6 The Late Neolithic Vlaardingen sites

6.1 The Vlaardingen-group

6.1.1 General introduction

The sites of the Vlaardingen-culture are confined to the Rhine/ Meuse delta and date from circa 4700-4100 BP, conventional ^{14}C-dates. Because of its specifically coastal distribution (cf. Zandwerven, Vlaardingen, Hekelingen I) the culture was initially referred to as 'Coastal Neolithic' (Modderman 1953: 10). It was only after the type site of Vlaardingen had been excavated in 1961 that the various assemblages were designated as belonging to the Vlaardingen-group (cf. Louwe Kooijmans 1983a: 65).

Up to now c. 25 sites have been found (*fig. 53*). They are located in four different environmental zones:

1. on coastal barriers (Haamstede, Voorschoten, Leidschendam)
2. on levees along creeks in the freshwater tidal zone (Vlaardingen, Hekelingen)
3. in the peat area on riverdunes (Hazendonk)
4. in the area of river-clay deposits on stream levees (Ewijk)

The Vlaardingen-group (VL) has been subdivided chronologically into phases 1a, 1b, 2a and 2b on the basis of the pottery (Louwe Kooijmans 1976). The West Group of the Funnel Beaker culture (TRB), in the northeast of the Netherlands, is roughly contemporaneous but there is little evidence of mutual interaction (Louwe Kooijmans 1983a: 58). Both VL and TRB are contemporaneous with the Seine-Oise-Marne culture (SOM); the northernmost SOM sites are located in the Belgian Ardennes and Hainault. Strangely enough the area between SOM and VL seems to be archaeologically rather sterile (see Louwe Kooijmans 1983a: fig. 1): just a few isolated finds are known. It is only in Limburg, in the valley of the Meuse, that we encounter a few sites, such as Koningsbosch, Kraaienberg and Stein, which are contemporaneous with VL and closely related in terms of the material found there. Louwe Kooijmans (1983a) has suggested that these sites could be termed the Stein-group. Later VL occupation phases are synchronous with the Protruding Foot Beaker culture (PFB); the relationship between these two entities is not yet entirely clear.

Characteristic of VL pottery assemblages are the large thick-walled vessels, stone-gritted and often with perforations under the rim or knobs. Collared flasks and clay discs are common finds. Bone awls and chisels are present in considerable numbers. The flint assemblages are typified by transverse, leaf-shaped and tanged arrow heads, borers, scrapers and polished axes with oval cross-section (Van Regteren Altena et al. 1962-1963). The only convincing house plan derives from Haamstede; it measures approximately 5 x 10 m and has a rectangular shape. House plans have also been reported for Vlaardingen (Glasbergen et al. 1961: 57, 1967: 103) and Leidschendam (Glasbergen et al. 1967: 100), but the cluster of postholes from which these plans were derived could also be interpreted differently.

6.1.2 Subsistence economy

One of the questions preoccupying Dutch archaeologists concerned with the Neolithic is the degree to which the people were fully sedentary and dependent on agriculture and animal husbandry for their subsistence. In the Early Neolithic, during which the Bandkeramik farmers had settled in Limburg (c. 6400 BP), ample evidence exists that a hunter-gatherer lifestyle continued in the north and west of The Netherlands. One example from the Late Mesolithic is the Leien-Wartena complex (Newell 1970). It is also beyond doubt that the transition to sedentary farming was completed by the time of the Early or Middle Bronze Age. However, for the intervening period the picture, especially for the coastal area, is not yet entirely clear.

A number of models have been proposed to explain the transition from hunter-gathering to farming. Zvelebil (1986: 8-10) has provided an outline of the various models regarding this typical archaeological problem. He differentiates between two basic approaches. Firstly, knowledge is supposed to have been the limiting factor: as soon as hunter-gatherers became aware of the advantages of this 'superior' mode of subsistence, they switched over. Secondly, there is an approach based on imbalances between population and resources. Within this framework several variations have been put forward. One idea is that environmental factors, such as desiccation, might have induced people to change to a farming way of life. Another variation is the idea that population growth forced people to farming (Cohen 1977).

The idea that knowledge might have formed the limiting factor can be dismissed on several grounds. Firstly, it has become clear that the basic assumption underlying this model, of farming being a 'superior' mode of subsistence, is

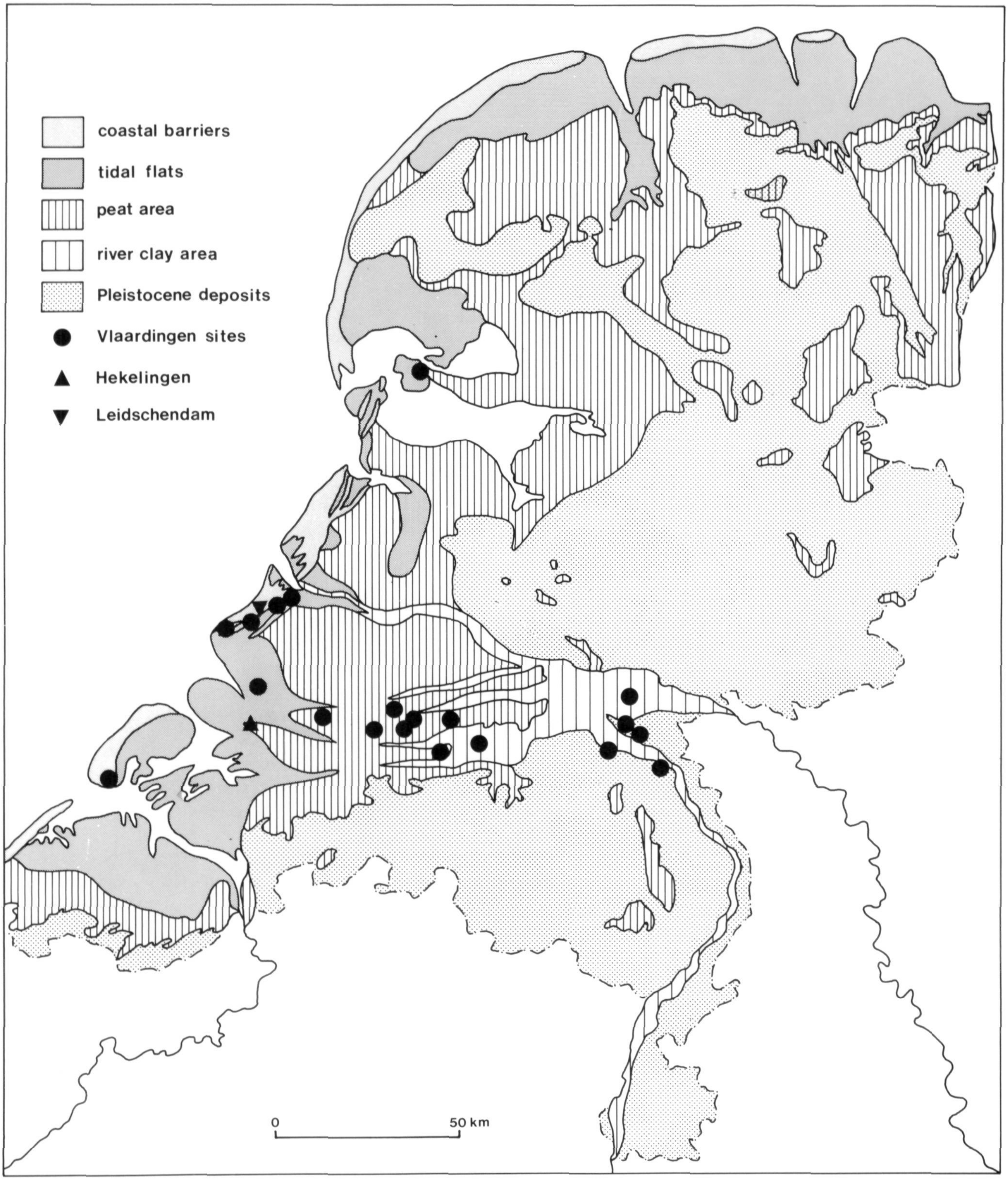


Fig. 53 Location of VL-sites in relation to the geomorphological situation (drawing L.B.M. Verhart).

not valid (cf. the affluent hunter-gatherer (Lee/ DeVore 1968)). Moreover, archaeological and ethnographic evidence shows that both modes of subsistence existed alongside each other for extended periods of time; hunter-gatherers must have known of agriculture, especially because they habitually travel long distances. The second general model, of an imbalance between population and resources, embodies the danger of environmental determinism. Recently, a somewhat attenuated version has been proposed, implying three phases: during the 'availability phase' only foraging is relied upon, in the 'substitution phase' foraging and farming exist alongside each other, while in the 'consolidation phase' farming becomes the main mode of subsistence with foraging losing its economic importance (Zvelebil/ Rowley-Conwy 1984; Zvelebil 1986: fig. 3). This model is quite attractive because it offers a continuum of possible 'poses' with which to describe variability in settlements; it unfortunately does not provide an explanation for the differential change from foraging to farming.

The VL sites can be examined in the light of this issue. We can assume that knowledge about agriculture and animal husbandry was available throughout the Netherlands by the Late Neolithic. In fact some of the VL settlements, those located on the coastal dunes and in the riverine area, reveal evidence of the cultivation of domesticated cereals (Groenman-van Waateringe et al. 1968; Asmussen/ Moree 1987). The same pertains to some of the partially contemporary PFB sites to the north, Kolhorn and Aartswoud (Pals 1983). However, several VL sites are not so easy to interpret: it is far from clear whether agriculture was practised in the freshwater tidal zone or on the riverdunes in the peat area.

Coastal and riparian environments are generally considered to be very productive because of their high biomass. This is especially true of the western coasts of Europe and the America's, where a warm gulf-stream has a moderating effect on the temperature, while seasonal variability is relatively great. Enough food can be obtained by fishing, hunting and gathering, while many of the products can be stored, albeit with some effort due to the prevailing humidity. Consequently, coastal populations are generally considered to be affluent societies (cf. the Indians of the Northwest Coast of America); an archaeological example is provided by the Danish Ertebølle culture. It is often assumed that farming was simply not 'necessary' (Zvelebil/ Rowley-Conwy 1984).

