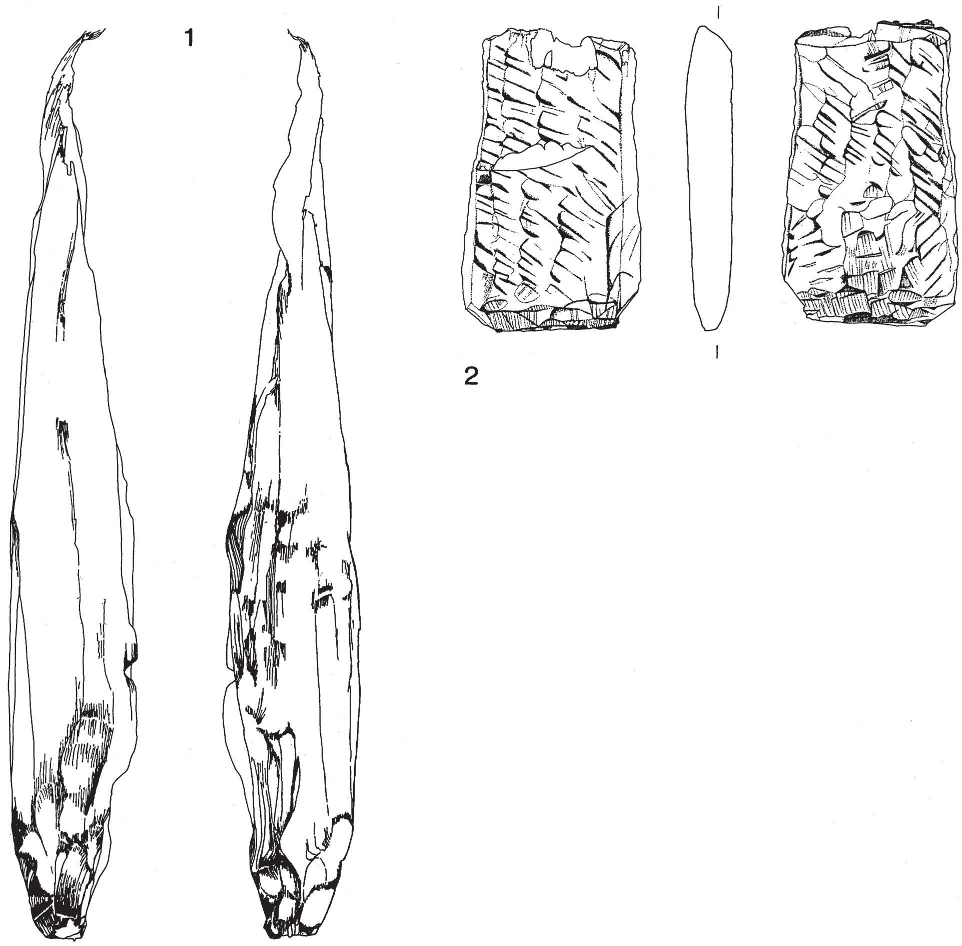

Figure 17. Two wooden artefacts from Wateringen 4. One of the ends of the post (1, from feature D91) had been sharpened to a point. The top part had been affected by oxidation. The wooden plank (2: from feature TT76) had been carefully finished; its use is unknown. Scale: 1:3.

suggesting that one of the features may be associated with a special activity. The hearth found outside the house contained no seeds whatsoever, only a large amount of charcoal. If this had been a normal domestic hearth, intended for the preparation of food, it would have yielded some charred seeds – that is at least usually the case with domestic hearths. The absence of charred seeds may indicate that this hearth had a different function.

5. Wood

K. Hänninen and C. Vermeeren

All the waterlogged wood encountered during the excavation was sampled. Charred wood was found in the samples collected for seed analysis and in the feature interpreted as a hearth. The wood was analyzed to obtain information about the vegetation in the vicinity of the site and about the occupants' use of wood. The wood was divided into four categories: waterlogged/unworked, waterlogged/pointed, waterlogged/worked and charred wood. The first category provided information about the vegetation, the other three shed light on aspects of human behaviour. All the worked wood was identified. The other categories were investigated by taking samples. The results are shown in table 2.

A large number of species were found. This, and the equal distribution of the different species over the four categories, suggests that the trees grew in areas not too far removed from the site. Most will have grown in small woods of trees and shrubs on dry dunes. The alder, willow and buckthorn will have grown on moister soils. Juniper is a special case. It will germinate only in open terrain, and only in areas shielded from blowing sand. Its stands were most probably to be found on the western beach barrier. The fact that the unworked remains of wood consisted mainly of juniper and alder suggests that these two tree species were the most readily available.

Different types of wood were selected for different uses. The outer posts of the house were made from juniper, probably because juniper is a strong type of wood. The

Table 2. Wood species represented at Wateringen 4.

	Unworked		Pointed		Worked		Charred		
Maple	4	8.0	–	–	4	33.3	–	–	Acer spec.
Alder	20	40.0	7	46.7	2	16.7	7	10.8	Alnus spec.
Alder?	–	–	–	–	–	–	3	4.6	cf. Alnus spec.
Dogwood	1	2.0	–	–	–	–	1	1.5	Cornus spec.
Hazel	1	2.0	–	–	–	–	–	–	Corylus avellana
Ash	–	–	–	–	2	16.7	1	1.5	Fraxinus excelsior
Juniper	15	30.0	7	46.7	2	16.7	6	9.2	Juniperus communis
Juniper?	–	–	–	–	–	–	2	3.1	cf. Juniperus communis
Apple/pear/hawthorn	1	2.0	–	–	–	–	29	44.6	Pomoidea
Sweet cherry	–	–	–	–	–	–	2	3.1	Prunus avium
Birdcherry?	4	8.0	–	–	–	–	–	–	Prunus cf. padus
Sloe?	1	2.0	–	–	–	–	4	6.1	Prunus cf.spinosa
Sloe/birdcherry	–	–	–	–	–	–	1	1.5	Prunus padus/spinosa
Prune	–	–	–	–	–	–	1	1.5	Prunus spec.
Prune/birdcherry	–	–	–	–	–	–	1	1.5	Prunus/Sorbus
Oak	3	6.0	1	6.6	–	–	2	3.1	Quercus spec.
Buckthorn	–	–	–	–	–	–	2	3.1	Rhamnus catharticus
Willow	–	–	–	–	2	16.7	–	–	Salix spec.
Total	50	100.0	15	99.9	12	100.1	65	100.2	
Indet.	14						4		

Table 3. Mammal species represented at Wateringen 4. 3a-3d refer to the sub-units of Unit 3.

	Total	%	3a	%	3b	%	3c	%	3d	%	Features	%	
Cattle	284	43.2	20	30.3	34	58.6	4	28.6	2	50.0	15	52.6	Bos taurus
Red deer	155	23.6	33	50.0	8	12.1	1	7.1	–	–	4	21.0	Cervus elaphus
Pig (w/d)	153	23.3	11	16.7	16	24.2	3	21.4	1	25.0	5	26.3	Sus scrofa/dom.
Dog	40	6.1	1	1.5	–	–	5	35.7	1	25.0	–	–	Canis familiaris
Beaver	10	1.5	–	–	–	–	–	–	–	–	–	–	Castor fiber
Otter	7	1.1	–	–	–	–	–	–	–	–	–	–	Lutra lutra
Wild cat	3	0.4	1	1.5	–	–	–	–	–	–	–	–	Felis silvestris
Mole	2	0.3	–	–	–	–	–	–	–	–	–	–	Talpa europaea
Water vole	1	0.1	–	–	–	–	–	–	–	–	–	–	Arvicola terrestris
Grey Seal	1	0.1	–	–	–	–	1	7.1	–	–	–	–	Halicoerus grypus
Carnivore	1	0.1	–	–	–	–	–	–	–	–	–	–	
Totals	657	99.8	66	100.0	58	99.9	14	99.9	4	100.0	19	99.9	
LM	110		5		5		1		3		1		
MM	11		3		–		1		–		1		
SM	5		–		–		–		–		–		
Indet.	2277		189		149		14		20		2		

trunks were remarkably thick. Alder was used for the inner posts (fig. 7). Alder wood is softer, but it was readily available in the vicinity of the site and as alders are tall trees, their trunks could be used to make long posts.

Remains of worked wood were found in five features. They seemed to consist mainly of waste. Much use had been made of maple wood, which is strong and easy to work. Maple wood had been used to make a remarkable artefact (fig. 17: 2) whose function is unknown. Other artefacts were made of alder, willow, ash and juniper. The pieces of worked wood were in very poor condition; no cutmarks were visible on them.

The charred wood derived from gathered fire-wood, discarded wooden objects and waste formed in wood working. Pomoidea, alder, juniper, prune, dogwood, ash, oak

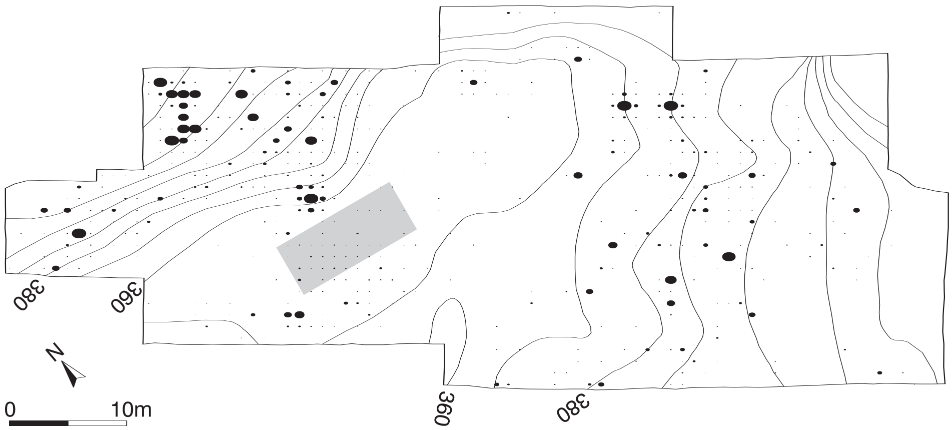

Figure 18. The spatial distribution of the bone remains. The largest dots represent at least 250 g per square.

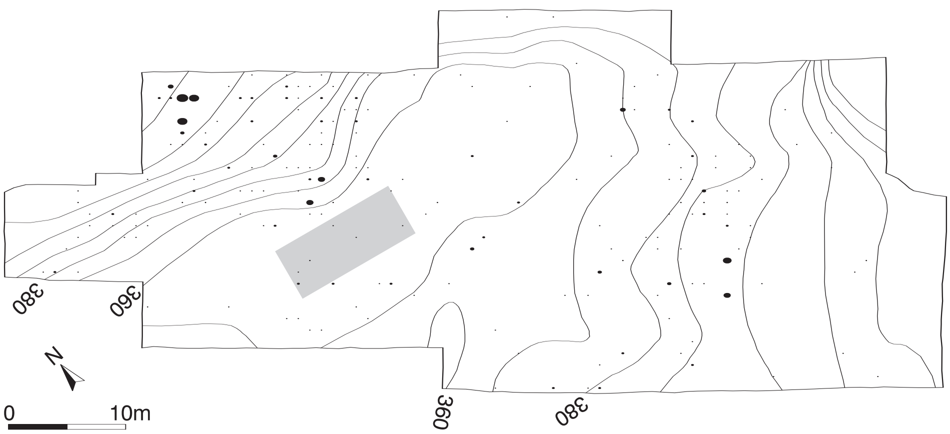

Figure 19. The spatial distribution of the bones of *Bos taurus*. The largest dots represent 8 bone fragments per square.

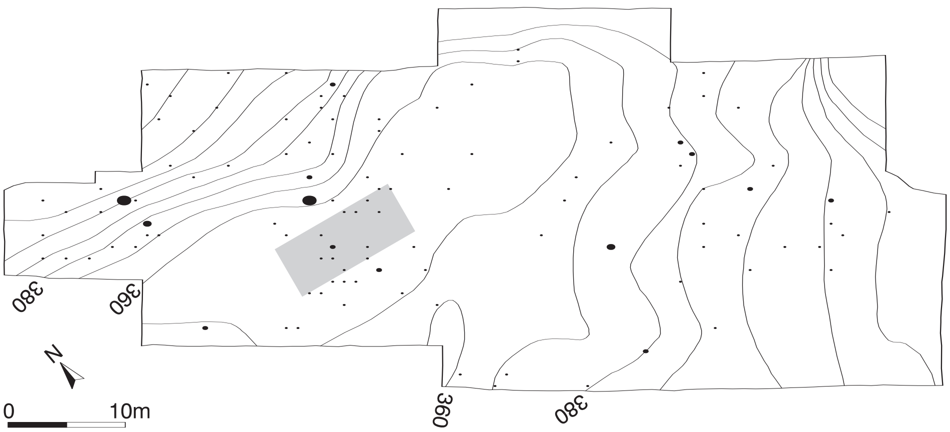

Figure 20. The spatial distribution of the bones of *Cervus elaphus*. The largest dots represent at least 5 bone fragments per square.

and buckthorn were identified. The charred wood from the hearth consisted exclusively of Pomoidea, wood that burns extremely well.

6. Mammal bones — D. Paalman

Table 3 presents a survey of the mammal bones. Cattle is the most frequently identified species, followed by pig (wild or domesticated) and red deer. Some bones could not be identified to species level. They were subdivided into *Large Mammals* (cattle or red deer), *Medium-Sized Mammals* (pig, dog or juvenile large mammals) and *Small Mammals* (beaver, otter, wild cat or juvenile medium-sized mammals) on the basis of their size.

The bones from the upper and lower part of the peat on the slopes of the dune were studied separately as it was hoped that any distinctive differences observable between the assemblages from those sub-units would shed more light on the chronology of the occupation. Unfortunately, however, the layers yielded insufficient finds to allow any conclusions.

The spatial distribution of the bones differs from the distributions of the other categories of finds (compare fig. 18 with figs 26, 29 and 33). The bones were found predominantly on the slopes of the dune, whereas the majority of the other finds came to light on top of the dune. This is particularly apparent in the figures showing the numbers of identified bones (figs 19, 20). The difference in the distribution of the bones could be attributable to either human activities or differences in preservation conditions between the top of the dune and the slopes. The facts that bones were also found on top of the dune and that they were of the same quality as those found further down implies that the spatial distribution of the bones is a consequence of human activities. If, as argued in section 3, the centre of the settlement indeed lay on top of the dune, this must mean that animals were either butchered away from the centre of the settlement, on the slopes of the dune, or in the centre of the settlement, after which their bones were taken elsewhere.

There is little evidence from which we may infer whether the site was occupied on a seasonal or a year-round basis. What could be an indication of seasonal occupation is a mandible of a calf of about two months old. If we assume that calves were born around April (Fokkinga 1985), this mandible points to summer habitation. A second indication of occupation in a specific season is provided by the remains of three full-grown antlers and fragments of the skulls of red deer. They suggest that the deer were killed some time between October and February/March (Peltzer 1991, 12). This leaves us with indications of both summer and winter activities at the site.

The proportion of cattle in the faunal spectrum of Wateringen is considerably higher than that found at P14 and Hazendonk 3, the only two contemporary sites in the

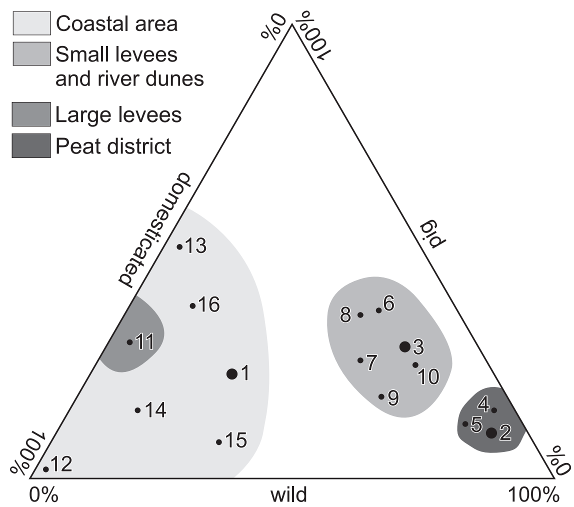

Figure 21. Triangular diagram showing the proportions of bones of wild and domesticated animals and (wild/domesticated) pig from 16 Middle Neolithic sites (see table 4). The bone spectrum of Wateringen 4 bears the closest resemblance to the spectra of the coastal settlements from the Vlaardingen period, where the bones were concentrated in clusters associated with different environmental zones.