Perhaps the VL sites in the peat- and freshwater tidal zone represent the remains of pockets of such hunter-gatherer-fisher communities. A second possibility (suggested by the presence of bones of domesticated cattle and pigs (see *6.2.1*)) is that it concerned more or less permanent inhabitations of pastorally oriented peoples, who also relied on hunting and gathering; the saltmarshes to the south provided excellent grazing. Lastly, the sites in question could have been bases of exploitation, subsidiary to farming settlements which needed resources specific to these wet environments. Such agricultural settlements might include VL settlements on the dune ridges, e.g. Leidschendam, or riverine sites such as Ewijk. Yet another possibility form the sites of the Stein-group or sites possibly situated to the south on the saltmarshes of Zeeland, where permanent inhabitation might have been possible, analogous to the siting of the PFB settlements of Kolhorn and Aartswoud (see also Louwe Kooijmans 1986, 1987).

6.1.3 Objectives

In this chapter I will try to shed some light on this problem. My intention was to compare assemblages deriving from all four different environmental zones in which the VL group was present. Paula Bienenfeld had already examined the material from Hazendonk, located in the peat area (Bienenfeld 1986). As well as Middle Neolithic habitation traces, Hazendonk yielded material from all VL phases but VL-2a. As Hazendonk is the only VL site excavated so far in this zone, it was decided to include Bienenfeld's results. The fluviatile depositional zone is not covered because a preliminary study of the material from Ewijk revealed that, unfortunately, the post-depositional surface modifications were too extensive to allow a microwear analysis. Ewijk represents the only site which was, albeit as a 'by-product' of research aimed at the retrieval of Iron Age and Roman remains, excavated in the area of the river-clay deposits. My emphasis was therefore put on the freshwater tidal zone, on the edge of which the site of Hekelingen III was located; the material retrieved here seemed suitable for functional analysis. As a comparison, the flint from the site of Leidschendam, situated on a coastal dune, was also examined. As this assemblage was affected by abrasion, I looked for additional material from this environmental zone, but the flint from the recently excavated site of Voorschoten (Van Veen 1989) displays the same abrasion problem. Consequently, the present chapter will present the results of the analysis of Hekelingen III and Leidschendam. In the conclusion to this chapter I will compare these two sites and the VL levels of Hazendonk.

6.2 Hekelingen III

6.2.1 Introduction and research goals

The site Hekelingen III is situated just south of Spijkenisse in the Vriesland polder. The settlement spreads across the northern levee of a c. 50 m wide freshwater tidal stream and forms a continuation of Hekelingen I, part of which was excavated in 1950 (Modderman 1953) (*fig. 54a*). Together, these sites extend over a distance of 600 m, 200 m of which had to be excavated because of building activities. On the levee, which was c. 20 m wide, a number of find concentrations could be distinguished, hereafter referred to as

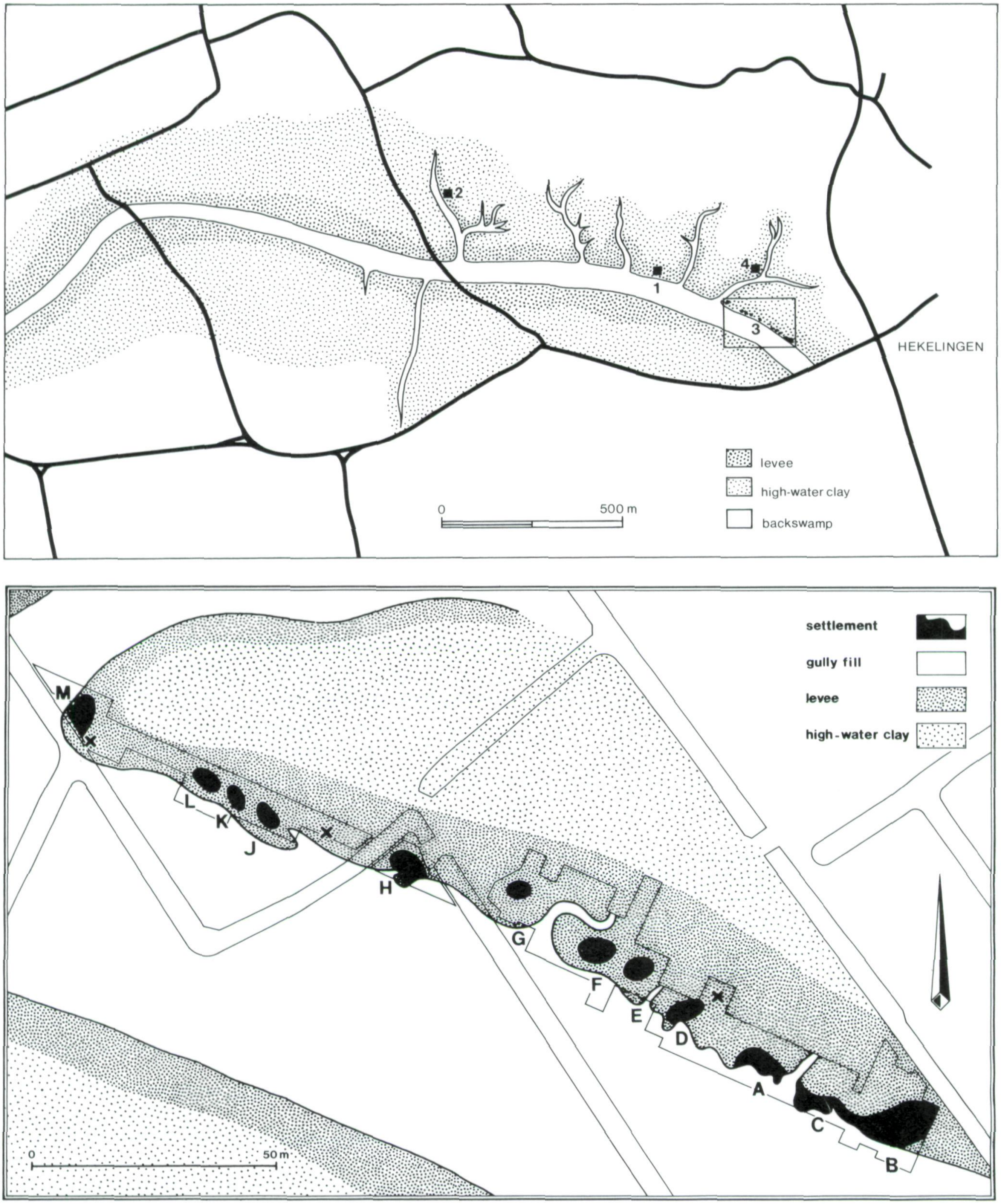


Fig. 54 a) Location of Hekelingen III in relation to the tidal creeks and backswamps. Hekelingen I, II and IV are shown as well. b) location of the archaeological units excavated in Hekelingen III; the excavation trench, following the edge of the levee, is also indicated.

archaeological units (*fig. 54b*). The salvage operation was carried out from April-October 1980 under the direction of Prof. Dr. L.P. Louwe Kooijmans and Dr. P. van de Velde. During the subsequent building activities another small site, Hekelingen II, was encountered closeby which could not be properly investigated. In addition, during a survey of the area, a fourth, very small site, called Hekelingen IV, was located just north of Hekelingen III on the levee of a small tributary of the main creek; this site was not investigated further (*fig. 54a*). To the south of Hekelingen III, on the opposite bank of the main creek no evidence for human habitation was found (Louwe Kooijmans/ Van de Velde 1980).

The Vriesland polder is unique in that the estuarine landscape formed during the Calais IV transgression phase (see below) lies close to the present-day surface, is undisturbed by subsequent erosion and has not been covered by a thick clay-deposit. The prehistoric landscape consisted of a major freshwater stream of c. 50 m wide and a number of small tributary creeks all lined by levees. Behind the levees lay the backswamp zone, in parts of which peat was growing, while elsewhere an open marsh was present. The system formed part of the delta of the Meuse. To the south, saltmarshes predominated, in what is now the province of Zeeland. Jagerman (1982) has done a geomorphological study of the area; the following description of the stratigraphy is based on his work. Louwe Kooijmans and Van de Velde have combined the geological stratigraphy with the archaeological remains.

Underlying the deposits on which habitation took place, are the saltmarsh deposits of the Calais III transgressive phase. These sediments are cut by the creek and levee system of Calais IV age. Two levee deposits can be differentiated. On the first levee deposit (Calais IV1a), consisting of sandy clay/ clayey fine sand, the archaeological units of Hekelingen III phase 1 are located: A1, B1, C1 and M1. The creek was still active during this period and it is probable that sedimentation occurred during occupation because the material from these sites is well preserved compared with the finds attributed to later phases (L.P.Louwe Kooijmans *pers. comm.*) This sedimentation phase is followed by a period of erosion, during which the creek eroded extensive tracts of the levee, causing some archaeological material to end up in creek deposits, as in unit A1g. Subsequently, sedimentation of the second levee deposit (Calais IVa2) and of the greater part of the channel fill took place. On this second levee, which is more clayey, are found the archaeological units attributed to phase 3: B3, C3, D3, E3, F3 and M3.

Phases 1 and 3 are stratigraphically clearly defined habitation phases (*fig. 55*). Between the erosion and subsequent second sedimentation stage, but stratigraphically somewhat higher than units A1, B1, C1 and M1, are located units H2 and I2, attributed to Hekelingen III phase 2. Since B1 is dated quite late in phase 1, and B3 early in phase 3, only marginally separated from each other by the second levee sediment, and because H2 is synchronous with this latter deposit, Louwe Kooijmans (*in prep.*) assumes a continuous,

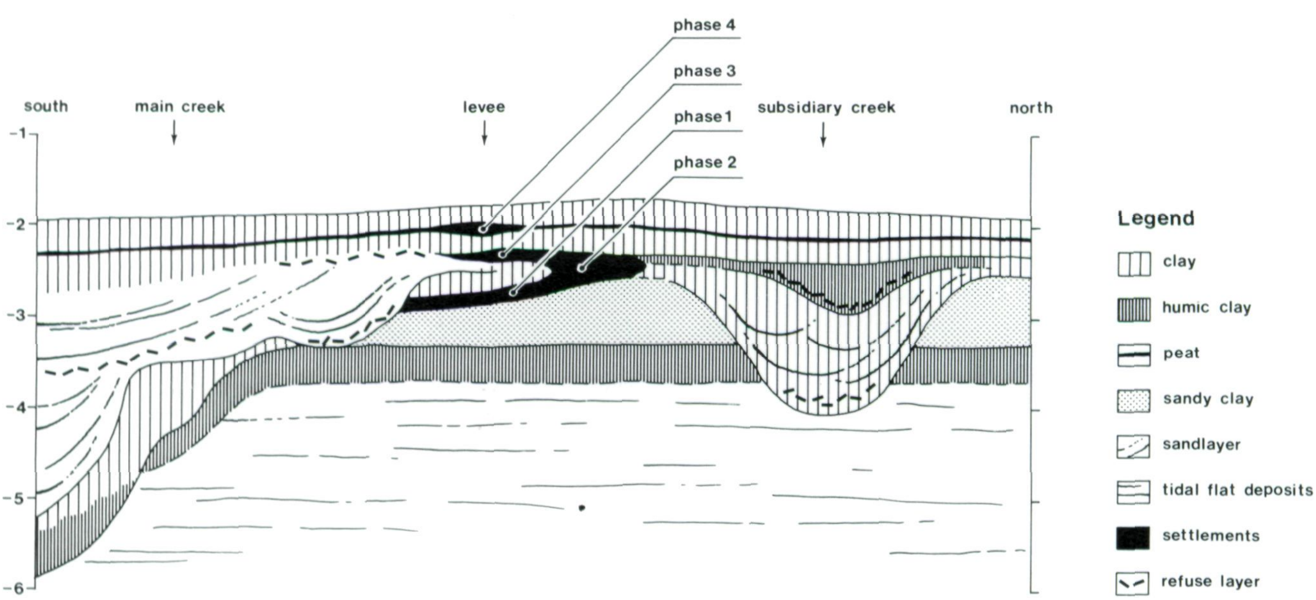


Fig. 55 Schematized profile across the levee and the main creek, indicating vertical position of the four occupation phases.

but shifting occupation. These three habitation phases all yield material belonging to the VL group. Overlying these deposits is the third and final levee sediment, on which Late Bell Beaker material has been encountered (phase 4). The prehistoric occupation levels were formerly sealed by a thick peat deposit of which only a thin band has remained, and on top of this a still extant clay cover.

The above sequence is supported by ^{14}C dates. During excavation a large number of samples could be taken, especially from phases 1 and 3 (Louwe Kooijmans 1985: 100). A total of 8 samples was selected for analysis: two from both phase 1 and 3, one sample each from phases 2 and 4, and one from each of the two creek fills, respectively. Table 28 shows the results. It reveals that the duration of the VL occupation can be estimated at between 200 and 450 years, in VL-1b and VL-2a. It seems that occupation was continuous and that no significant gaps in habitation occurred (Louwe Kooijmans *in prep.*).

A number of studies have attempted to elucidate the environment which prevailed during the period of occupation. Analysis of the wood remains has demonstrated that along the edge of the stream a vegetation of alder (*Alnus*) predominated, while somewhat higher up on the levee ash (*Fraxinus*) was present (Casparie/ Suwijn, *pers.comm.*). On the highest sections of the levee maple (*Acer*), hazel (*Corylus*), prunus (*Prunus*) and hawthorn (*Crataegus*) were attested. No traces of oak (*Quercus*) were found with the exception of five oak posts, belonging to a special funerary structure, which were probably imported (Hoogland 1985). In the backswamp behind the levee willow (*Salix*) and alder predominated. The picture gleaned from the pollen analysis is slightly different: a *Corylus*/ *Quercus* stand would have been growing on top of the levee, while a eutrophic alder carr would have been present in the backswamps (Bakels 1986, 1988).

The wild fauna living in this setting included red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). Beaver (*Castor fiber*) thrived in this humid environment. Freshwater fishes such as pike (*Esox lucius*) and roach (*Rutilus rutilus*) dominated, whereas sturgeon (*Acipenser sturio*) came to the area to spawn. Lastly, mullet (*Lisa ramada*) was available, a saltwater fish which occasionally visits freshwater streams in the summer (Prummel 1987).

Hunting formed an important component of the subsistence pattern of the inhabitants of Hekelingen III. Red deer was the major game animal. Small fur-bearing animals were captured as well, such as pine marten (*Martes martes*), otter (*Lutra lutra*) and beaver. Other game animals included wild boar, and brown bear (*Ursus arctos*). A few remains of grey seal (*Halichoerus grypus*) indicate that sea mammals were also taken, probably when stranded. Sturgeon, at the other hand, seemed to have been exploited to a considerable

Table 28 Hekelingen III: habitation phases with ^{14}C dates (after Louwe Kooijmans, *in prep.*).

		cal. B.C.		cultural
phase	C14 BP	minimum	maximum	affiliation
4	3865 ± 30	2525 – 2400	2550 – 2300	BB
3	4150 – 4050	2900 – 2800	2900 – 2650	VL 2a
2	4200 – 4150	c. 2925	c. 2925	VL 1b
1	4300 – 4200	3000 – 2950	3100 – 2950	VL 1b

extent. In addition to hunting and fishing, the inhabitants of Hekelingen III reared both pigs and, to a lesser extent, cattle (Prummel 1987). However, pollen analysis has shown that stinging nettle and onions were present on the levees, suggesting cattle had not been grazing there else these plants would have been eaten (Bakels 1986). An alternative grazing location would have been the saltmarshes of Zeeland.

The gathering of wild plants formed a significant contribution to the diet. Charred apples, hazelnuts and acorns were eaten; the acorns might have been collected elsewhere as the analysis of wood remains indicates oak to be absent (Bakels 1988: 160). Water nuts (*Trapa natans*) were also consumed. The people also had access to agricultural products. Remains of linseed (*Linum usitatissimum*), naked barley (*Hordeum vulgare* var. *nudum*) and emmer wheat (*Triticum dicoccum*) have been found; most of these seeds had been charred. Nevertheless, it is assumed that none of these crops were grown locally; although some chaff and rachis fragments have been encountered, this does not automatically imply local cropping (Bakels 1988). Unthreshed grain could have been taken along, with the advantage that seeds still enclosed by their glumes preserve better (Hillman 1981). Bakels (1988: 161) asserts that an important argument for the absence of agricultural fields at Hekelingen III would be the lack of space; assuming a group size of 15 persons (Louwe Kooijmans 1983b, 1985: 101) a levee of c. 500 m would be needed for the fields. Such an extensive clearance is not evident in the pollen diagram.

One unresolved problem is whether Hekelingen III could have been inhabited on a yearround basis, or reflects multiple short-term occupancies. There is evidence for occupancy during September in the form of water nuts, acorns and apples. The very few remains of hibernating birds indicate winter residence. Human presence during the winter months is also suggested by the fact that fur-bearing animals were captured; furs are at their prime in this season[1]. The sturgeon remains point to a late spring or early summer occupation when this anadromous fish swims up the creeks to spawn in the backswamps. So far no unequivocal evidence has been found for species which can only be exploited during early spring and late summer. The fact that human occupation during most of the seasons can be attested for, obviously does not mean that we can conclude yearround inhabitation. This is much more difficult to document and probably requires a combination of all possible avenues of research.

The use-wear analysis of the flint tools attempted to answer several such questions. A primary aim was to assess the character of the domestic craft activities carried out. It is often assumed that time-consuming activities such as bone- or hide-working were not carried out in a place where one resided only for a brief period of time. In this way the use-wear analysis could perhaps contribute to the question of duration of occupancy. Secondly, the role of flint tools in various subsistence tasks such as butchering, cereal-harvesting, plant procurement or fishing had to be ascertained. A third aim was to assess the variability between the various archaeological units through time and to search for the presence of activity areas. Lastly, the relationship between morphological aspects of artefacts, and the manner in which they were used, would be examined.

6.2.2 The flint technology

The morphology of the flint artefacts of Hekelingen III has been described by Verhart (1983) who paid special attention to the nature and possible source of the raw material from which the artefacts were produced, as well as technological aspects. The study of the Hekelingen III material is therefore limited to a functional analysis.

Verhart (1983) has been able to differentiate three main groups of raw material. The first type is of a mottled grey colour and fine-grained, supposedly originating from the vicinity of Spiennes in Hainault, Belgium. Most of the polished axes were made of this material. We find no blanks or prefabs for these axes, so it is likely that they arrived on the site as finished tools, probably in unbroken state. One axe exhibits an impact fracture, suggesting accidental damage during use. Such breakages formed excellent platforms which were used, without any modification, to produce flakes. Raw material type 1 predominates in the units attributed to Hekelingen III phase 1.

Although the second type of raw material shows some superficial similarities to the flint from Rijckholt in Limburg, the Netherlands, Verhart also seeks its origin in Hainault. It possessed a brownish-black color with tiny white specks, a fine grain size and sometimes coarser-grained grey inclusions. This material was brought into the site in the form of nodules. A few polished axe-fragments derive from this variety of flint.

A third type of raw material, not occurring during phase 1, is seen predominately in the units attributed to phase 3. It has a black color, a fine grain size, and sometimes a greasy appearance, and resembles most closely some flint samples from Boulognes-Sur-Mer, France. There are no axe fragments of this material. A fourth type was also present in small quantities; its origin probably lies in southern direction as well, but could not be specified further (Verhart 1983).

The question of whether or not there was ample access to raw material is difficult to answer. Certainly all of it had to be imported since natural occurrances of such good quality flint were not available nearby. In contrast with Leidschendam for example, local rolled flint was rarely used in Hekelingen III. The rather inefficient way of reducing the cores suggests that there was probably no lack of suitable material. I will deal with this problem in somewhat more detail in paragraph 7 of this chapter.

Cores (N = 49) are found on nodules or on broken polished axes. Because all the flint had to be imported, it is unlikely that large nodules were transported without pretreatment. This assumption is corroborated by the fact that the artefacts showed little cortex. Refitting-efforts produced virtually no joints, with the exception of some between units D, E and F, indicating their probable contemporaneity (Verhart, *in press*). This suggests that either only a small percentage of the implements was discarded at the site (i.e. was excavated), and/or that flint products were brought into the site in (semi-)finished form. Some flint was apparently knapped at the site, but the extent to which this took place is a little difficult to ascertain since no sieving was done during the excavation; the smaller fractions of debitage, had they been present, are therefore easily missed.