Netherlands to have yielded preserved bones, whereas the proportion of wild mammals is much lower (fig. 21, table 4). The bone assemblage of Wateringen bears a closer resemblance to the assemblages of the coastal sites of the Middle Neolithic B Vlaardingen Group than to that of Hazendonk 3. Figure 21, in which the bone spectra of Wateringen 4, Hazendonk 3 and P14 are compared, suggests that the economic diversity characteristic of the Vlaardingen period (contra Verhart 1992: 95) may already have existed in the Hazendonk 3 period.

7. Bird bones — D. Paalman

Of the total of 782 bird bones recovered, 463 could be identified (tab. 5). The high proportion of unidentifiable bones is attributable to gnawing by dogs, which resulted in a large number of bones without distal and proximal ends.

The spectrum is dominated by mallard (*Anas platyrhynchos*). Teal/garganey (*Anas* sp.) and widgeon (*Anas penelope*) are also well represented. Units 3a and 3b yielded relatively few bird bones, but the range of species represented in these layers and the proportions of the individual species are similar to those of the overall spectrum. The represented species are all water birds, which suggests that the birds were killed in an environment abounding in water.

The spatial distribution of the bird bones shows a few distinctive concentrations, which may represent the remains of a small number of fowling expeditions (fig. 22). Of the

Table 4. The mammal bone spectra of 16 sites. Nos 1-3 are of Wateringen 4 and two contemporary sites, the other are of the Vlaardingen Group. These data were used to construct the triangular diagram shown in fig. 21. After Gehasse 1995, table 9.10.

No.	site	'culture'	Wild animals	Pig	Domesticated animals	Literature
1	Wateringen 4	Hazendonk 3	27	23	49	
2	Hazendonk 3	Hazendonk 3	83	10	7	Zeiler 1991, table 4
3	P14, layers ABC	Swifterbant	57	29	14	Gehasse 1995, table 9.3
4	Hazendonk	Vlaardingen 1b	81	15	2	Zeiler 1991, table 5
5	Hazendonk	Vlaardingen 2b	77	12	11	*id*., table 6
6	Vlaardingen	Vlaardingen	48	37	15	Clason 1967, table 1
7	Hekelingen I	Vlaardingen	50	26	24	*id*., table 3
8	Hekelingen III-1	Vlaardingen	45	36	20	Prummel 1987, table 2
9	Hekelingen III-2	Vlaardingen	58	18	24	*id*.
10	Hekelingen III-3	Vlaardingen	61	25	14	*id*.
11	Ewijk	Vlaardingen	4	30	57	Clason 1990, 288-289
12	Zandwerven	Vlaardingen	2	2	96	Clason 1967, table 5
13	Voorschoten-D	Vlaardingen	3	51	46	Deckers 1991, table 1
14	Voorschoten-B	Vlaardingen 1	13	15	72	Groenman-van Waateringe *et al*. 1968, table 1
15	Voorschoten-B	Vlaardingen 2	32	8	60	*id*.
16	Leidschendam	Vlaardingen	12	38	50	*id*., table 2

Table 5. The bird species represented at Wateringen 4.

	Total	%	3a	%	3b	%	
Mallard	240	51.8	1	12.5	2	25.0	Anas platyrhynchos
Duck	120	26.0	3	37.5	3	37.5	Anatidae
Teal/Garganey	52	11.2	3	37.5	–	–	Anas spec.
Widgeon	38	8.2	–	–	–	–	Anas penelope
Eider	6	1.3	1	12.5	1	12.5	Somatria mollissima
Goose	4	0.9	–	–	1	12.5	Anser spec.
Coot	1	0.2	–	–	–	–	Fulica atra
Grey heron	1	0.2	–	–	1	12.5	Ardea cinerea
Plover	1	0.2	–	–	–	–	Chara spec.
Totals	463	100.0	8	100.0	8	100.0	
Indet.	319		2		2		

most frequently encountered species, widgeon was represented only in the concentration found on top of the dune (fig. 23). The majority of the teal/garganey bones, on the contrary, were found in the concentration around YY114. The distribution of mallard bones is very similar to that of all the bird bones collectively. It is tempting to interpret the deviating distribution patterns of widgeon and teal/garganey as the results of fowling expeditions that focused on these specific species. Mallards were presumably killed more often, which would explain why their distribution pattern corresponds to that of all the birds collectively, of which mallard is the dominant component.

Besides from the bones of certain mammal species, information on the season of occupation can also be inferred from the bones of certain bird species. On the basis of present-day evidence it is assumed that widgeon was caught in the winter half of the year. But other water birds that winter in the Netherlands nowadays – such as those represented at Bergschenhoek (Louwe Kooijmans 1985, 77) – are conspicuously absent in the bird spectrum. This is all the more remarkable in view of the relatively high proportion of identified bird bones. All the other bird species besides widgeon were probably available in the summer half of the year (teal), or throughout the year

Table 6. The fish species represented at Wateringen 4.

	Totals		Well 88C		Other		
Sturgeon	2	0.8	–	–	2	8.3	Acipenser sturio L.
Eel	136	54.0	136	59.6	–	–	Anguilla anguilla (L.)
Carp family	16	6.3	15	6.6	1	4.2	Cyprinidae
Bream	2	0.8	1	0.4	1	4.2	Abramis brama (L.)
Pike	7	2.8	6	2.6	1	4.2	Esox lucius L.
Salmon/Sea trout	3	1.2	3	1.3	–	–	Salmo spec.
Perch	4	1.6	4	1.7	–	–	Perca fluviatilis L.
Mullet family	17	6.7	13	5.7	4	16.7	Mugilidae
Thin-lipped mullet	14	5.5	5	2.2	9	37.5	Liza ramada (Risso)
Plaice family	46	18.2	41	18.0	5	20.8	Pleuronectidae
Flounder	5	2.0	4	1.7	1	4.2	Platichthys flesus (L.)
Totals	252	99.9	228	99.8	24	100.1	
Indet.	398		396		2		

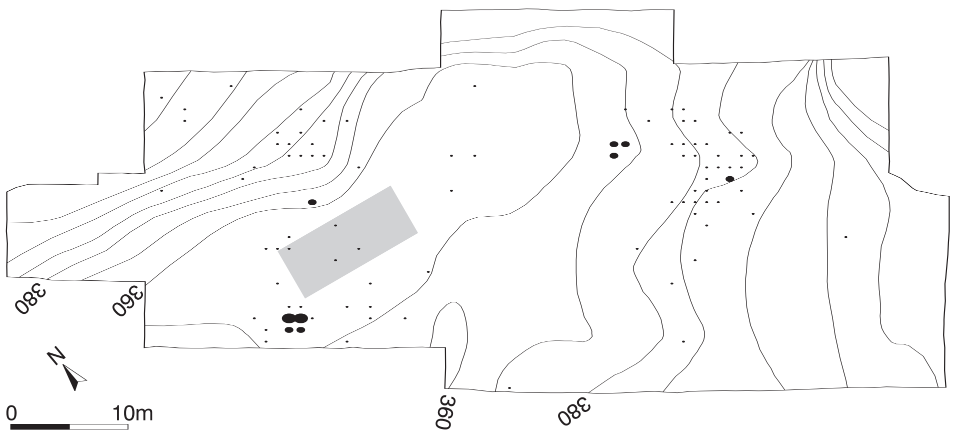

Figure 22. The spatial distribution of the bird bones. The smallest dots represent 1-5 bone fragments per square, the medium-sized dots 6-30 bones and the largest dots 74-93 bird bones per square.

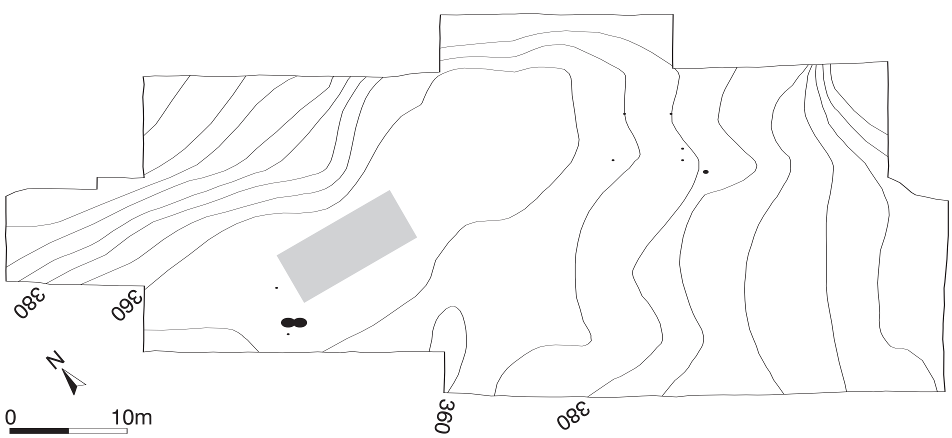

Figure 23. The spatial distribution of the bones of *Anas penelope*. The smallest dots represent 1 bone fragment per square, the medium-sized dots 2 bones and the largest dots 8-14 bird bones per square.

(mallard, eider, garganey). As no distinction was made between teal and garganey in the analysis of the bird bones we cannot conclude from this that the birds were killed only in the summer.

8. Fish bones B. Beerenhout

Owing to the employed excavation techniques, few fish remains were recovered at Wateringen. Only 26 fragments were collected by hand; 396 others were recovered from a sieved sample from well C88. As can be seen in table 6, the remains represent eight species. They include freshwater fish (pike (*Esox lucius* L.) perch (*Perca fluviatilis* L.) and bream (*Abramis brama*)), fish that tolerate fresh water for long periods (eel (*Anguilla anguilla*), mullet (Mugilidae) and flounder (*Platichthus flesus*)) and fish that tolerate salt water for long periods (sturgeon (*Acipenser sturio* L.) and salmon/sea trout (*Salmo spec*.). With the exception of perch, all these species can be found in brackish water, but they spawn either in fresh water (pike, perch, salmon/sea trout, sturgeon, bream) or in salt water (eel, mullet, flounder; Boddeke 1974; Nijssen/De Groot 1987). Generally speaking, all these species tolerate fresh water for varying lengths of time, which suggests that the site was situated in a freshwater environment (see also the section on the former vegetation, 4.2).

As the two fish bone assemblages differ considerably, they will be discussed separately below. 252 of the fragments from well C88 were identified, 38 of which were fragments of distorted vertebrae. According to Jones, the distortion is characteristic of vertebrae that have passed through a metabolic system (1984: 61-65). Six vertebrae moreover showed signs of gnawing or tooth marks. The sharp, pointed tooth marks cannot have been made by human beings or dogs. These remains were all very fragmentary, their surfaces partly eroded. The cranial skeleton was poorly represented in comparison with the rest of the skeleton. A final conspicuous aspect of these remains is that they included thirteen burned fragments, five of which were calcined. This suggests that the bones were not burned during cooking, for all foodstuffs become inedible at the high temperatures required for calcination. It is more likely that the fragments were secondarily burned.

The characteristics described above lead to the conclusion that this assemblage is not the result of human cooking activities, but the contents of the stomach of a fish-eating mammal, probably an otter. About 90% of an otter's diet consists of different kinds of fish; the rest comprises small mammals, birds, shell-fish and insects (Mason/Macdonald 1984, 7-10). When an otter catches a large fish, it takes the fish ashore and eats certain parts of it, in particular the soft parts behind the head and the stomach area; the rest of the fish is often left untouched (Broekhuizen 1985, 97-195). This behaviour would quite plausibly account for the fish remains found in well C88.

Otters exploit not only freshwater areas, but also brackish estuaries and marine environments (Green *et al*. 1984, 140). They favour areas with hiding places, where the water is not deeper than five metres. Otters show a preference for eel, especially in the summer, when eels are active and hence easy to find. In the winter, when they are not active, eels are harder to find (Mason/Macdonald 1984, 7). In estuarine environments, otters also commonly consume flatfish: in June and July they consume eel and flatfish in equal proportions, in August they often consume more flatfish (Herfst 1984, 66). These present-day data confirm the interpretation of this assemblage as the contents of the stomach of an otter.

The dominance of eel (and flatfish) suggests that the otter consumed his last meal in the summer. The fact that the contents of the butchered animal's stomach ended up in the secondary fill of well C88 suggests that this well was secondarily used as a refuse pit. The fish remains provide an indication of the aquatic conditions within a radius of 1.5-5 km from the place where the otter was killed – the size of the territory of a small group of otters (Veen 1975, 21-37). If the otter was killed near the settlement, then we may infer from the remains that the settlement was situated in a freshwater environment with brackish water nearby.

Outside well C88 no more than 26 fragments of fish bones were found. They are to be interpreted as a mixed assemblage spanning the entire period of occupation.
The remains of sturgeon and thin-lipped mullet, two species which were to be found near the site only in the summer season, are indisputable evidence for occupation in the summer (tab. 7). But they do not imply that the site was occupied on a seasonal basis only, as the remains of the other fish species may reflect occupation in the winter.

9. Pottery D.C.M. Raemaekers

9.1. Introduction

In total, the pottery sherds recovered in the excavation weighed 49,867 g. Only a portion of this pottery was analyzed, namely the sherds whose temper was still identifiable and whose surface had survived sufficiently intact for us to be able to determine whether or not the pottery had been decorated: *i.e.* 3063 sherds with a total weight of 40,371 g, 81% of the overall weight of the pottery.

Tables 8 to 11 show various qualitative and quantitative characteristics of the pottery from four different stratigraphic contexts. As no conclusions can be drawn from the 3 and 2 sherds that were recovered from Units 3c and 3d, respectively, those sherds have not been included in these tables. As can be seen in the tables, the average total weight of the pottery from 3b is considerably higher than that of the

Table 7. The probable seasonal presence of fish species in the surroundings of Wateringen 4.

month:	1	2	*	3	4	5	*	6	7	8	*	9	10	11	*	12
sturgeon					-----	-----	-----	-----	-----	-----	-----	-- --	--	--		
eel	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
bream	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
pike	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
salmon/sea trout	--				-----	-----	-----	-- --	-- --	--	--		-- --	-- --		
perch	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
thin-lipped mullet								--	-----	-----	-----	--	--			
flounder	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 8. Quantitative and qualitative characteristics of the Wateringen 4 pottery.

All sherds		Organic temper				Grog				Stone grit				Totals
		0	1	2	3	0	1	2	3	0	1	2	3	
Number		939	961	819	344	1630	727	613	93	367	1064	1081	551	3063
Percentage		*30.6*	*31.4*	*26.7*	*11.2*	*53.2*	*23.7*	*20.0*	*3.0*	*12.0*	*34.7*	*35.3*	*18.0*	
Weight (g)		10,721	13,405	11,578	4,653	20,472	9,973	8,852	1,329	3,794	12,651	15,245	9,081	40,346
Percentage		*26.6*	*33.2*	*28.7*	*11.5*	*50.7*	*24.7*	*21.3*	*3.3*	*8.4*	*31.3*	*37.8*	*22.5*	
Average weight (g)		11.4	13.9	14.1	13.5	12.5	13.7	14.0	14.3	9.2	11.9	14.1	16.5	13.2
Average wall thickness (mm)		8.8	9.2	9.4	9.7	9.2	9.0	9.4	9.7	9.6	9.1	9.1	9.4	9.2
Types of joins:	H-joins	100	146	178	84	214	131	126	8	95	201	120	53	550
	N-joins	29	70	44	13	93	37	23	2	13	58	64	21	157
	Z-joins	10	11	5	2	18	4	4	2	2	11	10	6	29
Surface finish:	Roughened	290	368	317	95	501	260	265	44	99	361	388	222	1070
	Smoothed	282	292	220	93	462	253	149	23	121	347	369	110	887
	Polished	62	13	30	30	78	20	36	1	40	30	54	11	135
	Besenstrich	17	20	17	6	36	11	12	1	3	18	19	20	60
	Smeared	4	8	9	0	12	4	5	0	2	4	10	5	21
	Irregular	165	120	93	49	264	68	82	13	39	138	153	97	427
Wall decoration:	Spatula	51	71	48	14	90	37	51	6	6	59	81	38	184
	Hollow instrument	30	8	6	5	34	4	10	1	4	14	22	9	49
	Single fingertip	129	106	124	33	186	121	71	14	16	126	147	163	392
	Double fingertip	23	15	14	7	36	10	9	4	2	13	30	14	59
Rim decoration:	Fingertip	2	5	1	1	7	2	0	0	0	2	4	3	9
	Spatula	3	0	0	0	2	0	1	0	1	1	1	0	3

pottery from the overlying 3a. This is undoubtedly due to the fact that the pottery contained in 3b became buried beneath a layer of peat relatively quickly, which protected it from the destructive effects of trampling. The 46 sherds that were recovered from the features are on average a little heavier and thicker than the sherds of the assemblage as a whole and they are also tempered with more grog and show less decoration. The relevance of these differences is difficult to asses. An aspect of the overall Wateringen pottery assemblage that should be mentioned here is that it contained no sherds of types not encountered at the other sites of the Hazendonk 3 Group. The fact that a number of sherds recovered from different contexts could be fitted together seems to justify our decision to treat the sherds as a single assemblage.