The cores possess a very irregular shape, the platforms are spaced haphazardly and platform preparation appears to be a rare phenomenon. This absence of planning and preparation results in a large number of hinge fractures inhibiting further reduction. Although the discarded cores are still quite sizable, closer examination of them reveals that there was indeed a good reason for discard: most have such an obtuse angle between platform and core-face that it would be impossible to produce any more flakes. Only after considerable modification could these cores be made productive again. Evidently the inhabitants of Hekelingen III chose not to undertake such work, either because they lacked the skill or because enough raw material was available to make it necessary to do so.

With regards to finished artefacts, it should be mentioned that a slight discrepancy sometimes exists in the number of retouched tools and of artefacts showing 'use-retouch' reported by Verhart and myself. This relates to disagreement at times as to whether certain edge-removals should be interpreted as use-retouch or as accidental breakages. Occasionally, there was also some difference of opinion over whether or not a certain artefact constituted a retouched tool. This confusion may seem incomprehensible to those who are not familiar with the character of Dutch Late Neolithic flint assemblages, which generally display very poor workmanship while standardized types are often lacking. Hekelingen III is a good example of such an assemblage. A standardized blade technology did not form part of the repertoire: it is clear that they were content with flakes, on the basis of which in fact all tools needed could be produced.

6.2.3 THE FUNCTIONAL ANALYSIS

6.2.3.1 Methods used and composition of the sample

The excavation procedure determined to a certain extent the composition of the sample. The site of Hekelingen III was excavated in the following manner: first, a backhoe was used to remove the soil overlying the first archaeological level and subsequent intervening sterile clay layers. Archaeological levels were excavated by shovel; finds were recorded in 1 x 1 m squares and collected by hand. No sieving was done because of the clayey matrix and the short time available. Basis for the sample taken for use-wear analysis formed the counts Verhart (1983) had made of the flint. Only those archaeological units which had yielded at least 10 modified artefacts were selected: A1, A1-creek (A1g), B1, M1, H2, B3, D3, E3, F3 (*table 29*), giving a total of 1011 artefacts.

From the total of 1011 artefacts, 337 were selected for analysis (33.3%), yielding 449 potentially used areas (PUAs). These PUAs include retouched edges (i.e. retouch ⩾ 1 mm), edges exhibiting 'use-retouch' (i.e. retouch < 1 mm), areas showing polish visible with the naked eye, points, and edges with a straight cross-section ⩾ 1.0 cm. Of the 449 PUAs, only 159 could be interpreted in terms of contact-material and motion, while 85 PUAs displayed no traces. This means that a mere 244 PUAs, or 54.3%, were interpretable, yielding 165 AUAs. The remainder possess secondary modifications, which prevent interpretation of tool use; several of these uninterpretable edges nevertheless were very probably used. Mean length of the examined

Table 29 Hekelingen III: composition of the sample.

unit	total flint	total weight (g)	number of artefacts examined	number of retouched tools	total interpretable AUAs
M1	138	821	53	24	22
A1	132	1003	34	20	18
A1g	210	809	64	40	36
B1	145	818	42	21	28
H2	88	568	40	15	26
B3	86	439	36	11	16
D3	63	354	22	9	7
E3	53	1234	15	6	5
F3	96	324	33	14	7
total	1011	6391	337	160	165

Table 30 Hekelingen III: raw material categories with the degree of wear (percentages, according to PUA). The discrepancy in number of PUAs in this table (455 instead of 449) is due to the computer registration. The additional six PUAs are from those tools displaying more than one AUA per PUA.

	type 1	type 2	type 3	type '790'	not applicable	unsure	total
no traces	54 (18.6%)	23 (31.5%)	4 (8.7%)	2 (22.2%)	2 (9.5%)	–	85
used	59 (20.3%)	12 (16.4%)	12 (26.0%)	1 (11.1%)	2 (9.5%)	1 (6.7%)	87
possibly used	38 (13.1%)	5 (6.8%)	5 (10.9%)	3 (33.3%)	3 (14.3%)	–	54
not interpretable	81 (27.8%)	26 (35.6%)	21 (45.7%)	2 (22.2%)	10 (47.6%)	12 (80.0%)	152
unsure	59 (20.3%)	7 (9.6%)	4 (8.7%)	1 (11.1%)	4 (19.0%)	2 (13.3%)	77
total	291	73	46	9	21	15	455

Table 31 Hekelingen III: inferred motion and contact-material by actually used area (AUA).

	scraping	whittling	cutting	carving	splitting	boring	projectile	hafting	unsure	total
hide	22	–	7	–	–	3	–	4	5	41
soft plant	–	–	3	–	6	–	–	6	1	16
wood	3	6	9	1	–	1	–	–	1	21
wood/bone/antler	1	–	–	–	–	1	–	–	2	4
bone	4	–	12	9	–	2	–	–	–	27
antler	2	–	1	1	–	–	–	–	4	8
soft stone	–	–	–	–	–	1	–	–	–	1
shell	–	–	–	–	–	1	–	–	–	1
hard material	2	–	4	–	–	1	–	–	3	10
soft material	3	–	–	–	–	3	–	–	8	14
unknown	3	–	1	–	–	4	3	2	9	22
total	40	6	37	11	6	17	3	12	33	165

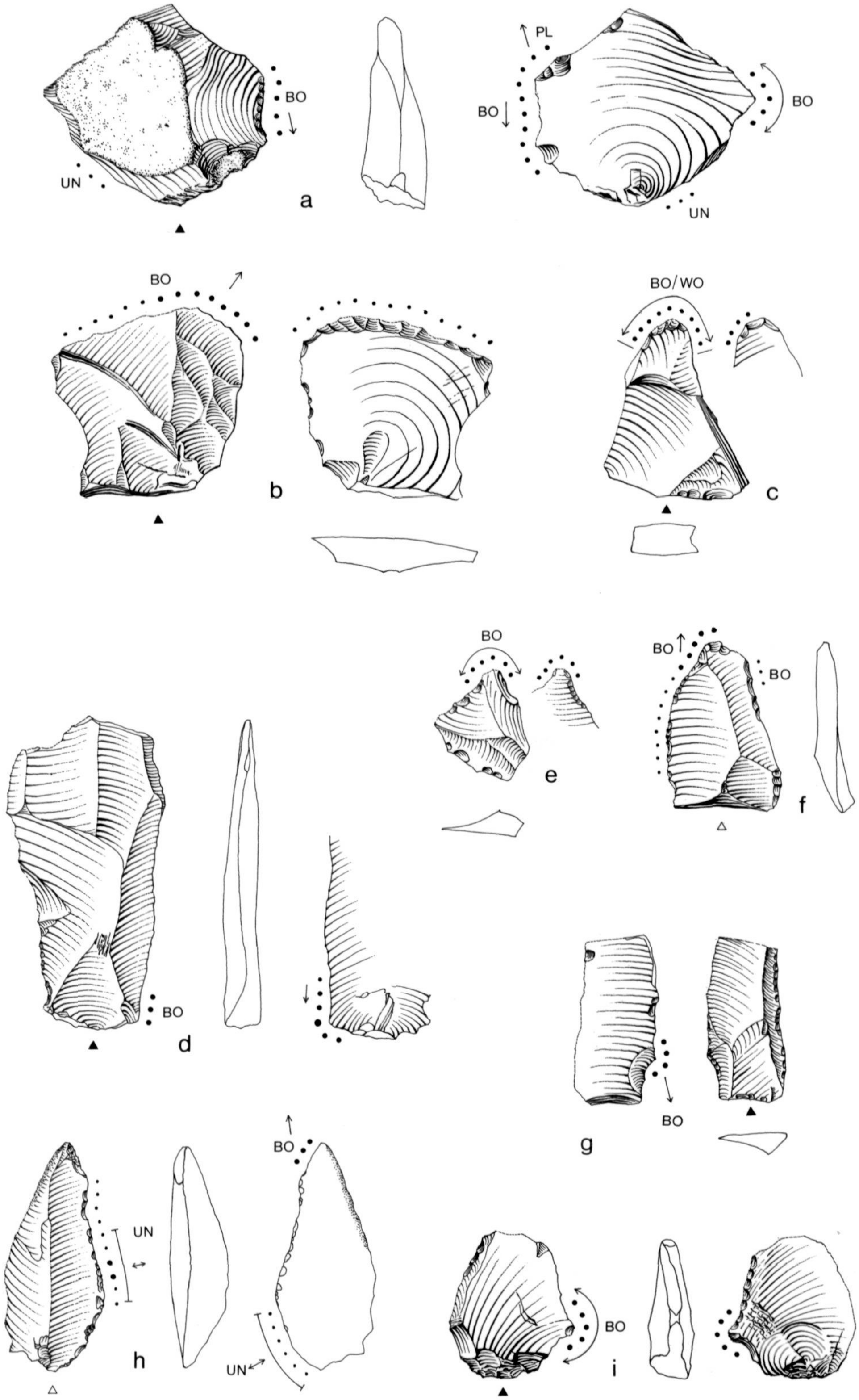
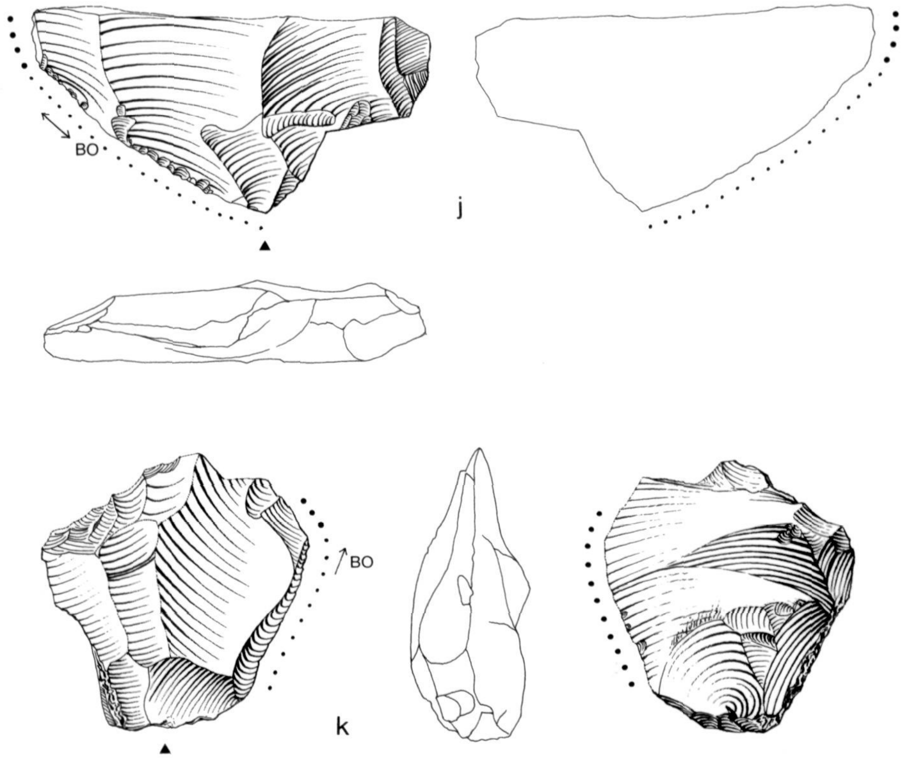


Fig. 56 Bone-working implements from Hekelingen III. a) B3/15 used for carving and boring, b) D3/3 used for scraping, c) borer B1/13, d) B3/18 used for carving, e) A1g/10 used for boring, f) A1/23 used for carving, g) M1/5 used for carving, h) B1/24 used for carving, possibly also displaying traces of having been hafted, i) E3/3 used for boring (1:1).