9.2. Description

First the characteristics of the pottery will be discussed, an the employed variables will be introduced, after which the fragments shown in figures 24 and 25 will be briefly described. Finally, the main features of the pottery will be summarised and the pottery will be compared with that from other Hazendonk 3 sites.

9.2.1. *Temper*

The amount and type of temper used for a pot may have been dictated by considerations relating to, for example, the size or function the pot, its wall thickness or whether or not the pot was to be decorated, or it may have been culturally determined, as perhaps suggested by the chronological

Table 9. Same as table 8, now for the sherds from Unit 3a.

Unit 3a		Organic temper				Grog				Stone grit				Totals
		0	1	2	3	0	1	2	3	0	1	2	3	
Number		8	8	5	1	17	5	–	–	1	5	9	7	22
Percentage		*36.4*	*36.4*	*22.7*	*4.5*	*77.3*	*22.7*	–	–	*4.5*	*22.7*	*40.9*	*31.8*	
Weight (g)		109	122	63	18	250	62	–	–	5	79	92	136	312
Percentage		*34.9*	*39.1*	*20.2*	*5.8*	*80.1*	*19.1*	–	–	*1.6*	*25.3*	*29.5*	*43.6*	
Average weight (g)		13.6	15.2	12.6	18.0	14.7	12.4	–	–	5.0	15.8	10.2	19.4	14.2
Average wall thickness (mm)		9.2	8.5	11.6	11.0	9.7	9.2	–	–	13.0	9.2	10.3	8.4	9.6
Types of joins:	H-joins	1	1	0	0	1	1	–	–	0	2	0	0	2
	N-joins	0	1	1	0	2	0	–	–	0	0	2	0	2
Surface finish:	Roughened	1	1	0	0	2	0	–	–	0	0	0	2	2
	Smoothed	3	3	0	1	5	2	–	–	0	4	2	1	7
	Besenstrich	3	2	1	0	4	2	–	–	1	0	1	4	6
	Irregular	1	0	1	0	2	0	–	–	0	0	2	0	2
Wall decoration:	Spatula	1	0	1	0	2	0	–	–	0	0	2	0	2

Table 10. Same as table 8, now for the sherds from Unit 3b.

Unit 3b		Organic temper				Grog				Stone grit				Totals
		0	1	2	3	0	1	2	3	0	1	2	3	
Number		23	10	2	5	28	8	4	–	3	11	17	9	40
Percentage		*57.5*	*25.0*	*5.0*	*12.5*	*70.0*	*20.0*	*10.0*	–	*7.5*	*27.5*	*42.5*	*22.5*	
Weight (g)		541	219	21	70	494	265	92	–	41	347	263	200	851
Percentage		*63.6*	*25.7*	*2.5*	*8.2*	*58.0*	*31.1*	*10.8*	–	*4.8*	*40.8*	*30.9*	*23.5*	
Average weight (g)		23.5	21.9	10.5	14.0	17.6	33.1	23.0	–	13.7	31.5	15.5	22.2	21.3
Average wall thickness (mm)		9.6	9.6	9.0	12.8	10.3	8.7	10.2	–	13.4	9.9	9.8	9.1	10.0
Types of joins:	H-joins	1	1	0	3	4	1	0	–	3	0	2	0	5
	Z-joins	0	1	0	0	0	0	1	–	0	0	1	0	1
Surface finish:	Roughened	2	0	0	0	2	0	0	–	0	0	0	2	2
	Smoothed	7	6	0	1	9	3	2	–	1	5	5	3	14
	Besenstrich	4	1	2	3	7	2	1	–	1	2	3	4	10
	Irregular	7	3	0	1	8	2	1	–	0	4	7	0	11
Wall decoration:	Spatula	1	1	0	0	0	1	1	–	0	0	2	0	2
	Single fingertip	4	0	0	0	2	2	0	–	0	2	1	1	4

variations observable in some Middle Neolithic pottery (Louwe Kooijmans 1976, 255-280). The determination of the amount and type of temper is therefore an important aspect of pottery analysis.

A set of reference sherds was used to determine the amounts of temper in the sherds. Six sherds containing different amounts of stone grit, grog and organic temper determined the limits of three ranges representing small, average and large quantities of temper. The average particle size of the stone grit and grog was estimated in mm; the average particle size of the organic temper was not estimated, as that would have been too difficult in most cases. The grit encountered in most of the sherds was crushed quartz; a few sherds contained crushed granitic rock.

In order to be able to study the relation between the types and amounts of temper on the one hand and the other characteristics of the pottery on the other, the sherds were subdivided on the basis of the type of temper contained in them. The results are presented in tables 8 to 11. These tables were used as a basis for studying differences within the assemblage and between this assemblage and other assemblages.

As can be seen in table 8, the majority of the sherds are tempered with average or large quantities of grit, but much use was also made of organic temper and grog. The average particle size of the grit temper varies from 2.0 mm (small quantity) to 2.7 mm (large quantity); the average particle size of the grog varies from 2.1 mm (small quantity) to 2.9 mm (large quantity).

Table 11. Same as table 8, now for the sherds from the various features.

Features		Organic temper				Grog				Stone grit				Totals
		0	1	2	3	0	1	2	3	0	1	2	3	
Number		4	7	24	11	12	11	21	2	4	24	11	7	46
Percentage		*8.7*	*15.2*	*52.2*	*23.9*	*26.1*	*23.9*	*45.6*	*4.3*	*8.7*	*52.2*	*23.9*	*15.2*	
Weight (g)		38	101	451	194	154	168	433	29	27	417	139	201	784
Percentage		*4.8*	*12.9*	*57.5*	*24.7*	*19.6*	*21.4*	*55.2*	*3.7*	*3.4*	*53.2*	*17.7*	*25.6*	
Average weight (g)		9.5	14.4	18.8	17.6	12.8	15.3	20.6	14.5	6.7	17.4	12.6	28.7	17.0
Average wall thickness (mm)		9.7	10.9	10.2	9.9	9.8	9.8	10.5	10.5	9.7	10.2	9.6	11.1	10.2
Types of joins:	H-joins	2	1	12	4	1	5	13	0	3	12	2	2	19
	N-joins	1	0	0	0	1	0	0	0	0	0	1	0	1
	Z-joins	0	0	2	0	0	0	0	2	0	0	2	0	2
Surface finish:	Roughened	1	1	5	1	3	2	1	2	0	3	4	1	8
	Smoothed	2	1	2	3	3	3	2	0	0	5	3	0	8
	Besenstrich	0	0	2	0	0	0	2	0	0	2	0	0	2
	Smeared	0	1	0	0	1	0	0	0	0	0	0	1	1
	Irregular	1	3	13	7	3	5	16	0	4	14	3	3	24
Wall decoration:	Spatula	1	0	0	1	1	1	0	0	0	1	1	0	2
	Single fingertip	1	1	1	0	2	1	0	0	0	1	2	0	3
	Double fingertip	0	0	2	0	0	0	0	2	0	0	2	0	2

9.2.2. *Number and weight*

Indicated are the numbers of sherds and their total weights. Comparison of the number and weight percentages of the different groups of sherds reveals the relation between the types and amounts of temper on the one hand and the degree of fragmentation on the other.

The average weight of the 3063 analyzed sherds is 13.2 grams. The number percentages and weight percentages of the different groups are similar, which suggests that the fabrics' strength was not influenced by the amount and type of temper used. There is one exception: the average weight of sherds containing large quantities of grit is considerably higher than that of sherds containing less or no grit. This cannot be explained by assuming that a large quantity of grit implies a stronger fabric – on the contrary, large amounts of grit result in poorer cohesion of the fabric, which would imply a higher degree of fragmentation. It is more likely that, in our analysis, we overestimated the amount of grit contained in the larger (and heavier) sherds.

9.2.3. *Wall thickness*

The average wall thickness is 9.2 mm. There seems to be no relation between the wall thickness and the type and amount of temper used.

9.2.4. *Joins*

The relative importance of the different types of joins may be regarded as a technological characteristic with chronological implications, for it has been found that H-joins were gradually replaced by N-joins and Z-joins in the Middle and Late Neolithic (Louwe Kooijmans 1976, 255-286).

736 sherds (24%) showed signs of strip building. H-joins predominated (75%), followed by N-joins (21%), and a small number of Z-joins (4%). Generally speaking, H-joins were observed comparatively frequently in sherds containing large quantities of organic temper; they were observed comparatively rarely in sherds containing large quantities of grit temper. There seems to be no relation between the amount of grog used and the type of join.

9.2.5. *Rim decoration*

Rim decoration was very rare: only 12 of the 723 rim sherds were found to be decorated (2%). The decoration, consisting of fingertip impressions (75%) and spatula impressions (25%), was always on the outside of the pot.

9.2.6. *Wall decoration*

The technique used to decorate the walls could be identified in the case of all the decorated sherds, in contrast to the positions and patterns of the decorations, which could be identified only on the large fragments. Two types of decorative techniques were distinguished. The first entailed making double or single impressions in the soft clay with the fingernails or fingertips. As there was not always a clear-cut distinction between fingernail and fingertip impressions, only double and single impressions have been distinguished in the tables. Whether the impressions were made with the fingernails or fingertips is specified in the descriptions of the depicted fragments where possible.

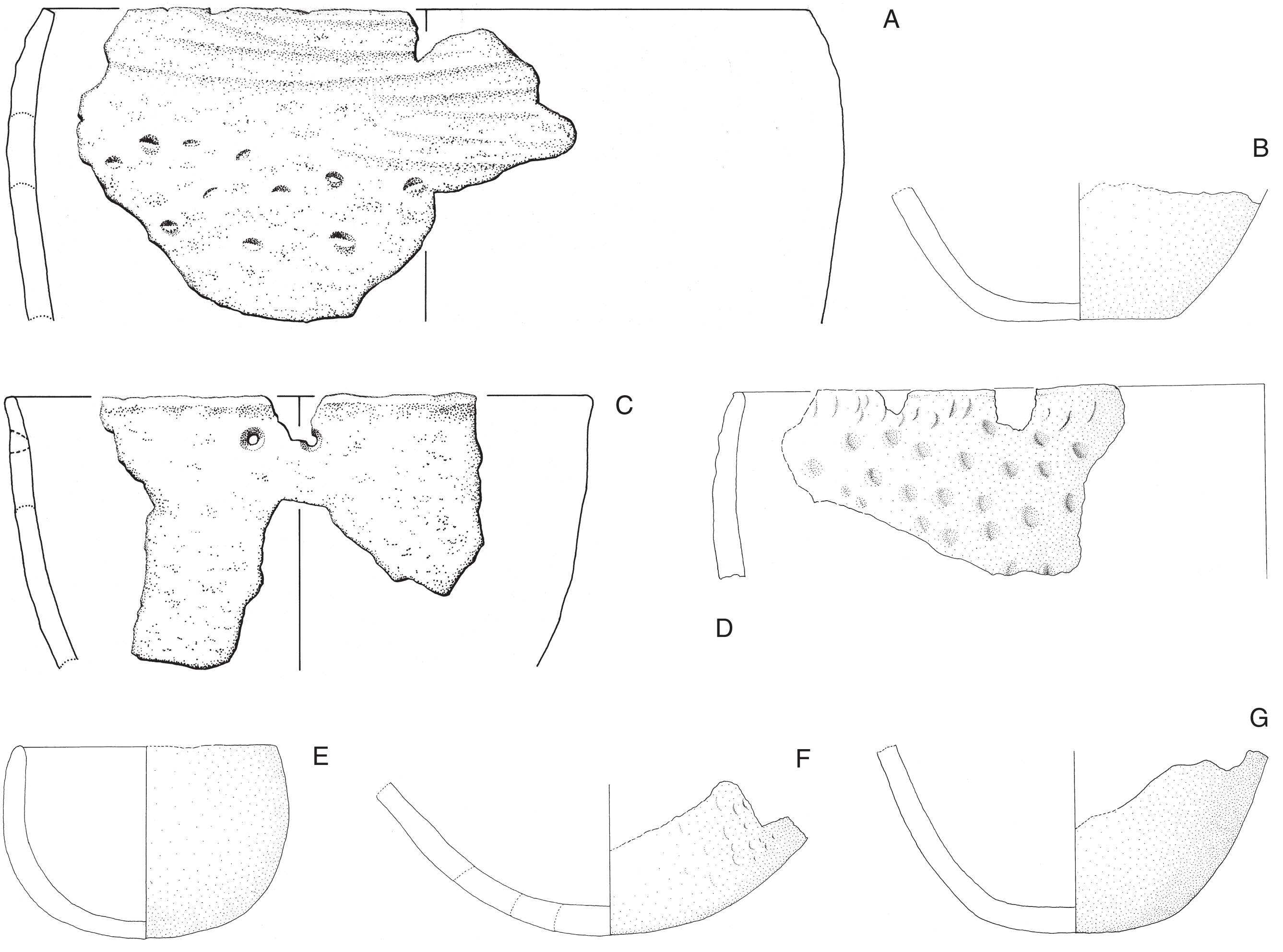

Figure 24. Large pottery fragments from Wateringen 4. Letters A-G refer to the text. Scale 1:3.

The second type of decorative technique entailed making impressions with the aid of an instrument: either a small hollow object, like the bone of a bird or part of a reed stem, or a blunt spatula (simply referred to as a spatula below). The term 'pin pricks' has in the past been used to describe such impressions made with the aid of a small spatula (Louwe Kooijmans 1976, 257).

About 22% of the sherds are decorated. If we consider only the large sherds, this figure increases to approx. 36-42% (fig. 26). The percentage of decorated sherds may be regarded as an indication of the percentage of decorated pots. The most common form of decoration (66%) consists of single (57%) and double (9%) fingertip/fingernail impressions. Impressions made with the aid of an instrument (34%) are of two different kinds: one kind was made with the aid of a spatula (26%), the other with the aid of a hollow instrument (7%). There seems to be no relation between the amount and type of temper used and the type of wall decoration.

9.2.7. *Surface treatment*

The surface treatment of 2600 sherds was identified (85%). Various finishing treatments were distinguished: roughening (41%), smoothing (34%), polishing (5%), *Besenstrich* (2%) and smearing (1%). The rest of the identified sherds (16%) have irregular surfaces.

In the category of pottery with a high grit or grog content the percentage of sherds with a roughened surface is much higher than that of sherds with a smoothed surface.
The pottery with a high grit content also includes a high

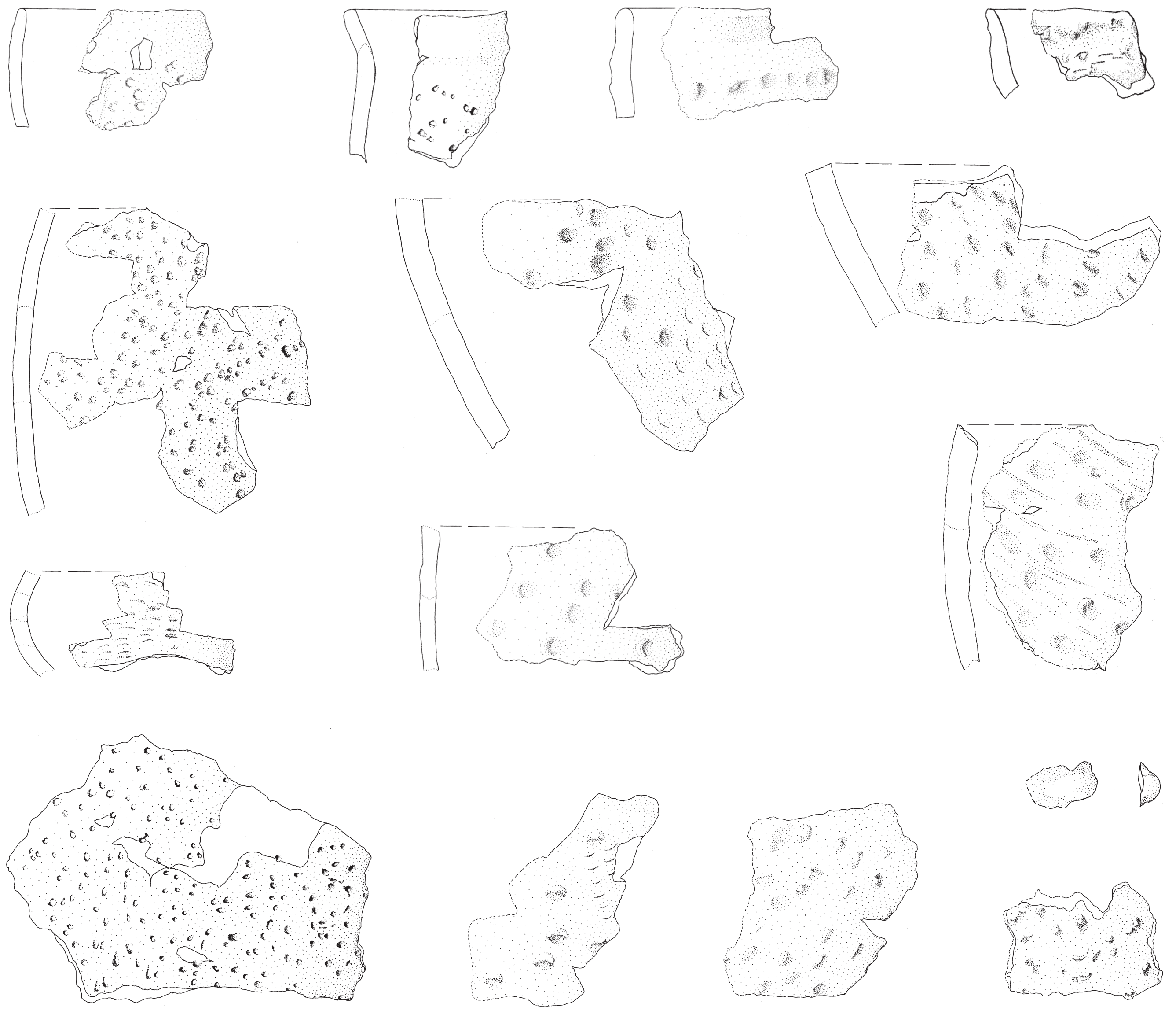

Figure 25. Pottery from Wateringen 4. Scale 1:3.

percentage of sherds with an irregular surface. No relation was observed between the amount of organic temper and the surface treatment.

The depicted pottery fragments (fig. 24):

A. Fragment of a barrel-shaped pot with a rim diameter of 32 cm. The clay was mixed with three types of temper, all of which were used in small quantities: grit (particle size 2 mm), grog (3 mm) and organic temper. The pot was built from strips joined via H-joins and had an irregular surface. The wall decoration consists of single fingertip impressions that covered the entire surface of the pot with the exception of the rim. A band with a width of 6 cm around the top of the pot was decorated with a series of horizontal shallow grooves drawn with the fingertips.
B. Fragment of a flat-based pot tempered with an average quantity of grit (particle size 3 mm) and a small

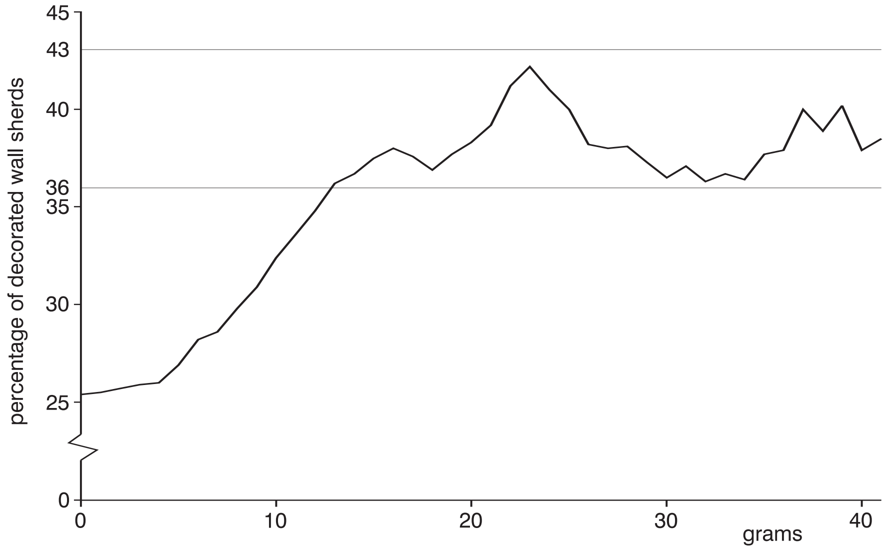

Figure 26. The percentage of decorated wall sherds in relation to the sherds' minimum weight in grams. When only the largest sherds are considered, the percentage of decorated wall sherds is about 36-43%.

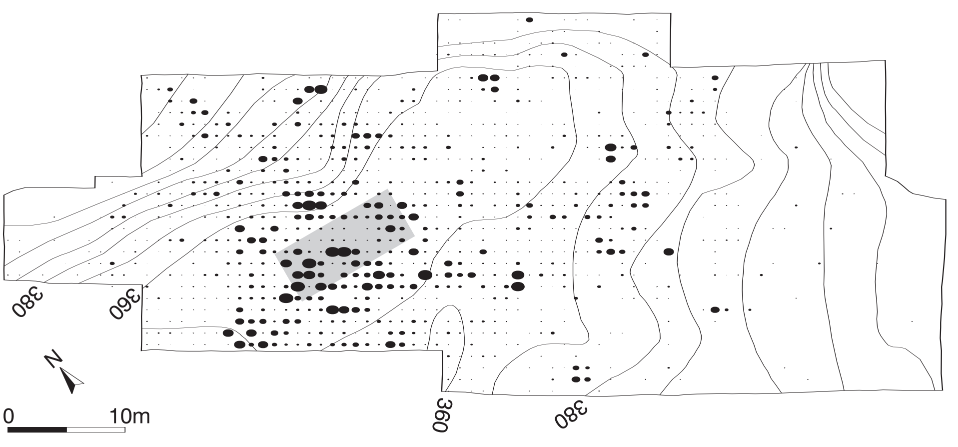

Figure 27. The spatial distribution of the pottery. The largest dots represent at least 250 g per square.

quantity of organic matter. The pot was built from strips joined via H-joins and had an irregular surface.

C. Fragment of a bucket-shaped pot with a rim diameter of 24 cm. The clay was tempered with an average quantity of organic matter and a small quantity of grit (particle size 2 mm). The pot, which was built from strips joined via H-joins and had an irregular surface, contained two holes, which were at some time repaired.

D. Fragment of a barrel-shaped pot with a rim diameter of 44 cm. The clay was tempered with a small quantity of grit (particle size 3 mm). The surface of the pot was smoothed. The rim of the pot was decorated with a single row of nail impressions, the rest of the pot's surface with single fingertip impressions.

E. An intact pinched bowl with a rim diameter of 11 cm and a height of 8 cm. The clay was tempered with an average quantity of grit (particle size 2 mm). The pot's surface was smoothed.

F. Fragment of a round-based pot tempered with a large quantity of grit (particle size 2 mm) and an average quantity of grog (particle size 3 mm). The pot, which was built from strips joined via H-joins, was decorated with randomly arranged nail impressions.

G. Fragment of a *Wackelboden* tempered with an average quantity of grit (particle size 2 mm) and a small quantity of grog (particle size 3 mm). The pot was built from strips joined via H-joins and had a smoothed surface.

Table 12. Raw material versus cortex extent.

		absent	dorsal < 50%	dorsal ≥ 50%	total n	total %	unsure
terrace flint		4	51	36	91	18.1	–
pebble-Meuse eggs		10	98	206	314	62.5	–
Rijckholt		16	1	0	17	3.4	–
Valkenburg		3	0	0	3	0.6	–
Light-grey Belgian		24	2	0	26	5.2	–
Zevenwegen		3	3	1	7	1.4	–
axe fragments		44	0	0	44	8.8	–
Total	n	104	155	243	502	100.0	–
	%	20.7	30.9	48.4	100.0		
indeterminable		393	135	30	558		5

Table 13. Typology versus raw material. 1=terrace flint; 2=pebble-Meuse eggs; 3=Rijckholt; 4=Valkenburg; 5=Light-grey Belgian; 6=Zevenwegen; 7=axe fragments.

		1	2	3	4	5	6	7	unsure	Total n	Total %
triangular points		2	4	2	–	2	–	–	12	22	2.1
leaf–shaped points		–	–	–	–	–	–	–	1	1	0.1
transverse arrow-heads		–	–	–	–	–	–	–	4	4	0.4
other points		1	1	–	–	–	–	–	1	3	0.3
pointed blades		–	–	–	–	–	2	–	–	2	0.2
borers / reamers		1	1	1	–	–	–	–	3	6	0.6
scrapers		4	6	1	1	4	1	–	10	27	2.5
flint axes		–	–	2	–	–	–	–	2	4	0.4
retouched blades		2	1	1	–	2	1	–	3	10	0.9
retouched flakes		4	3	1	–	2	1	–	9	20	1.9
retouched waste		–	1	–	–	–	–	–	3	4	0.4
other retouched mat.		2	1	2	–	–	–	–	9	14	1.3
unretouched flakes		36	139	4	1	8	1	26	242	457	42.9
unretouched blades		1	5	1	–	3	–	–	–	10	0.9
cores		2	20	–	–	2	–	–	4	28	2.6
unretouched waste		17	41	2	–	2	1	7	66	136	12.8
splinters		4	17	–	1	1	–	5	169	197	18.5
potlids		2	3	–	–	–	–	6	25	36	3.4
pebbles		13	71	–	–	–	–	–	–	84	7.9
Total	n	91	314	17	3	26	7	44	563	1065	100.1
	%	8.5	29.5	1.6	0.3	2.4	0.6	4.1	52.9	99.9	

To summarize, the pottery from the Wateringen site comprises fragments of barrel- and bucket-shaped pots and one small, round-based pinched bowl. The pots had flat or round bases or a type of base known as a *Wackelboden*. The clay of the majority of the pots was tempered with grit, but organic matter and grog were also commonly used as temper. Rim decoration is very rare, but about 40% of the pottery shows wall decoration, consisting of impressions made with the fingertips/fingernails or some instrument. Most of the pots had a roughened or smoothed surface; some had an irregular surface.

On the basis of the pottery characteristics described above the Wateringen 4 site may be classified in the Hazendonk 3 Group (Louwe Kooijmans 1976, 267-276): in technological and morphological terms the pottery from Wateringen 4 shows a close resemblance to the pottery from Hazendonk

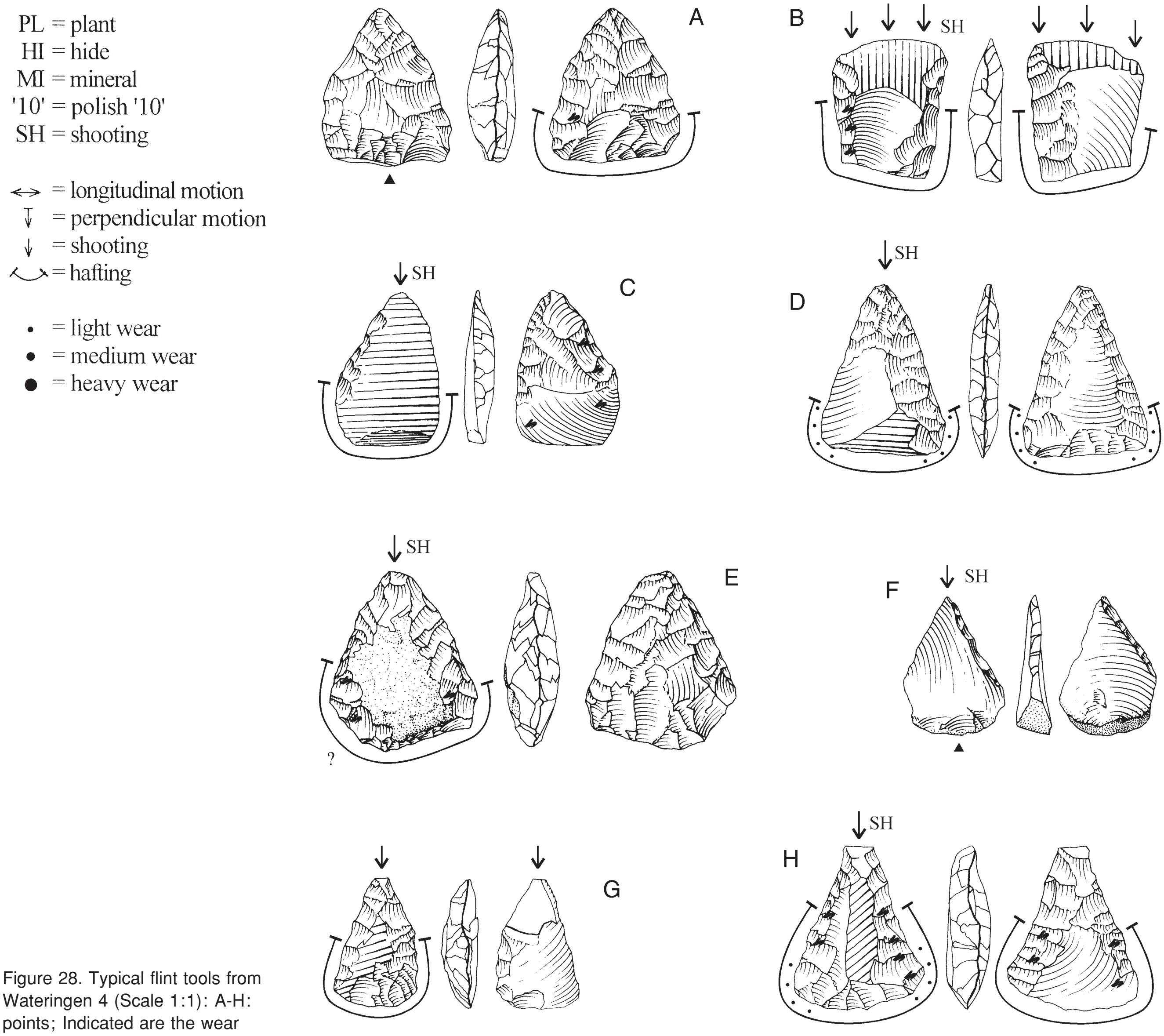

Figure 28. Typical flint tools from Wateringen 4 (Scale 1:1): A-H: points; Indicated are the wear traces observed on the tools (see legend).

(Louwe Kooijmans 1974, 150-155; 1976, 267-271), Het Vormer (Louwe Kooijmans 1980), Gassel (Verhart/Louwe Kooijmans 1989), Meeuwen-Donderslagseheide (Creemers/Vermeersch 1989) and Grave-Pater Berthierstraat (Verhart 1989). A striking difference is however the absence of the groove patterns that constitute a common decorative feature on the walls of the pots from the other Hazendonk 3 sites.

9.3. Spatial distribution

Figure 27 reveals a close relation between the amount of pottery and the height of the dune: the greater part of the pottery was found on top of the dune. There is also a relation between the position of the house plan, on top of the dune, and the distribution of the pottery. The area around the house plan was interpreted as a primary deposition zone. The zone containing the watering places yielded very few finds in comparison with other areas at the same altitude. This suggests that this area was deliberately kept clean to avoid contamination of the drinking water. Some of the stray finds recovered on the slopes were found in primary contexts, others in secondary contexts. The latter is illustrated by the fact that matching pottery fragments were found lying at distances of up to 40 metres apart. They had been moved from their primary contexts by post-depositional processes such as trampling and children's play. One group of matching sherds comprises sherds from the find layer, a feature and Unit 3b. This seems to justify our decision to regard the pottery from the different contexts as a single assemblage in the analysis.

10. Flint A.L. van Gijn

10.1. Introduction

In total, the excavators found 1,065 flint artefacts, with an overall weight of 5,335 g. The composition of the assemblage is to some extent the result of the recovery procedure used in the field: small chips are definitely underrepresented. All the flint artefacts were described in terms of their metrical dimensions, weight, basic technology, typology, raw material, grain size, breakage patterns, kind and extent of cortex, presence of traces of burning, patination, polished facets and spatial context. In addition, a sample of 179 implements was selected for microwear analysis.