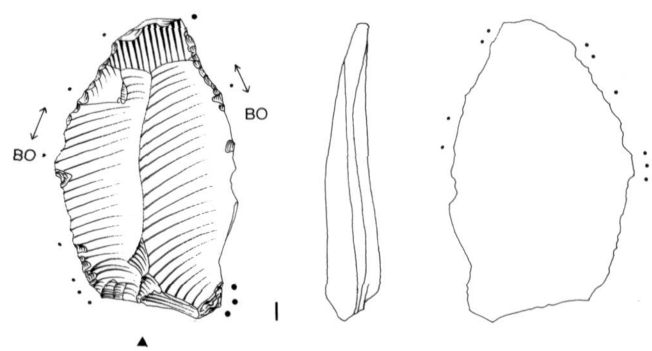


Fig. 56 cont. j) bone-sawing implement B1/29, k) carving tool A1/27, l) bone-sawing implement A1g/34 (1:1).

pieces (N = 337) comprised 3.0 cm, mean width 2.5 cm and mean thickness 0.7 cm.

The artefacts were not systematically cleaned with chemicals. Only in those cases where a film of unknown substance appeared to be overlying the surface, were the flint immersed in a 10% HCl solution and treated in an ultrasonic cleaning tank. To avoid a continuing reaction between stone and HCl (Van Gijn 1989) flints were only immersed for a short period of time and afterwards thoroughly rinsed in tap water and neutralized with KOH. Artefacts not exhibiting deposits were only soaked in luke-warm soapy water. During analysis tools were regularly wiped with alcohol to remove finger-grease.

The character of the post-depositional surface modifications is difficult to ascertain. Most likely it concerns mechanical abrasion. The matrix in which the artefacts were deposited varies from clayey fine sand to slightly sandy clay. Sand is known to be a highly effective abrasive, while experiments have shown that even clay quickly polishes a flint surface, especially if water is present (Van Gijn 1986a). Trampling on the levee surface by inhabitants of the site, and 'settling' of the sediments, might have been responsible for abrasion (cf. *4.2.3*).

It should also be noted that raw material type 3, displays post-depositional surface modifications (pdsm) more frequently than the other raw material types (see *table 30*). This observation corresponds with the fact that artefacts from archaeological units D3, E3 and F3 show a higher incidence of pdsm; raw material type 3 predominates in the units attributed to occupation phase 3. Whether type 3 raw material is more vulnerable to abrasion or whether more trampling took place during phase 3, is impossible to tell. Unit M1 also displays a high incidence of pdsm.

6.2.3.2 Activities inferred

In this paragraph the results of the use-wear analysis will be

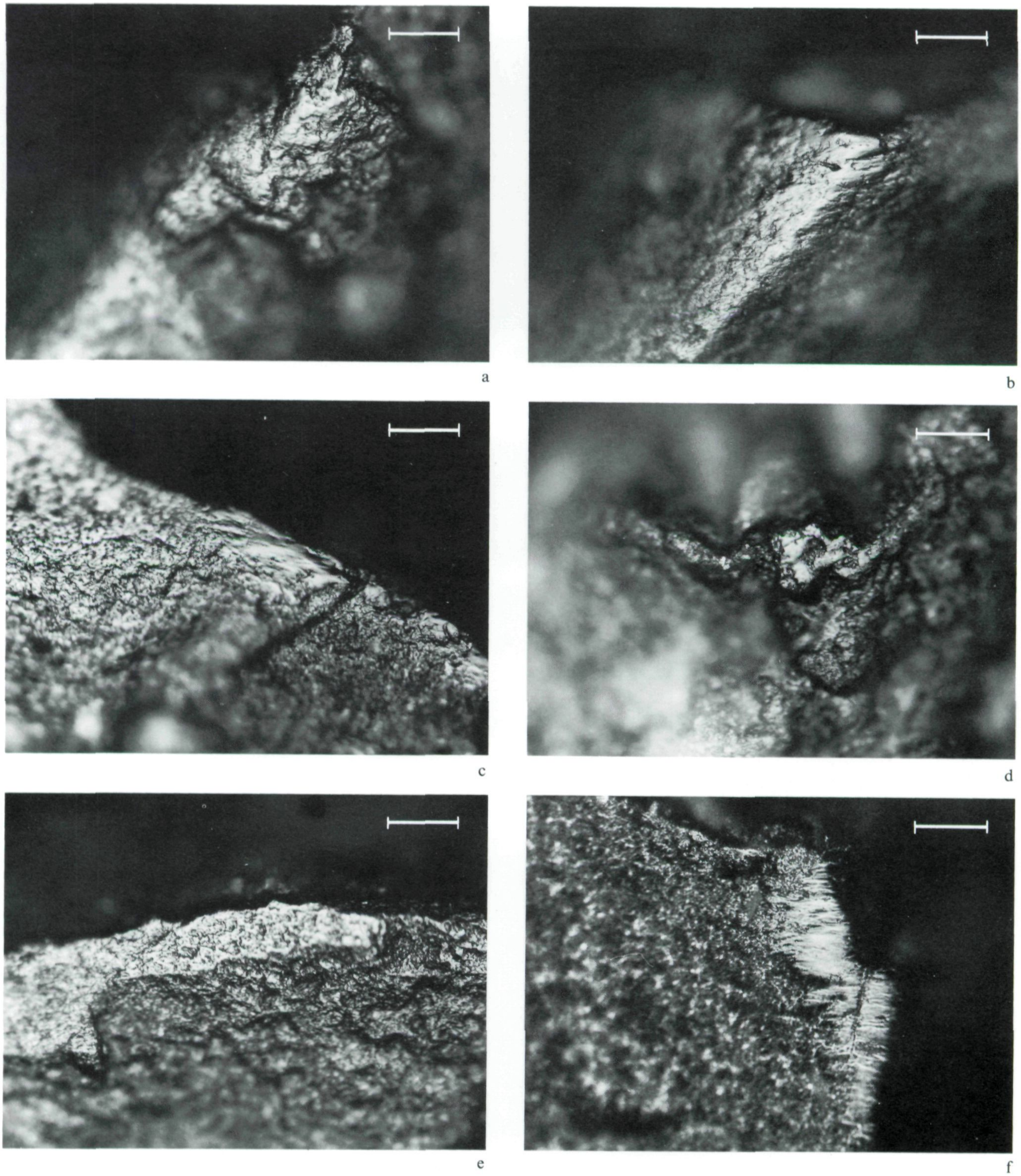


Fig. 57 Hekelingen III: micrographs of traces interpretable as being the result of contact with bone (see *fig. 56*). All scale bars equal 50 μ. a) D3/3 (200x), b) A1/23 (200x), c) B1/24 (200x), d) B3/18 (200x), e) M1/5 (200x), f) B3/15 (200x).