10.2. Morphological description

The Wateringen 4 flint assemblage is the result of a flake technology, blades being almost completely absent (53.1% *versus* 2.7%). Besides flakes and blades, the assemblage also includes a large amount of waste, *i.e.* artefacts without indications of flaking direction (44.2%). A high percentage (39.2%) of the implements shows traces of burning. As the assemblage contains so few blades, the degree of fragmentation is very low: only 21 pieces were found to have broken and there were no indications of intentional breaking whatsoever. Flint axes were reused as cores for the production of flakes: 7.3% of the artefacts show polished facets. Such reuse was very common in the subsequent Vlaardingen group (Hooijer 1961). The greater part of the

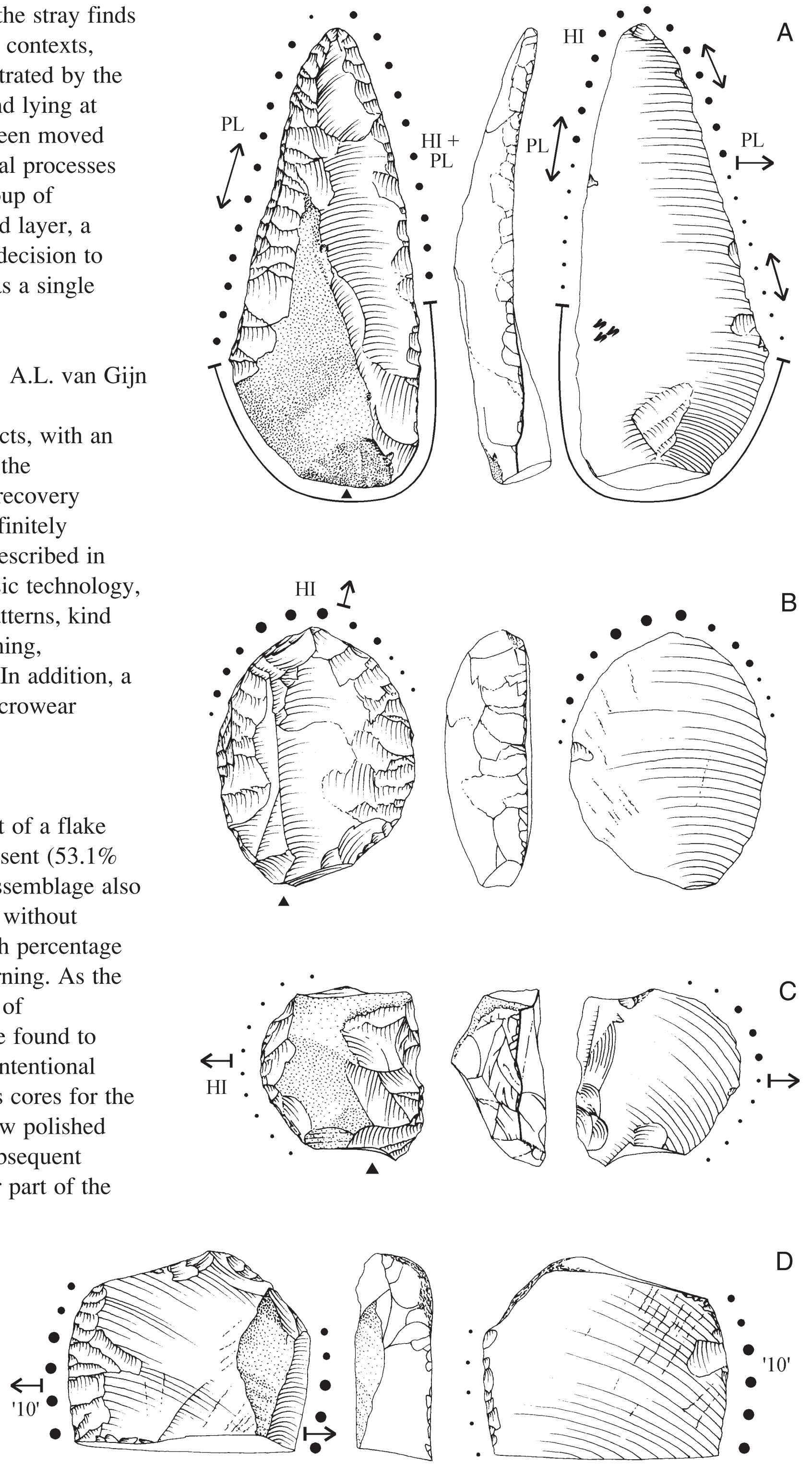

Figure 29. Typical flint tools from Wateringen 4 (Scale 1:1): A: pointed blade; B-D: scrapers. Indicated are the wear traces observed on the toold (see legend).

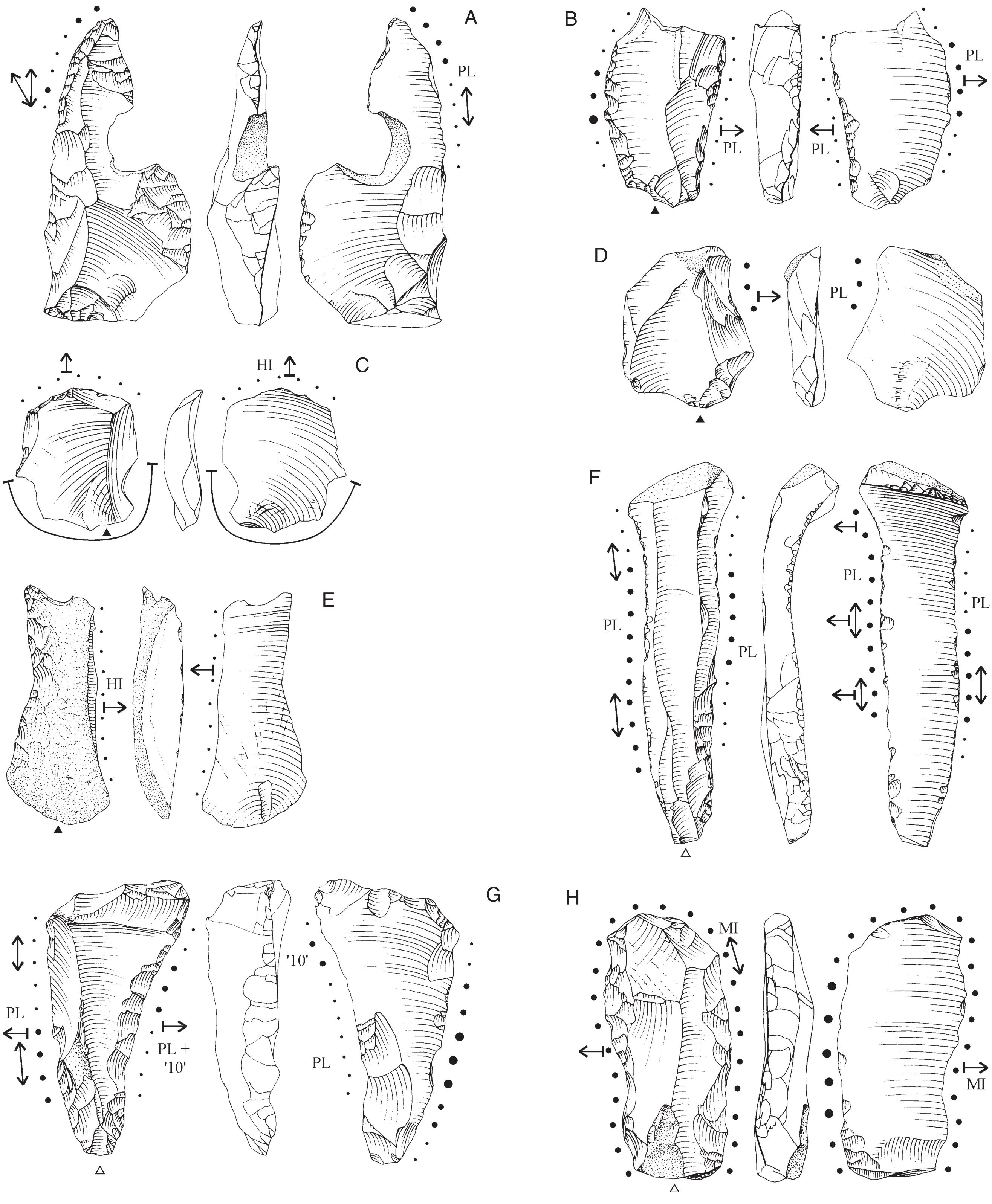

Figure 30. Typical flint tools from Wateringen 4 (Scale 1:1): A-H: retouched flakes and blades. Indicated are the wear traces observed on the tools (see legend).

identifiable raw material in the assemblage consists of flint from river gravels and what are known as pebble-Meuse eggs, small pebbles of relatively fine-grained flint of varying colours. The imported flint includes Rijckholt (1.6%), Light-grey Belgian (2.4%), Valkenburg (0.3%) and Zevenwegen (0.7%) flint. Many artefacts showed cortex to varying extents (53.3%), mostly of a weathered kind; 84 artefacts were completely covered with cortex (the pebble-Meuse eggs). This high percentage is attributable to the type of raw material selected: largely river gravels, almost all of which (391 of the 405) showed cortex. Many of the implements produced from imported flint showed no traces of cortex, which suggests that they entered the site in finished form (tab. 12). The fact that most of the cores (N=29) and core fragments and the greater part of the waste consist of flint from the river gravels shows that this flint was knapped on the spot (tab. 13). Generally speaking, the artefacts are rather small: the average length of complete blades is 3.8 cm (N=15), of flakes 2.8 cm (N=94). This is evidently also attributable to the use of small river pebbles for the production of implements.

10.3. Tool typology

Of the total of 1065 artefacts 117 pieces were intentionally modified (11%) (tab. 13). The points (fig. 28: A-H) constitute the largest category of formal tools (N=30, *i.e.* 26% of the retouched implements); this is an exceptionally high percentage in comparison with the figures obtained for other contemporary sites. The majority of the points are triangular (N=22), 7 having a straight base, 3 a concave base and 12 a convex base. The position of the retouch was found to vary considerably; in some cases it was confined to the tool's margin, in others it extended over the entire surface. In addition to the triangular points, one leaf-shaped, four transverse and three non-diagnostic points were recovered.

The second largest category (N=27) (fig. 29: B-D) consists of scrapers, the most common tool type in most Neolithic assemblages. There is no evidence suggesting a preference for a scraper of a specific shape: short endscrapers, lateral scrapers and double scrapers are represented in equal proportions. The position of the scraper head was evidently dictated by the morphology of the flake, which in most cases was quite irregular owing to the restrictions imposed by the poor-quality raw material. One scraper head was observed on a core.

Borers are not well-represented in the assemblage: only six were identified, one of which may be a reamer (fig. 31: A-C). In addition, two pointed blades were found, figure 29: A.

Besides the relatively well-defined tool types, the assemblage includes quite a few retouched flakes (N=20), blades (N=10) and retouched waste (N=4), figure 30: A-H. Thirteen implements may be termed modified but they cannot be classified in a specific tool category. Finally, the assemblage also includes two axe fragments and a core that was secondarily used as a hammerstone.

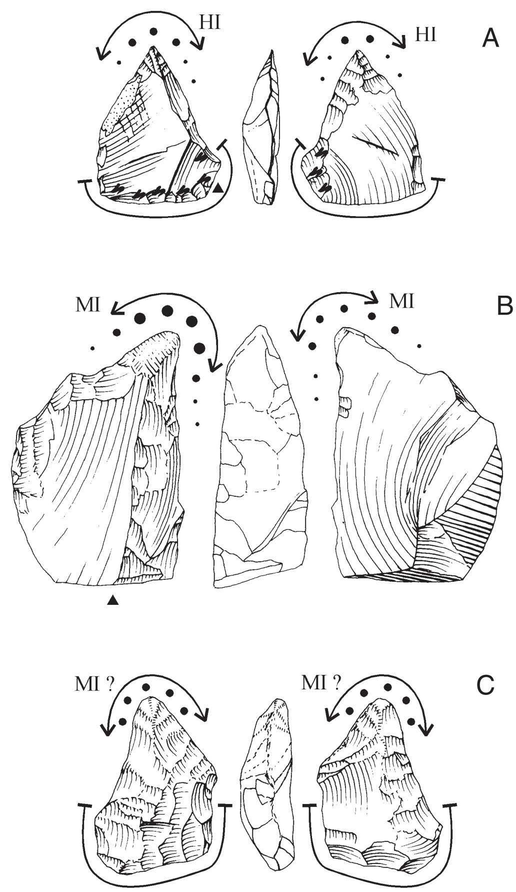

Figure 31. Typical flint tools from Wateringen 4 (Scale 1:1): A-C: borers. Indicated are the wear traces observed on the tools (see legend).

10.4. Microwear analysis

10.4.1. *Methods*

All of the 117 modified implements (among which I include the tools with only a very small amount of retouch) and 62 unmodified artefacts were examined for the presence of traces of use; the unmodified artefacts were selected on the basis of the presence of a regular cross-section of at least one cm (*cf.* Moss 1983; Van Gijn 1990). As some implements showed traces of residues preserved on their surfaces, the tools were examined for the presence of organic remains with the aid of a stereomicroscope before being cleaned. Where such remains appeared to be present, samples were a b

c d

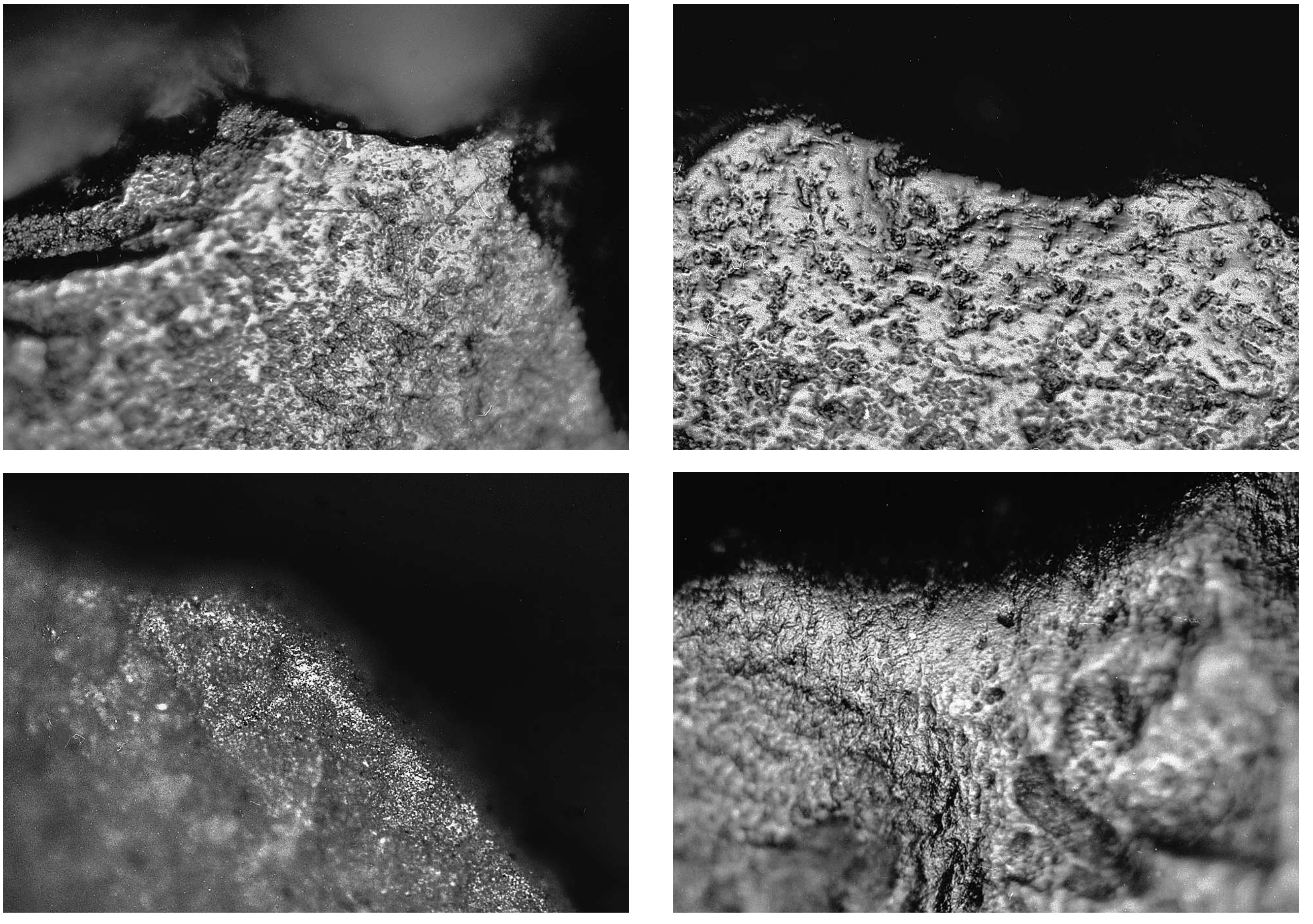

Figure 32. Micrographs of wear traces. a: polish from contact with plants seen on tool no. 13 (fig. 30G, 200x); b: plant polish on tool no. 100 (fig. 30F) used for silicious plants (200x); c: traces from scraping hide, seen on tool no. 67 (fig. 29B, 100x); d: so-called polish '10' with a perpendicular directionality, observed on tool no. 47 (fig. 29D, 100x); e: same tool (200x); f: traces from boring a mineral substance, perhaps pottery, seen on tool no. 35 (100x); g: rough polish interpreted as being the result of scraping a mineral substance, seen on tool no. 107 (fig. 30H, 100x); h: friction-gloss from impact seen on the tip of a point used for shooting (no. 115, fig. 28D, 200x).

taken by dissolving the residue in distilled water and smearing it on a glass slide for examination beneath a transmitted light microscope. After this initial screening, the implements were washed in water containing a detergent and were regularly wiped with a cloth drenched in alcohol. A small number of implements displayed a film of highly resistant 'dirt', which was removed through immersion in an ultrasonic cleaning tank. None of the implements were chemically cleaned. The microwear analysis was carried out with the aid of an incident light microscope, at magnifications ranging from 100 to 600×.

10.4.2. *Results*

On the whole, the surface of the implements was reasonably well-preserved, post-depositional surface modification occurring on only 34 pieces; 9 implements could not be studied because they were too severely burnt. In total, 86 of the 179 artefacts studied displayed traces of use, often in several zones: 13 tools displayed two zones of use, three implements even showed three zones of use. Five tools showed zones of several uses, either on different contact materials, or in different motions. The residues, for which the tools were systematically studied, were limited to remnants of birch tar, associated with hafting.

The contact material most frequently encountered is plant (N=18, table 14). In most cases the plants were of silicious species such as reeds or grasses (fig. 32: a-b). The polish is very bright and smooth, with a fluted topography. The traces are well-developed. None of the implements displayed plant residues. Longitudinal and transverse motions are represented e f g h

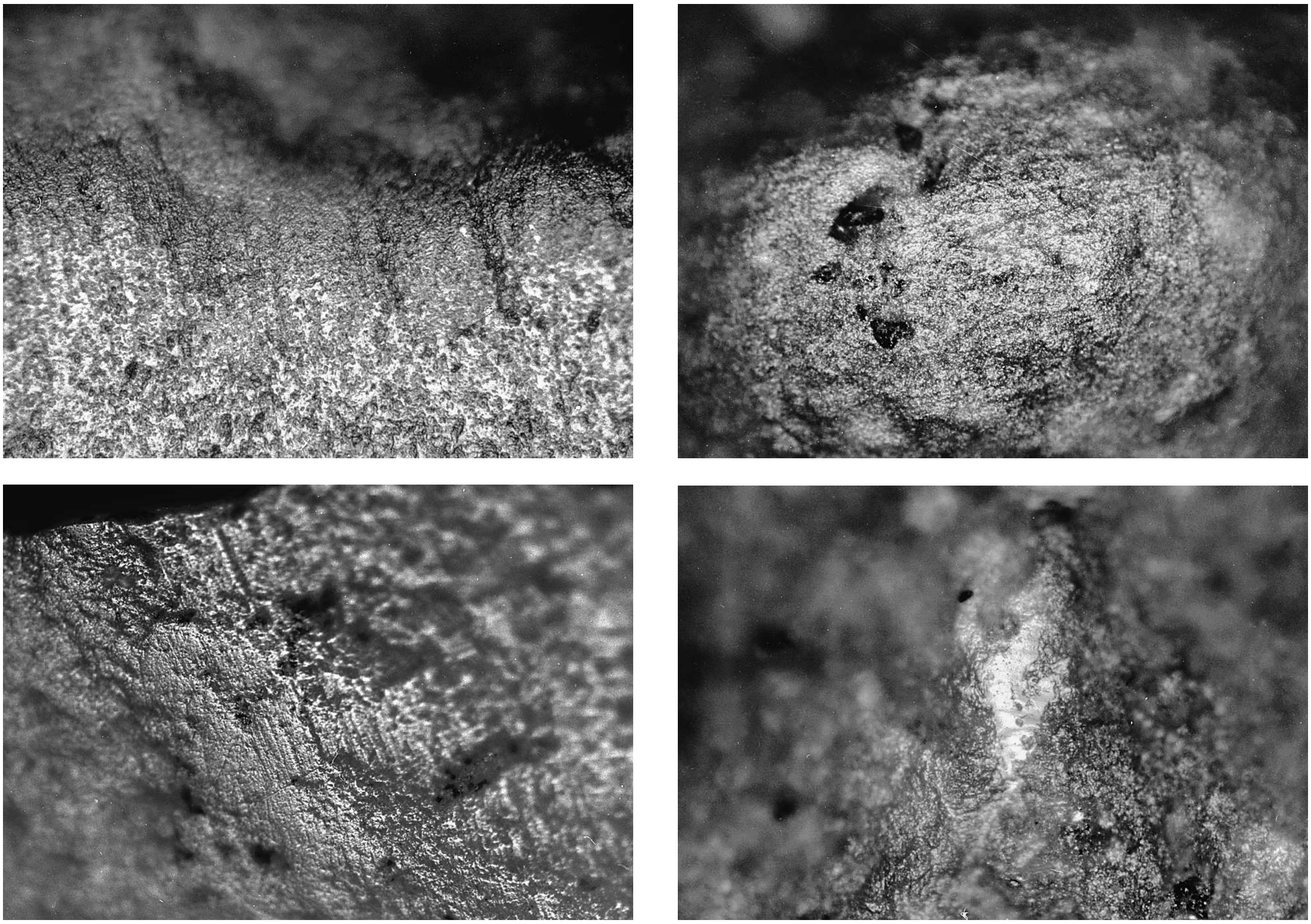

Fig. 32 continued

in equal proportions, which suggests that the tools were used for both collecting and processing activities. No typical sickle inserts were found, but they may have remained unidentified as such amongst the plant-cutting implements. Evidence for wood working was observed in only seven zones of use. It pointed to light tasks, for which the implements were employed in a transverse direction. The nature and extent of edge removals indicated that one flake had been used for chopping into wood.

Evidence for bone working was found in only six zones of use: four edges showed traces of a scraping movement, while one point and a pointed flake had been used for boring bone. In addition, four zones of use displayed traces of contact with soft animal material. The fact that three of these implements had been used in a cutting motion suggests that they were light butchering tools.

Traces of contact with hide were observed more frequently, in 13 zones (fig. 32: c). The appearance of the hide polish and the absence of extensive rounding of the working edges show that the tools were not used for hide treatments such as currying. It is more likely that they were used in relatively simple hide-cleaning operations. An exception is a standardised scraper of Light-grey Belgian flint (fig. 29: B) displaying a well-developed dry hide polish. The edge is extremely blunt and obtuse-angled, indicating multiple resharpening phases. This may clearly be regarded as a curated tool. The evidence pointing to the cutting and boring of hides besides scraping suggests that hides were also processed into products such as garments and the like.

Most of the typological points were indeed used as projectiles (N=15). Evidence confirming this includes impact fractures and linear traces of matt polish, generally referred to as MLITS as well as friction gloss (see Fisher *et al*. 1984; Odell/Cowan 1986; Van Gijn 1990).

A total of ten edges displayed either so-called polish ‘10’ (see Schreurs 1993; Van Gijn 1997) or a ‘mineral’ polish. Polish ‘10’ is a rough, matt, bright polish, occurring in a band along the edge, which is usually extremely rounded

Table 14. Contact material versus motion. 1=longitudinal; 2=transverse; 3=boring; 4=diagonal; 5=chopping/wedging; 6=shooting.

		1	2	3	4	5	6	unsure	Total n	Total %
plant		6	8	2	–	–	–	2	18	20.9
wood		–	5	–	1	1	–	–	7	8.1
bone		–	5	1	–	–	–	–	6	7.0
hide		2	10	1	–	–	–	–	13	15.1
soft animal mat.		3	–	–	–	–	–	1	4	4.6
mineral		3	1	3	–	–	–	–	7	8.1
polish ‘10’		–	3	–	–	–	–	–	3	3.5
unsure		–	2	5	–	2	15	4	28	32.5
Total	n	14	34	12	1	3	15	7	86	99.8
	%	16.3	39.5	13.9	1.2	3.5	17.4	8.1	99.9	

Table 15. Raw material versus degree of wear (only for implements showing traces of use).

		light	medium	heavy	unsure	Total n	Total %
terrace flint + pebble-Meuse eggs		20	9	4	–	33	38.4
imported flint		9	4	6	–	19	22.1
unsure		21	4	7	2	34	39.5
Total	n	50	17	17	2	86	100.0
	%	58.1	19.8	19.8	2.3	100.0	

(fig. 32: d-e). In appearance it sometimes resembles hide polish, at other times plant polish, but it is probably attributable to neither of those contact materials. It has not yet been reproduced experimentally. Polish ‘10’ was observed on two tools, one with two worked edges. Both of the tools were of exotic material. The implements were used in a transverse motion. The tools that were interpreted as having been used on some unknown mineral material are more varied (fig. 32: f-g). There was evidence for cutting, scraping and boring. The boring implements were of local flint, the cutting and scraping tools of exotic, Light-grey Belgian flint. The latter implements are quite remarkable as they were found to display polish over large parts of their surfaces, both their ventral and their dorsal surfaces. The implements were subsequently retouched. The tools may have been used to scrape pottery, but the traces do not match the experimental equivalents sufficiently to corroborate such an interpretation.

Finally, 28 implements displayed undiagnostic traces of use, which could not be further specified.

Quite a few tools showed traces of hafting, in particular the points. The traces comprised remnants of birch tar and microwear traces. A remarkable tool in this respect is one of Zevenwegen flint (fig. 29: A), which was used on hide and plant and was hafted in birch tar. There was no clear evidence suggesting that tools of imported flint were more frequently hafted than locally made implements.

Neither was there any evidence suggesting a preference for a specific raw material for a particular contact material, except perhaps the traces of polish ‘10’ observed on two tools of Zevenwegen material. The implements of imported flint had however been more frequently used than those made on flint from the local river gravels (table 15). The tools of Light-grey Belgian flint in particular showed clear evidence for resharpening: in four of the eight cases the traces of primary use had been removed by subsequent retouch. Another interesting feature of the imported tools is that the majority were used for different purposes, as indicated by the traces of different contact materials and

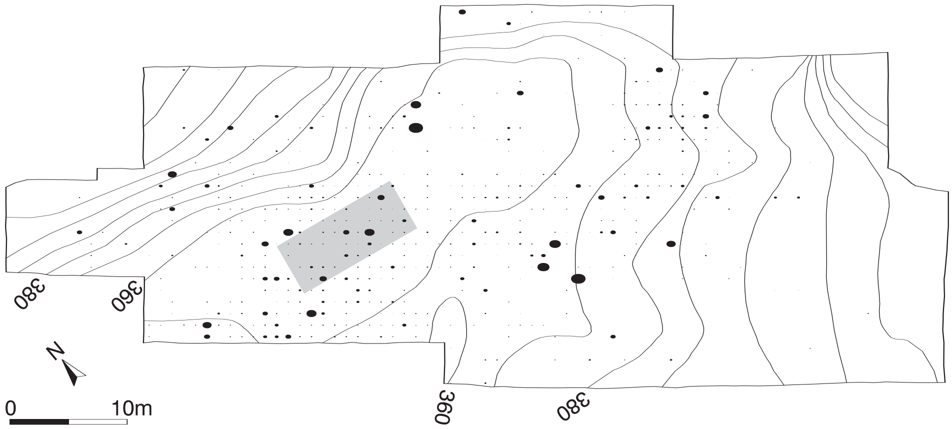

Figure 33. The spatial distribution of the flint material. The largest dots represent at least 100 g per square.

different motions. The use-wear traces are moreover better developed and indicate more extensive use.

When we examine the relationship between tool use and tool typology we find that the points were almost invariably used as projectiles; some showed signs of use as borers, but this may have been a secondary use. The scrapers were indeed used in transverse motions, usually on hide, but also on bone.

10.5. Spatial distribution

The spatial distribution of the flint, based on its weight, corresponds roughly to the density distribution of the pottery: the density is highest around the house plan (fig. 33). A difference with respect to the pottery distribution is however that comparatively more flint was discarded on the slopes of the dune, close to the watering places. The distribution of the implements of Zevenwegen and Rijckholt flint displays a higher concentration along the circumference of the excavated area, but this is probably due to fact that a large part of the flint was found at the peripheries of the inhabited area. This may be attributable to a desire to keep the living area free of sharp-edged debris. This intentional clearing of the living area further supports the assumption that Wateringen 4 was a permanently inhabited settlement.

The distribution of the different tool types does not show any particular clustering. All the types were more or less evenly distributed across the excavated area (fig. 34). Only the arrow heads seemed to be concentrated in the northern part, around the house plan. This may be associated with retooling activities (Keeley 1982) at the centre of the living area.

In considering the distribution of the different activities inferred from the wear traces on the implements (fig. 35) we must allow for the possibility that some of the finds may have been recovered from secondary contexts. It is probably safe to assume that the artefacts that were found on top of the dune were discarded at the site of their last active use. Tools showing traces of hide working appeared to be largely confined to the central living area. The evidence for the cutting and boring of hides suggests that the hides were processed into products like garments within the central living area. The presence of hide scrapers within the living area is rather remarkable because we tend to regard hide working as a rather smelly, dirty activity that will preferably have been carried out some distance from the living area. It is therefore more likely that their presence is associated with retooling activities. The presence of the points showing traces of shooting on top of the dune is in accordance with our views on the areas in which specific activities were carried out within a settlement: arrow shafts may have been retooled around the hearth.

The used implements found on the slopes of the dune are to be differently interpreted. These implements consist predominantly of plant-working tools and implements showing microwear polish ‘10’. This may imply that these tools were discarded on completion of the task for which they were used, but we do not know whether that task was performed in the living area or on the slopes of the dune.

10.6. Conclusion

The picture that emerges from the examination of the flint component of the Wateringen 4 assemblage is that of a permanently inhabited settlement, largely dependent on local raw materials. However, the presence of implements of exotic flint that were brought to the dune in finished form attests to contact with areas further south. These tools were definitely curated. A conspicuous aspect of these tools is that they showed traces of ‘foreign’ contact materials such as dry hide and the materials implied by polish ‘10’. Similar traces

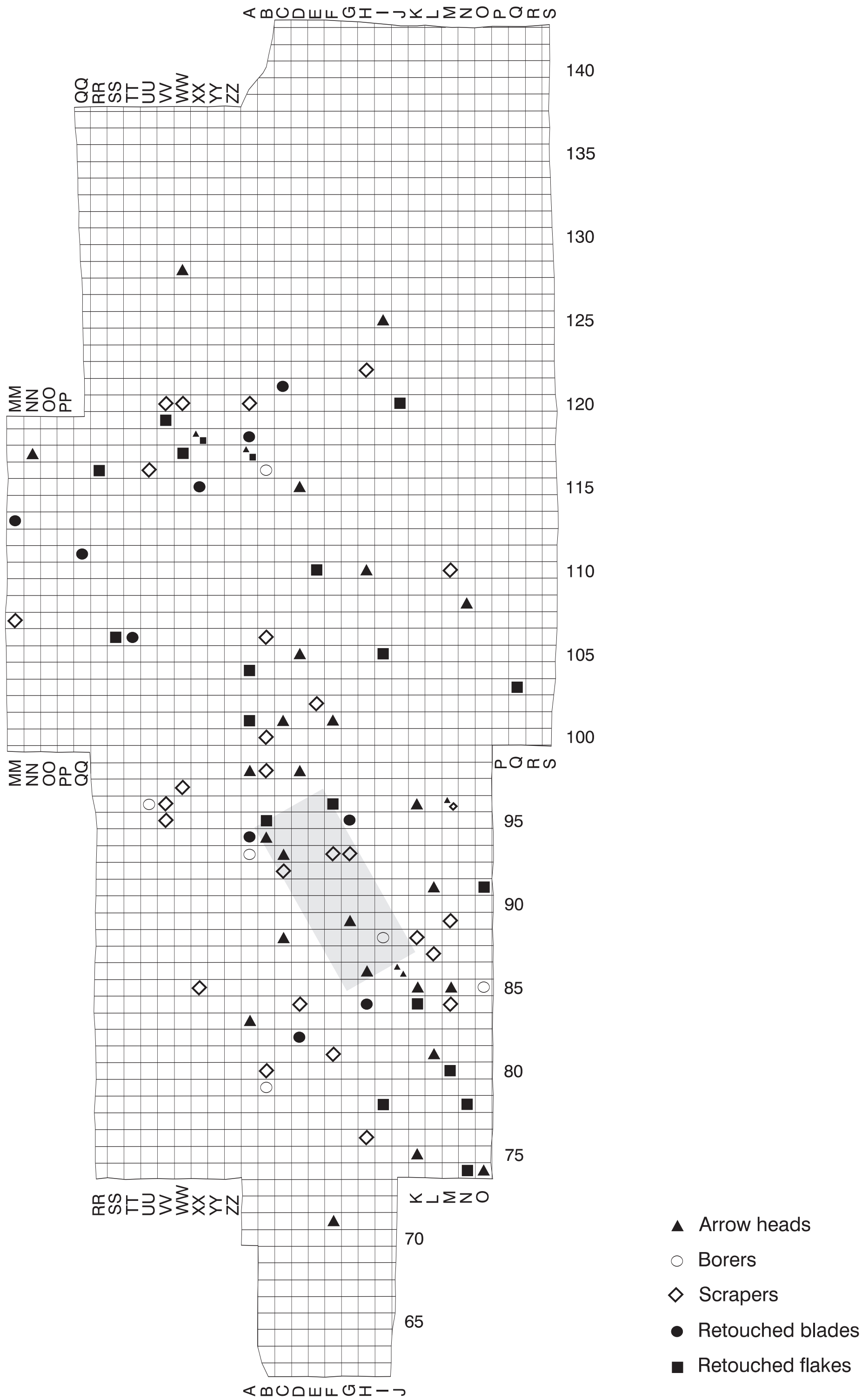

Figure 34. The spatial distribution of the flint tools in relation to the excavation grid and the house plan.