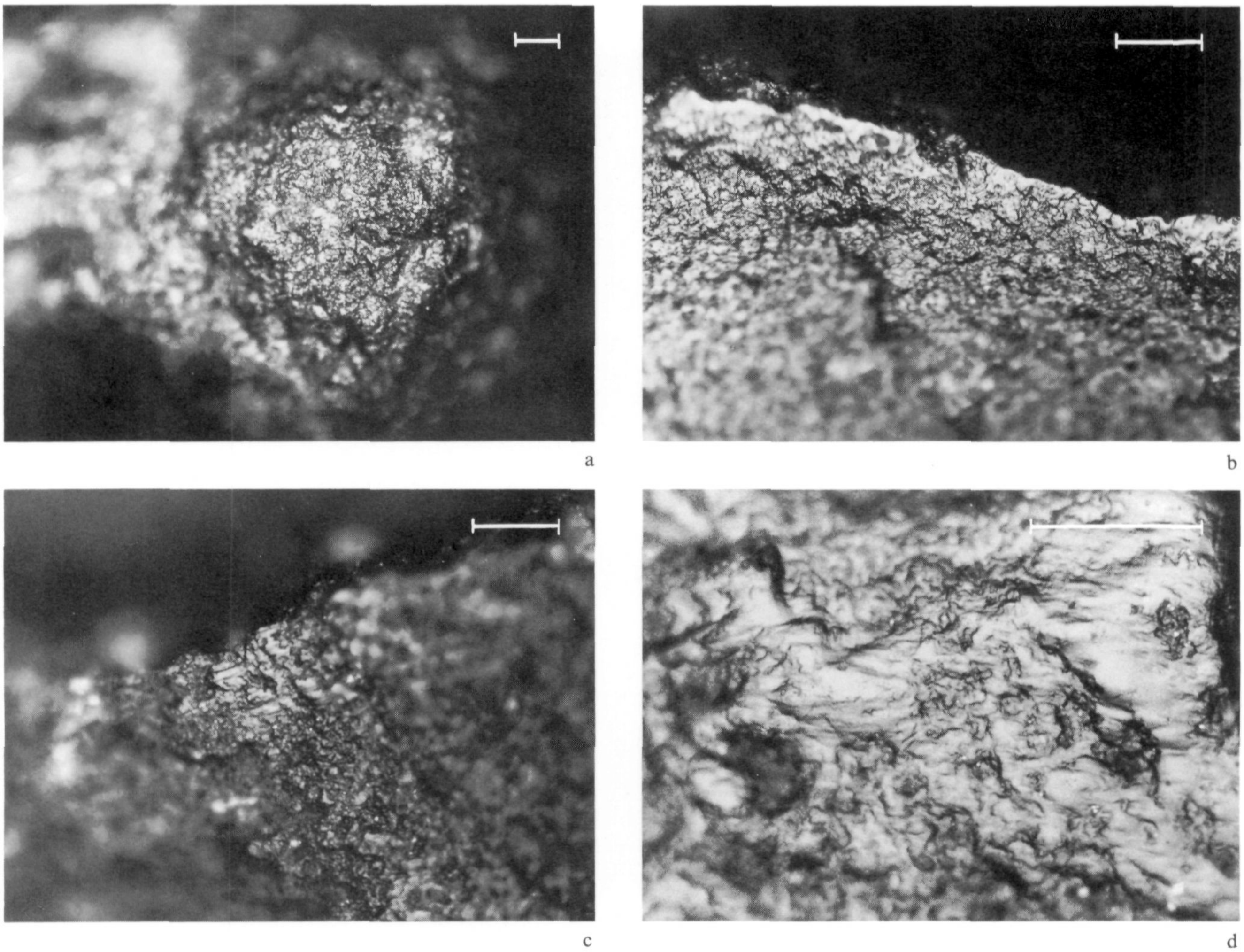


Fig. 58 Hekelingen III: micrographs of traces interpretable as being the result of contact with bone (see *fig. 56*). All scale bars equal 50 µ. a) A1g/10 (100x), b) B1/13 (200x), c) A1/27 (200x), d) A1g/34 (400x).

discussed for Hekelingen III as a whole (*table 31*). I will describe the various tasks inferred and attempt to relate them to other sources of information concerning the site.

BONE-WORKING

A major activity which was inferred is the working of bone (*fig. 56*). A total of 27 PUAs on 21 implements is interpreted as having been used on this material. On the basis of directionality within the polish two major motions could be distinguished: on 12 PUAs a parallel directionality indicates sawing or cutting, on nine PUAs a diagonal polish orientation suggests a carving motion. The carving tools exhibit a smooth, very bright polish with comet-shaped pits (*figs. 57b-f*). The distribution of the polish is limited to the very edge. Because of the remarkable similarity of the wear traces on experimental and archaeological bone-carving implements, these inferences have a very high probability. This is less so with the edges used in a longitudinal motion: the polish is somewhat rougher and is it not impossible that some antler-cutting tools were included here (see *3.4*). Edge-scarring on the latter pieces is quite extensive, involving step- and hinge fractures and trapezoidal-shaped scars. Striations are absent.

Interestingly enough, a large number of bone awls and chisels, as well as numerous waste pieces and rejects, have been encountered at Hekelingen III. Maarleveld (1985), who has studied the bone tools, reports that for the most part these tools have been produced on the metapodia of red deer and, to a lesser extent, on metapodia of roe deer. He suggests the following manufacturing sequence for the awls and chisels (*fig. 59*). The first step involved the deepening of the natural furrows present on the anterior and posterior aspects of a metapodium, with a pointed flint tool. The second step consisted of sawing a groove around the circumference of the bone, again with a flint tool, in order to

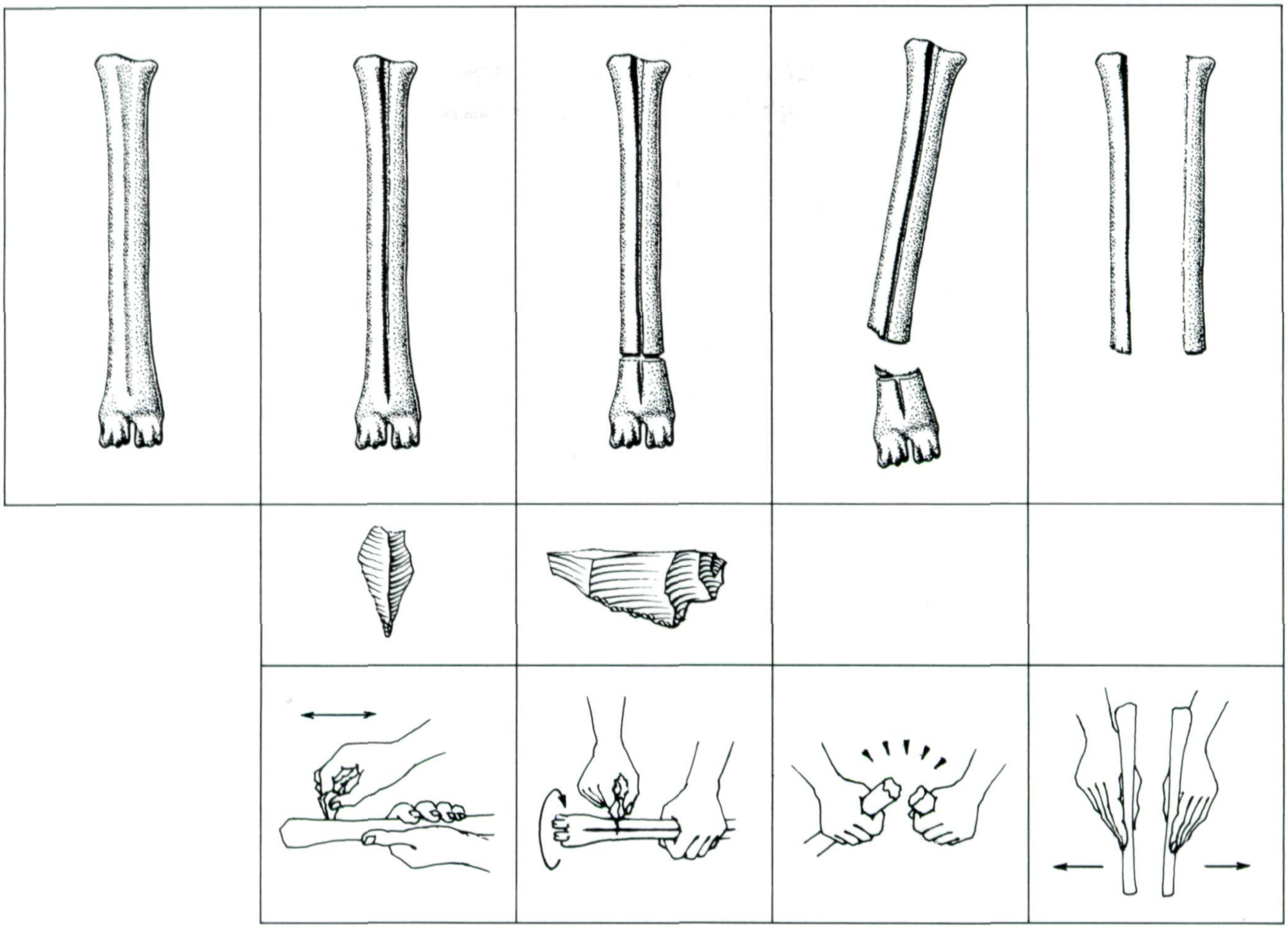


Fig. 59 Manufacturing sequence of bone awls and chisels (after Maarleveld 1985).

enable the removal of the knobby distal end by breaking it off. Lastly, the metapodium was split in half lengthwise, after which the two sections could be ground into their final shape. Van den Broeke (1983), who examined the bone points and awls from Hazendonk, arrived at the same production sequence.

Van den Broeke did some experiments with flint tools in order to test their suitability for carving and sawing bone. I examined the implements he used, all of them made of a rather fine-grained variety of Rijckholt flint (experiment nos. 63-72; see *appendix II table 3*). The wear traces observed on the experimental carving tools (*fig. 17c*) show a remarkable similarity to those on the archaeological pieces, interpreted as having been used for carving bone. One possible explanation is that the pointed flakes on which these traces were found (*figs. 56f-h*) had been employed for deepening the grooves on the metapodia. Some of the archaeological artefacts used in a sawing motion might have played a role during the second stage of awl and chisel manufacture, but the similarity in polish is not so striking as in the case of the carving-implements. All in all, it seems that here we have an example of a reconstruction of the exact task involved, because of the detailed archaeological context available. It is also interesting to note that 'simple', unretouched, flakes were involved in the task of bone awl and chisel manufacture.

In addition to the carving and sawing tools, four implements appear to have been used for scraping bone (*fig. 56b*). These scrapers had rather steep edge angles, while the polish exhibited the 'beveling' (see *3.4.2.1*) such as is reported by Plisson (1985a). Lastly, several borers with 'bone-polish' had been found (*figs. 56a, 56c, 56e, 56i*). Their tips were very heavily rounded, with a clear directionality visible in the polish (*fig. 58a*). One of these borers was probably hafted (B3/15, *fig. 56a*); this tool was also used for carving bone.

SOFT PLANT-WORKING

A total of 16 used zones on 14 tools display traces interpretable as being the result of contact with soft plants. The most interesting are six artefacts exhibiting a pointed end

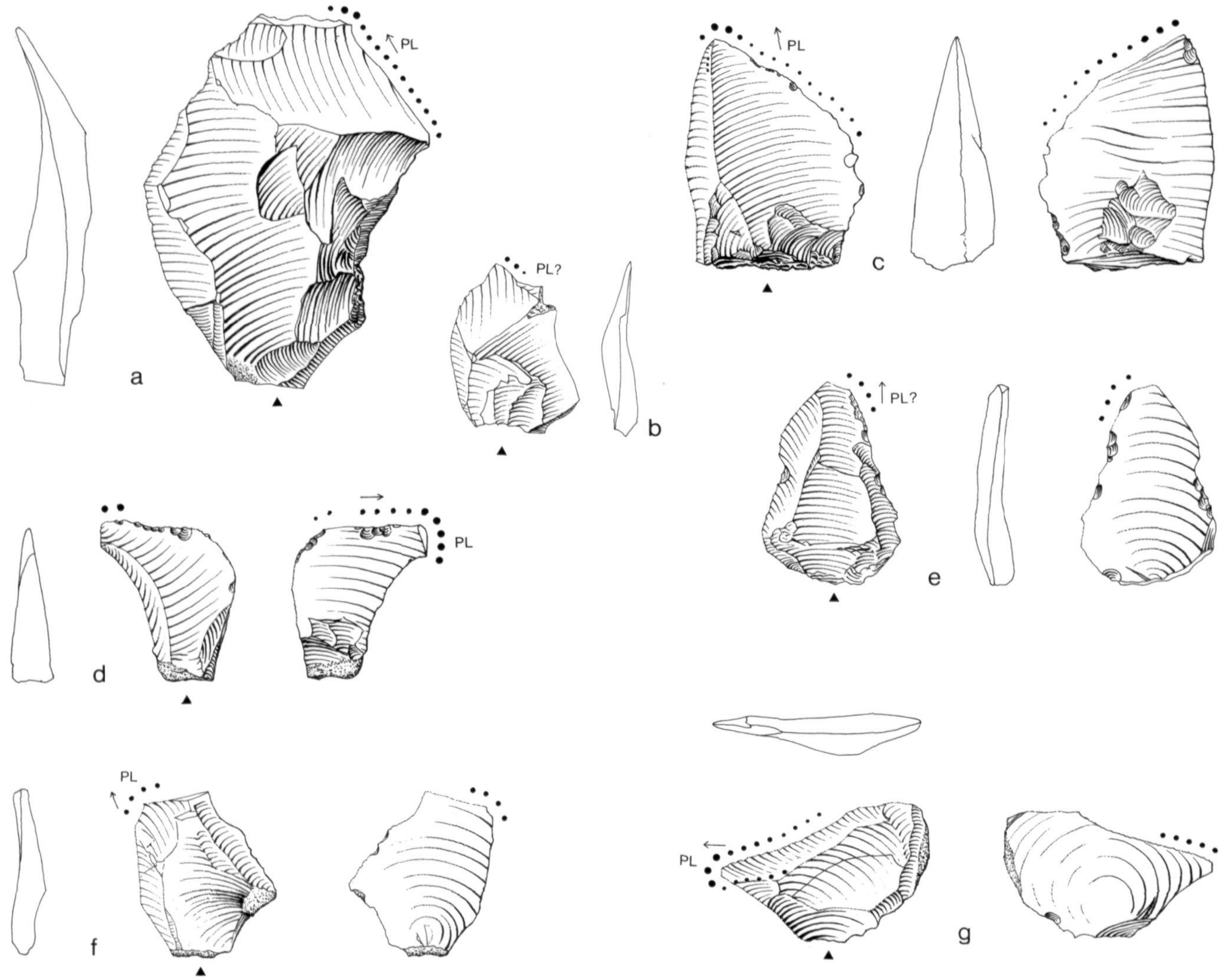


Fig. 60 Artefacts from Hekelingen III displaying wear traces interpretable as being the result of soft plant-processing. a) B3/31 used for cutting grasses, b-g) plant-splitting implements: b) B3/33, c) D3/20, d) D3/19, e) H2/31, f) H2/37, g) E3/14 (1:1).

(see *figs. 60b-g*). Little micro-scarring is present on these tips, but they are covered by a bright, smooth polish extending c. 3 mm from the edge of the tool (*fig. 61b-f*). It has not been possible to exactly reproduce this combination of wear-traces. Initially, it was assumed that the implements would have been used to split willow branches for basketry or matting (*fig. 62*). However, this kind of activity does not create the same polish as is visible on the archaeological tools. Experiments with splitting reeds did not produce a similar use-wear pattern either (*fig. 62*). Nevertheless, with particular reference to the distribution of the polish, I would argue that splitting non-silicious soft plants or twigs is the most likely explanation for the traces observed on these artefacts.

The other soft plant-working tools include three blades or elongated flakes such as B3/31 (*figs. 60a, 61a*), used in a cutting motion. The polish extends 0.5-1.0 mm into the piece, is very bright and smooth, and somewhat resembles 'sickle-gloss'. These tools display little or no edge-removals. It is the limited width of the polish band which gives rise to the interpretation that these artefacts have been used to cut wild grasses (possibly for basketry). As has been shown before (see *3.5*), there is a significant difference in distribution between gloss induced by grasses and by cereals or

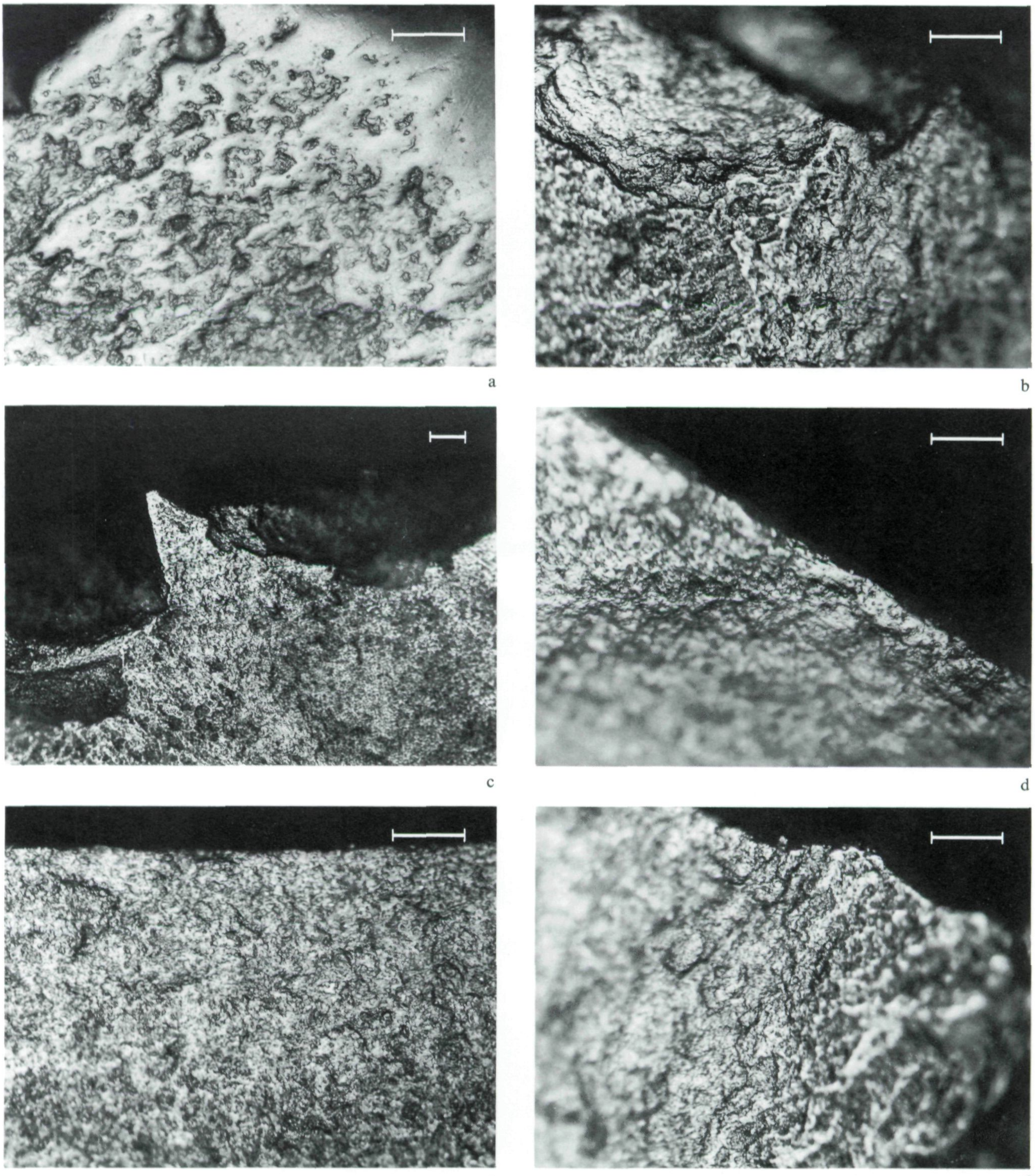


Fig. 61 Hekelingen III: micrographs of traces interpreted as being from soft plant-processing (see *fig. 60*). All scale bars equal 50 μ. a) B3/31 (200x), b) D3/19 (200x), c) D3/20 (100x), d) H2/37 (200x), e) B3/33 (200x), f) H2/31 (200x).

Fig. 62 Experiments with splitting willow (above) and reed (below) as an attempt to replicate the archaeological traces interpreted as being from splitting plants.

reeds. Polish caused by the latter two plant categories covers an area along the edge of the tool of c. 1 cm wide. In contrast, grasses inflict a polish band of maximally c. 2 mm.