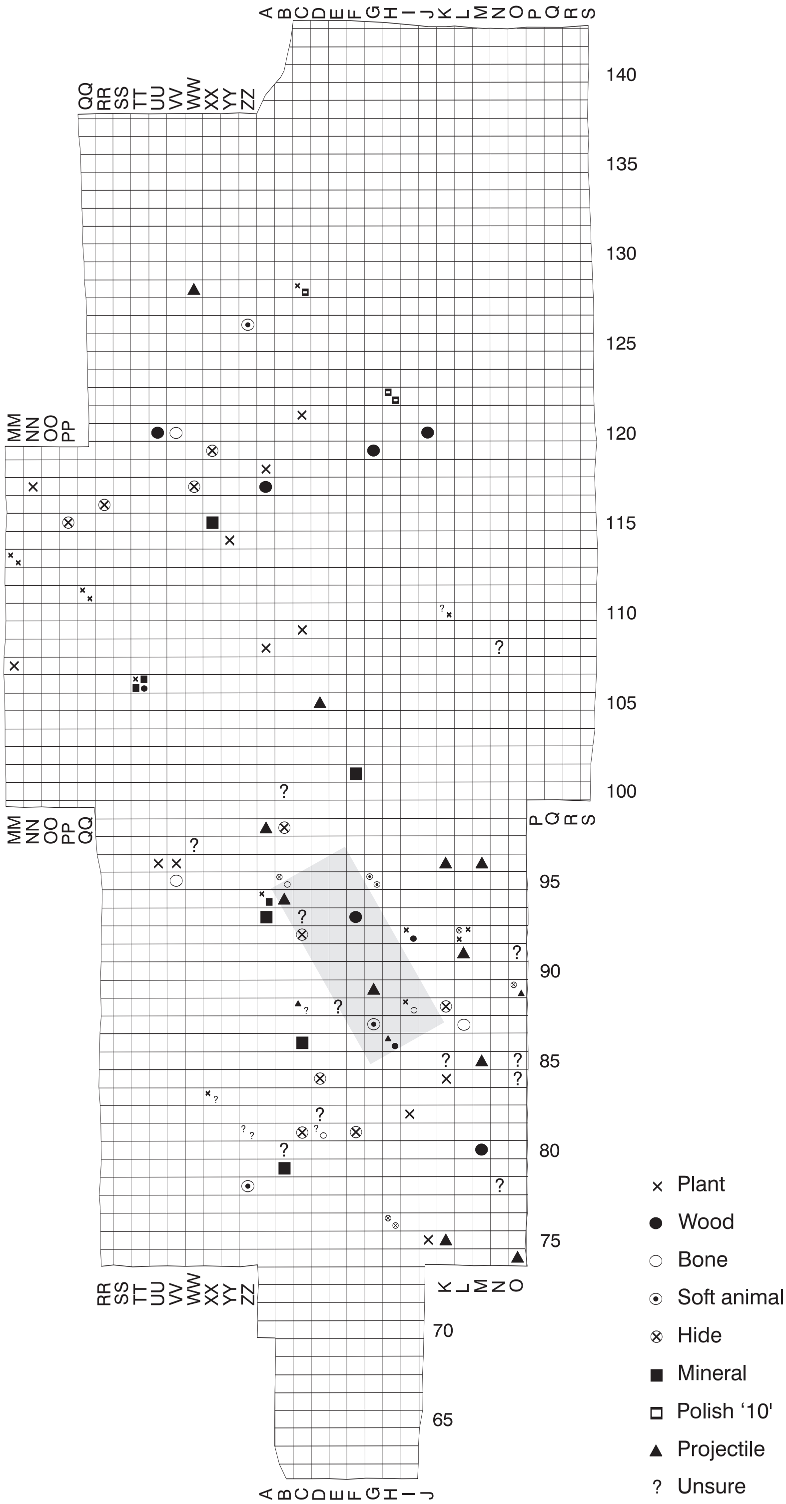

Figure 35. The spatial distirbution of the flint artefacts with traces of use in relation to the excavation grid and the house plan. Indicated is the distribution of inferred materials.

Table 16. The different types of stone encountered at Wateringen 4 and the proportions in which they were found based on the number of fragments found.

Number	blocks	%	pebbles	%	tools	%	total	%
Quartz	4	7.1	205	58.1	3	4.8	212	45.0
Quartzite	8	14.3	123	34.8	31	50.0	162	34.4
Sandstone	6	10.7	22	6.2	7	11.3	35	7.4
Other metamorph.	16	28.6	–	–	5	8.1	21	4.5
Crystalline	7	12.5	–	–	8	12.9	15	3.2
Quartzitic sandstone	4	7.1	2	0.6	7	11.3	13	2.7
Marcasite	6	10.7	–	–	–	–	1	1.3
Jet	1	1.8	–	–	1	1.6	2	0.4
Slate	1	1.8	–	–	–	–	1	0.2
Porphyry	–	–	1	0.3	–	–	1	0.2
Indeterminable	3	5.4	–	–	–	–	3	0.6
Totals	56	100.0	353	100.0	62	100.0	471	99.9

were also observed on a large retouched flake of Zevenwegen flint from the contemporary site of Rijswijk (author's observation). This implement showed evidence for several instances of use and intermediate resharpening.

The inhabitants of Wateringen 4 practised a range of activities, related to both subsistence tasks and the processing of various materials. Plants were gathered and processed; those plants may have been reeds which were made pliable so as to be suitable for the manufacture of mats and the like. The many arrow points that were used for hunting in the vicinity of the site were taken back to the living area to be repaired and rehafted. Bone objects were also made, if on a small scale. There is evidence for hide working. Some of the hides may have been used to manufacture skin products. The fact that no sickle blades were found does of course not mean that agriculture was not practised: negative evidence of this nature is not significant.

The results of the analysis of the Wateringen 4 flint assemblage closely resemble those of the few contemporary sites that have been studied. As far as the use of raw material is concerned, the proportion of local flint (pebble-Meuse eggs) is higher than that of imported material (Rijckholt, Light-grey Belgian, Valkenburg, Zevenwegen). This was the case in particular at Hazendonk 3 (32% imported flint) and Rijswijk (12%; Raemaekers, pers. comm.). At Gassel and Kraaienberg, which are both situated closer to the southern flint sources, the percentages of imported flint were higher (Louwe Kooijmans / Verhart 1990; Verhart / Louwe Kooijmans 1989). The technology was aimed largely at the production of flakes; blades are rare. All four sites yielded relatively few modified tools: Hazendonk 3 12%, Gassel 16%, Kraaienberg 13% and Wateringen 4 11%. The use-wear traces observed on the flint represent comparable broad spectra of activities at all four sites (the Rijswijk assemblage has not yet been subjected to functional analysis) (Bienenfeld 1989; Schreurs *in prep.*). 'Exotic' traces, such as polish '10' and polish '23', were found mostly on southern, imported flint implements (Van Gijn 1997). Generally speaking, the evidence points to permanently inhabited sites with, for example at Wateringen 4, a strong emphasis on hunting.

Wateringen 4 yielded evidence for the use of polished axes as cores, as also attested at the later Vlaardingen sites. 7.3% of the artefacts from Wateringen 4 showed polished facets. The greatest difference between the Wateringen 4 assemblage and the assemblages from the Vlaardingen sites in terms of the range of activities represented is the almost complete lack of traces of bone working in the former (*cf.* Van Gijn 1990).

11. Stone — S. Molenaar

11.1. Raw materials

471 pieces of stone with a total weight of 7,129.2 g were collected. They represent ten different kinds of stone (tables 16, 17). The two most common kinds are quartz and quartzite, with weight percentages of 53.5% and 21.8%, respectively. The large difference in percentages between the number of quartz fragments and their weight is due to the large number of small fragments of this stone.

What is perhaps the most remarkable aspect of the lithic assemblage is the presence of marcasite (FeS_2), an iron compound which occurs as lumps in layers of chalk. The nearest natural occurrences are in the Devonian chalks and schists of the Ardennes (Louwe Kooijmans, pers. comm.). Among the sedimentary rocks are several fragments of an unidentified rock. As these fragments include five artefacts they were regarded as a separate group of unidentified fragments.

The number and size of the pebbles indicate that the greater part of the lithic material was probably obtained from

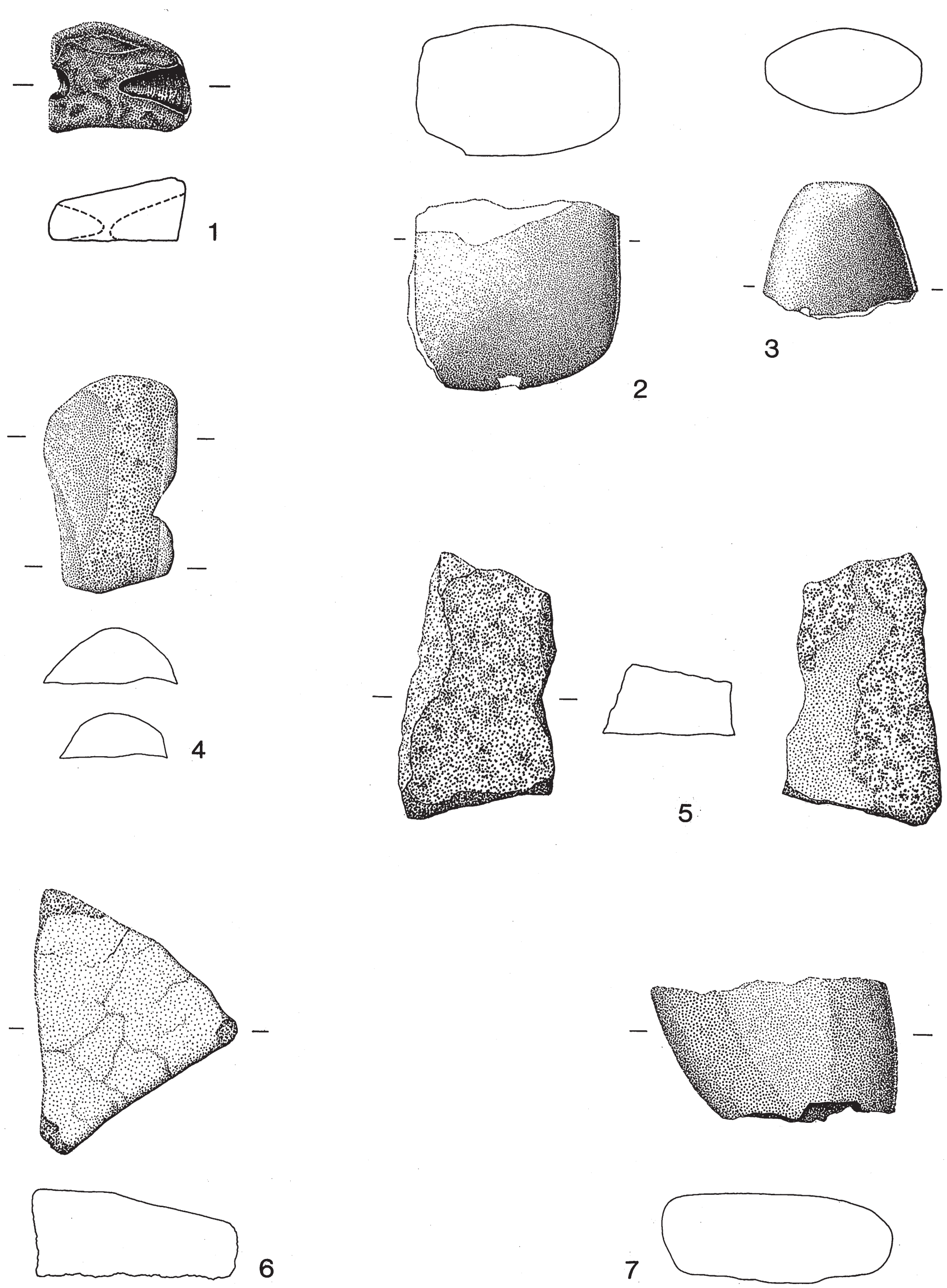

Figure 36. Stone tools from Wateringen 4. 1: jet bead; 2-4: fragments of polished stone axes; 5-7: stones with polished surfaces. Jet bead scale 1:1, all the other fragments scale 1:2.

Meuse and Rhine gravels. Some of the stone may have been picked up on the beaches along the North Sea coast. The assemblage also includes imported material. A jet bead found at Swifterbant is thought to have come from northern France (Deckers *et al*. 1980, fig. 121). A similar source may perhaps be proposed for the jet bead that was found at Wateringen 4.

11.2. Artefacts

Table 18 presents a survey of all the 62 fragments of stone artefacts. Noteworthy is a piece of a polished jet stone with two incomplete conical perforations – probably the result of an unsuccessful attempt to produce a bead (fig. 36.1). A similar bead was found at Vlaardingen (Glasbergen *et al*. 1967: fig. 19).

Table 17. Same as table 16, with the proportions based on the weight of the fragments.

Weight (g)	blocks	%	pebbles	%	tools	%	total	%
Quartz	9.4	2.3	1,296.5	35.8	250.8	8.1	1,556.7	21.8
Quartzite	39.5	9.8	2,075.7	57.3	1,702.7	54.9	3,817.9	53.5
Sandstone	49.9	12.3	213.5	5.9	373.2	12.0	636.6	8.9
Other metamorph.	65.8	16.3	–	–	136.1	4.4	201.9	2.8
Crystalline	48.4	12.0	–	–	267.3	8.6	315.7	4.4
Quartzitic sandstone	26.3	6.5	12.7	0.4	368.1	11.9	407.1	5.7
Marcasite	20.3	5.0	–	–	–	–	20.3	0.3
Jet	3.8	0.9	–	–	1.4	0.0	5.2	0.0
Slate	43.0	10.6	–	–	–	–	43.0	0.6
Porphyry	–	–	27.0	0.7	–	–	27.0	0.4
Indeterminable	97.8	24.2	–	–	–	–	97.8	1.4
Totals	404.2	99.9	3,625.4	100.1	3,0996	99.9	7,129.2	99.8

Table 18. The relation between the types of stone tools and the raw materials. 1=hammerstone, 2=grindstone, 3=quern, 4=axe fragment, 5=mortar, 6=bead, and 7=indeterminable.

Artefacts	1	2	3	4	5	6	7	Total
Quartzite	10	8	3	3	–	–	7	31
Crystalline	–	–	–	–	–	–	8	8
Sandstone	–	–	2	–	–	–	5	7
Quartzitic sandstone	–	1	–	1	1	–	4	7
Other sedimentary	–	–	–	–	–	–	5	5
Quartz	3	–	–	–	–	–	–	3
Jet	–	–	–	–	–	1	–	1
Totals	13	9	5	4	1	1	29	62

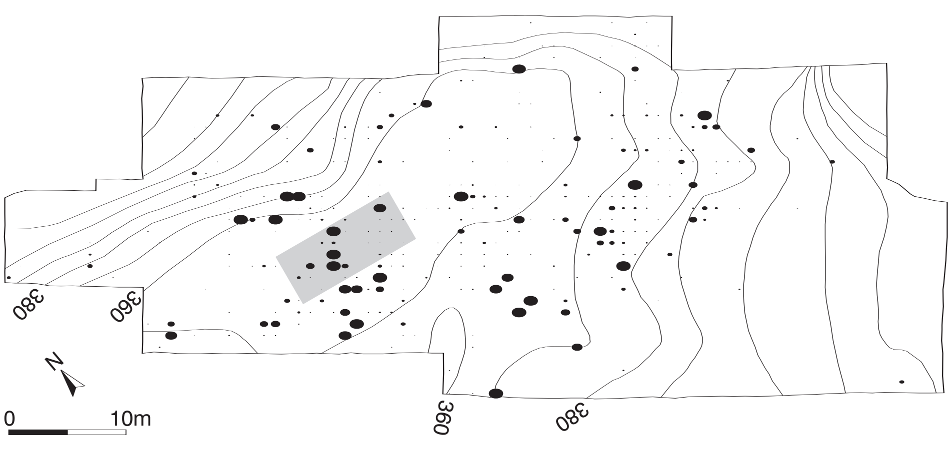

Figure 37. The spatial distribution of the stone material. The largest dots represent at least 100 g per square.

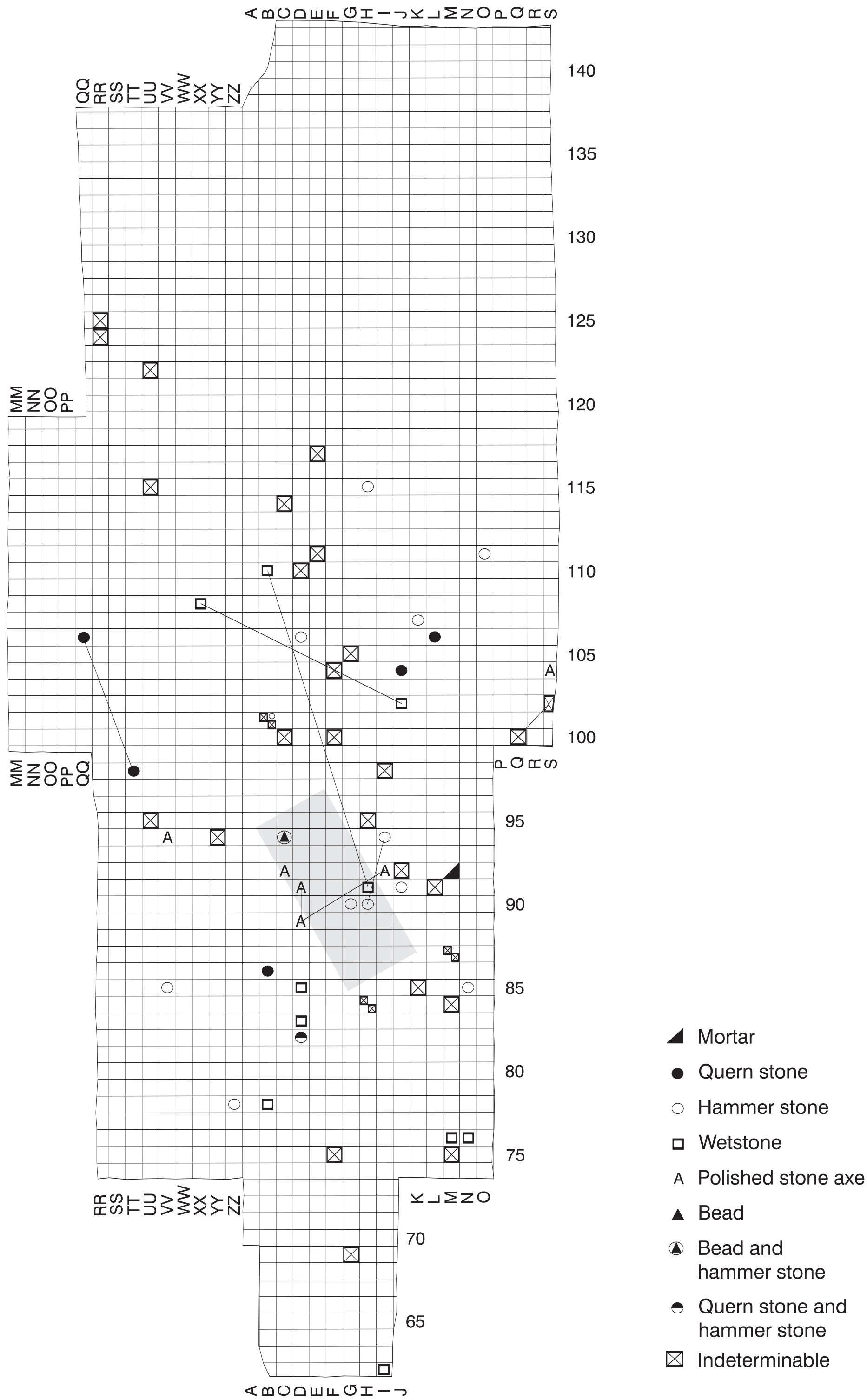

Figure 38. The spatial distribution of the stone tool fragments in relation to the excavation grid and the house plan. Fitting fragments are joined by solid lines.

Table 19. The intrasite distribution of various categories of finds and other variables.

Source	northern slope	central zone	unlined wells zone	southern slope
fig. 5	watering places	postholes / house plan	wells	–
fig. 15	–	salt marsh plants	–	–
fig. 16	–	cereals	–	–
fig. 18	bone	–	bone	bone
fig. 19	cattle	–	–	–
fig. 22	–	birds	birds	–
fig. 23	–	widgeon	–	–
fig. 27	–	pottery	–	–
fig. 33	–	flint	–	flint
fig. 34	–	arrow heads	–	–
fig. 35	plant working	–	plant working	plant working
	polish '10'	–	polish '10'	polish '10'
	–	hide working	–	–
	–	projectiles	–	–
fig. 37	–	stone	–	stone
fig. 38	–	hammerstone	–	hammerstone
	–	mortar	–	–

Three fragments of quartzite stone axes were identified: a flake, an almost complete edge and a tip (fig. 36: 2, 3). All three showed traces of pounding. It could not be inferred from the fragments whether they had all belonged to the same axe. The edge may have formed part of a *Fels Rechteckbeile A*, a type of axe known from various Neolithic cultures (Beuker *et al*. 1992, 117-120; Schut 1991, 7-25). A fourth fragment of quartzitic sandstone may also be part of an axe, judging from its three facetted sides, figure 36: 4.

Large and rounded pebbles with roughened surfaces may have been used as hammerstones, for instance in flint working. In some cases a fragment of the pebble had been removed in the hammering. The lithic assemblage also includes five fragments of querns, of sandstone and quartzite. Some of these fragments show clear traces of the deliberate roughening of the surface. Other stones show polished surfaces (see fig. 36, 5-7).

Stone tools are not extensively discussed in the reports on the other sites of the Hazendonk 3 Group. Wateringen 4 yielded far more fragments of stone tools than the other sites, but the majority of those fragments represent the same types of tools as also encountered at most of the other sites. There is therefore no evidence to suggest a difference in function between Wateringen 4 and the other Hazendonk 3 sites.

11.3. Spatial distribution

The greater part of the lithic material was concentrated on top of the dune and on the southern slope (see figs 37, 38). Two clusters of artefacts were distinguished within the overall distribution: a first cluster, which included hammerstones and fragments of quartzitic sandstone axes, in and around the house plan and a second, consisting predominantly of indeterminable artefacts, on the southern slope.

12. Synthesis

D.C.M. Raemaekers

The first occupants of the Wateringen site settled on a dune in a natural environment that had only shortly before developed freshwater conditions. The dune was surrounded by a diverse landscape with marshes, creeks and small woods on the nearby small dunes. The potential of this area was equally diverse: cattle could be pastured on the nearby salt marshes, there was probably an abundance of wild animals and cereals could be cultivated on the dunes.

The subsistence activities of the occupants of the Wateringen 4 site included crop cultivation and animal husbandry, hunting and gathering. Other activities attested at the site are the processing of plants and the working of wood, bone and hides and the activities represented by the enigmatic polish '10' observed on some flint artefacts. The occupants dug various kinds of pits, some of which have been interpreted as unlined wells and watering places. Moreover, at least one house was constructed.

It proved possible to relate some of these activities to specific zones of the excavated area (tab. 19). The majority of the activities appear to have taken place predominantly in the central zone rather than on the slopes of the dune. Some of the finds recovered on the slopes represent activities, others the discarding of waste formed in the activities on top of the dune. The unlined wells and watering places were all situated exclusively on the slopes.

As far as the season/seasons of the occupation is concerned, the mandible of a two-month old calf and the remains of fish bones from the stomach of an otter constitute evidence for occupation during the summer season. Winter activities are represented by widgeon bones and three full-grown antlers.

But does this mean that the site was occupied on a seasonal basis, in the form of winter occupation in some years and summer occupation in others, or on a year-round basis? Year-round habitation seems more likely, because

1. the area seems to have been suitable for crop cultivation and animal husbandry,
2. there appears to have been a clear difference between the relative importance of the economic activities practised at the different sites in the Hazendonk 3 period. Wateringen was a more permanently occupied settlement (see fig. 21),
3. the house plan implies a considerable investment in time and labour (contra Verhart 1992, 92-94).

It is very difficult to compare Wateringen 4 with the other sites of the Hazendonk 3 Group on account of the nature of the latter sites. Most of those other sites were found to be surface scatters, where all zoological and botanical remains had disappeared due to oxidation. Many had moreover remained occupied for a long period of time, as a result of which the remains from different phases had become mixed. This greatly complicates or even precludes comparisons of aspects like site dimensions, site structure and economy.

Hazendonk is the only published site that does not present the aforementioned difficulties. In several respects Hazendonk differs considerably from Wateringen 4. In the first place it is believed that the occupants of Hazendonk, which was situated on top of a small river dune in an entirely different natural environment, cannot have practised crop cultivation, as the area available on the dune was too small and there were no areas suitable for crop cultivation in the vicinity of the site (Bakels 1986). The Hazendonk 3 subsistence data reflect the importance of the hunting of otters and beavers (Zeiler 1991, tab. 4).

The flint artefacts from Wateringen 4 closely resemble those found at the other Hazendonk 3 sites in technological and typological respects. Marked differences are observable in the raw materials used: whereas terrace flints and pebble-Meuse eggs were rare at Gassel and Grave-Pater Berthier, they constituted about 70% of the raw material used at Vormer and Hazendonk 3. At Wateringen 4 this percentage is even higher. Wateringen moreover yielded far more flint artefacts and tools than the other Hazendonk 3 sites.

As for the pottery, the typical bucket- and barrel-shaped pots were found at all the Hazendonk 3 sites. The same holds for the small round-based bowls. The pottery from the different sites is remarkably uniform in morphological and technological terms. A conspicuous feature of the Wateringen pottery is the absence of the groove patterns

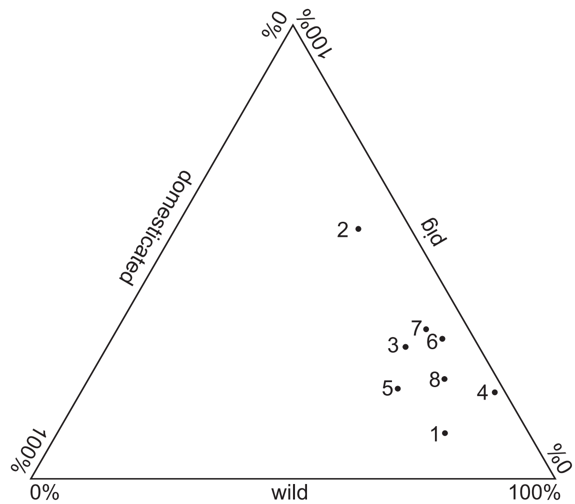

Figure 39. Triangular diagram showing the proportion of bones of wild and domesticated mammals and (wild/domesticated) pig from 8 Neolithic sites, all of which are older than Wateringen 4 (see fig. 21). The sites may be identified on the basis of table 20.

which were found to be the main form of decoration at the other Hazendonk 3 sites. This may suggest closer links with the south (Zeeland and Flanders) than with the east.

A few important conclusions can be drawn from a comparison of the data from Wateringen 4 with the evidence from the Middle Neolithic B Vlaardingen settlements in the coastal area. In the first place, in the centuries between the abandonment of Wateringen 4 and the arrival of the Vlaardingen settlers, the natural environment changed drastically from an open, newly developed freshwater environment to a relatively mature deciduous forest (Groenman-van Waateringe *et al.* 1968). It is however believed that both environments were suitable for agriculture.

Secondly, the resemblance between the bone spectra of the Hazendonk 3 period and those of the Vlaardingen period suggests that the economic diversity attested by the evidence from the Vlaardingen period may have existed already in the Hazendonk 3 period. To take this argument one step further, we may even suggest that the settlement system of the Hazendonk 3 period resembled the relatively well-known Vlaardingen settlement system.

At what time did the Neolithic occupation of the Dutch coastal area begin? This question can be approached from two different starting points. The first is the beginning of the formation of the beach barriers in this area, which constitutes a sound *terminus post quem* for the period of occupation.
It is thought that this took place around 4850 BC (Van der Valk 1992, 120-121). This would leave a period of about

Table 20. The mammal bone spectra of 8 Middle Neolithic sites, all of which are older than Wateringen 4. These data were used to construct the triangular diagram shown in fig. 35. After Gehasse 1995, table 9.3.

No. site	'culture'	Wild animals	Pig	Domesticated animals	Literature
1 Hazendonk 1/2	Swifterbant	74	10	16	Zeiler 1991, table 3
2 Swifterbant S3	Swifterbant	35	55	10	Zeiler 1991, table 1
3 P14, layers ABC	Swifterbant	57	29	14	Gehasse 1995, table 9.3
4 Hüde I	Swifterbant	79	19	2	Hübner *et al.*1988, table 16
5 Brandwijk L30	?	60	20	20	Robeerst 1995
6 Brandwijk L50base	Swifterbant	63	31	6	Robeerst 1995
7 Brandwijk l50top	Swifterbant	59	33	8	Robeerst 1995
8 Brandwijk L60	Swifterbant	68	22	10	Robeerst 1995

1225-1400 years between the formation of the beach barriers and the Wateringen 4 occupation. Although we know of no actual settlements from this period, the Bergschenhoek fowling camp (dated around 4300/4200 BC) indicates that the resources of the coastal area were being exploited (Louwe Kooijmans 1977, 245-248; 1987, 238-242).

Our second starting point is of an archaeological nature. Where did the colonist of the coastal area come from? This question is of course difficult to answer, though it is quite tempting to correlate the decrease in settlement density in the peat district of the Rhine-Meuse delta attested from the Hazendonk 3 period onwards with the beginning of the occupation of the coastal area. Both the number of sites in the peat district and their sizes decreased (Verbruggen 1993). It may well be that the Hazendonk 3 occupants of Wateringen (and those of Rijswijk) came from the peat district. Around this time marked changes began to take place in the relative importance of the subsistence activities, too: the subsistence activities attested at the sites from the Hazendonk 3 and Vlaardingen periods shows a wider degree of differentiation than those of the preceding period (compare figs. 39 and 21 or tables 20 and 4). This greater diversity in subsistence activities may reflect a greater diversity in settlement types. Of course, the observed differences may also be attributable to differences in the intensity of archaeological research.

From what has been said above it may be concluded that the coastal area was first occupied either in the Hazendonk 3 period or a little earlier, but not before about 4850 BC.
If the area was occupied before the Hazendonk 3 period, the occupation was probably of a different nature than the Vlaardingen-like occupation of the Hazendonk 3 sites.
We would like to suggest that any earlier occupation of the Dutch coastal area will have been of a pioneering nature, in seasonally occupied fowling or hunting camps whose occupants hesitantly explored the possibilities of the virgin area. Later, probably from the beginning of the Hazendonk 3 period onwards, the occupation gradually acquired a more permanent character.

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notes

1 Radiocarbon dates RGD 1 and RGD 2 were corrected for the age effect of surface ocean water and the delta ^{13}C effect, but not for the age effect of the admixture of fresh water. Van der Valk (1992: 127-129) has suggested that radiocarbon dates obtained for mollusc shells may be 300 to 400 years too old owing to the admixture of fresh water. This is probably also the case with the dates obtained for the shells of Wateringen 4. This would narrow the gap between the formation of the beach barriers and their occupation. Subtraction of 350 years from the date obtained for the mollusc shells from Unit 4, which postdates Unit 3 (the peat layer), yields a date of around 3350 cal. BC. This would agree with the age of the peat layer.
The RGD dates are quoted here with the kind permission of the RGD.

2 All dates BC given in this article are calibrated dates.

3 According to Van der Valk, the beach barriers of Rijswijk are among the oldest preserved barrier chains. Around 4850 cal. BC

(or several hundreds of years later if the ^{14}C dates are differently interpreted) the barriers began to prograde northwards at a high rate.

4 Unit 2 is similar to Unit 3b of the Rijswijk A4 temporary exposure; see Van der Valk 1992.

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