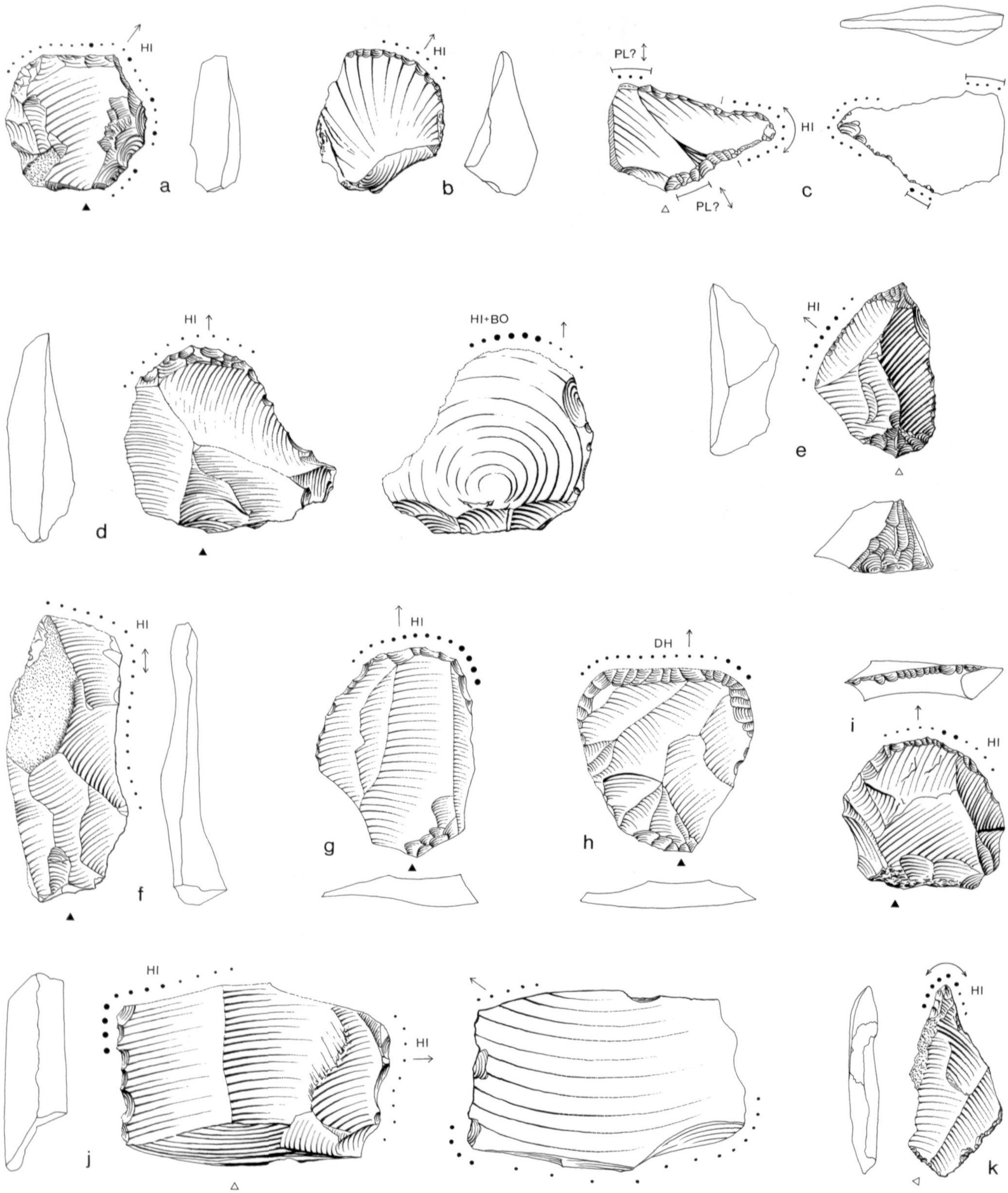
No soft plant scrapers were found. Of one implement the motion in which the tool was involved could not be ascertained. Of the remaining six PUAs the 'soft plant'-polish is interpreted as being the result of a binding for hafting. These implements will be discussed in the paragraph on hafting (see below).

HIDE-WORKING

Hide-working was a very common activity: 41 PUAs on 38 tools were interpreted as having been in contact with hide (*fig. 63*). Characteristic wear attributes include a heavily rounded edge (*figs. 64a-d*), little or no edge-removals, and a band of rough polish, which extends into the retouched scars. The traditional distinction between gloss from dry and fresh hide is not very clear (cf. *3.2.2*); if a polish is 'matt' it is assumed to be the result of scraping a dry hide, whereas a polish with a greasy 'wet' appearance suggests contact with a fresh hide. In Hekelingen III, 26 of the hide-working tools display a 'matt' appearance and therefore they customarily would be interpreted as having been used on dry hide. However, in paragraph 6.2.6 I will argue that the 'matt' appearance of the polish and the edge-rounding on these tools could be due to the addition of abrasives while scraping very moist and greasy raw hides such as those of fox and bear.

Motions inferred, include scraping (22 PUAs), cutting (7 zones) (*fig. 63j*), and boring (N= 3) (*figs. 63c, 63k*). Lastly, four PUAs displayed 'hide-polish' in such a way that hafting was inferred; these will be discussed in a later paragraph.

Fig. 63 (opposite) Hekelingen III: implements displaying wear-traces inferred as being from processing hides. a, b) scraping (B1/16, A1g/28), c) boring implement B1/9, also displaying traces of a possible haft with plant-fibre binding, d, e) scraping (H2/1, B1/4), f) cutting (A1g/44), g-i) scraping: g) B1/21, h) H2/2, i) A1/3, j) cutting (H2/39), k) boring (B1/5) (1:1).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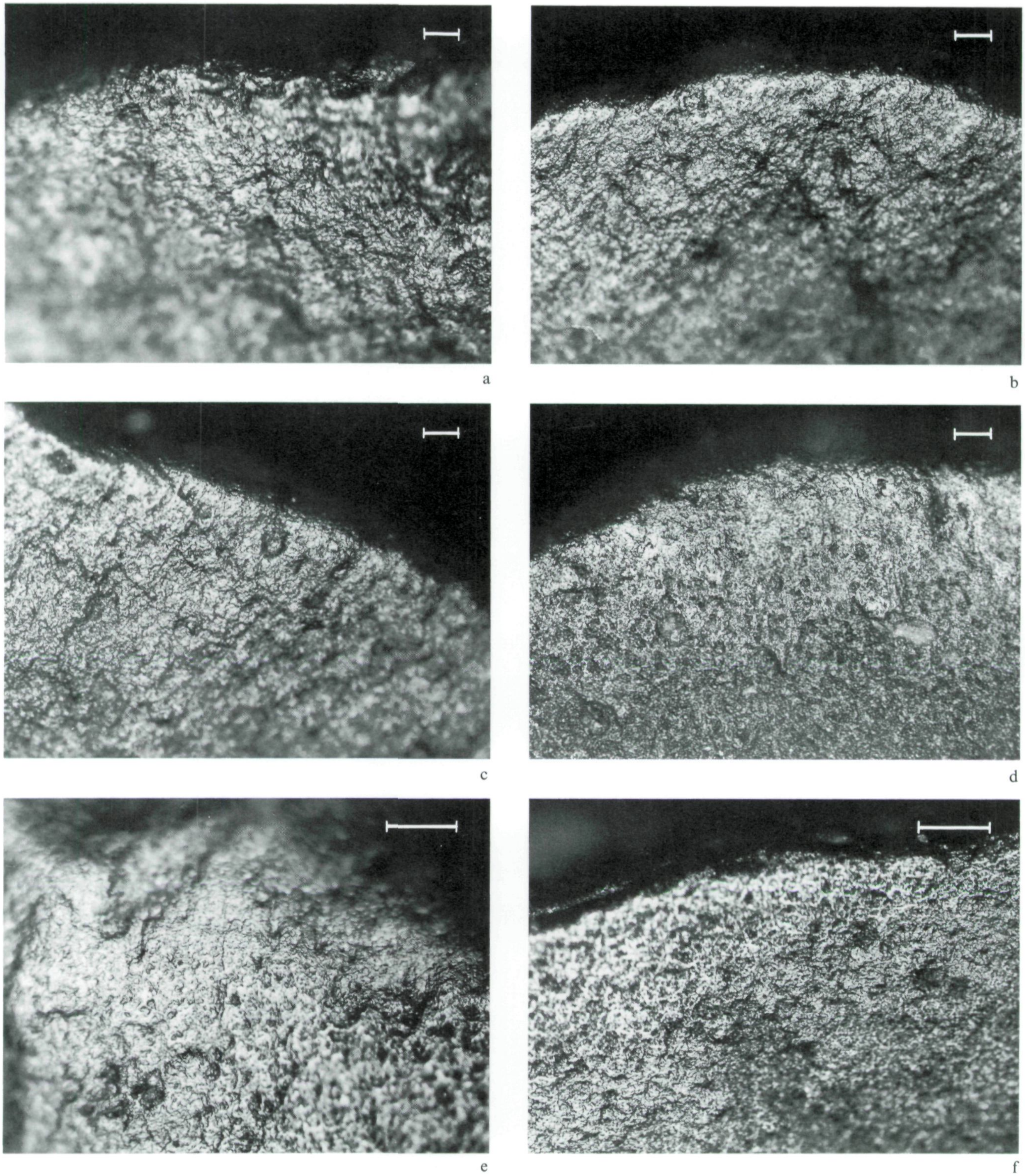


Fig. 64 Hekelingen III: micrographs of inferred hide-working traces on tools depicted in fig. 63. All scale bars equal 50 μ. a) B1/21 (100x), b) B1/16 (100x), c) B1/16 (100x), d) A1/3 (100x), e) H2/39 (200x), f) A1g/44 (200x).

WOOD-WORKING

Hekelingen III has yielded a number of wooden artefacts, notably a paddle, a bow of yew, and an axe shaft of maple. In addition, several hewn poles have been found, probably forming part of constructions. With such an assortment of wooden objects it is not very surprising to encounter a number of wood-working tools: 21 PUAs on 18 artefacts can be reported (*fig. 65*). The wear attributes include a rather smooth undulating or domed polish, which never extends very far across the tool, and moderate edge-scarring (*figs. 66a, 66b*). A number of activities are represented by these artefacts. Some of them (9 PUAs) such as E3/1 and D3/14 had been used for cutting (*figs. 65a, 65d*), others such as H2/10 for whittling activities such as, possibly, the straightening of arrow shafts (*fig. 65c*) (6 PUAs). One implement (F3/3) was employed both in a boring and scraping motion; one whittling tool was also used for scraping (H2/10) (*fig. 65c*), while one artefact was only employed for scraping. Lastly, on one wood-working implement, no evidence for motion was present.

WOOD-/BONE-/ANTLER-WORKING

On three PUAs (located on three implements) traces were found which could either be ascribed to contact with bone or antler. In two of these instances the motion in which the implements were used could not be inferred, in the third instance, it was probably used for cutting. All three tools derive from archaeological unit M1 from which a great many bone- and antler-working implements derive. From unit B1, a borer originates with a polish which, because of its domed appearance and presence of striations, could be interpreted as either have been used on wood or on bone/antler.

ANTLER-WORKING

Although it is often impossible to differentiate between the polish and edge-damage resulting from contact with antler and that from bone (see *3.4.2*), scraping antler usually produces a fluid, rather characteristic polish which I have never observed on bone-scraping implements. Eight PUAs (on seven tools) displayed this kind of bright, smooth almost 'wet' polish. The distribution of this polish was limited to the edge. These pieces were largely confined to archaeological unit M1, exceptional in many other respects (see below), where we find five of the eight PUAs with antler-working traces. From the directionality present in the polish a scraping (2 PUAs), a cutting (1 PUA), and a carving motion (1 PUA) could be deduced, as well as an unknown motion (4 PUAs). One tool (M1/32) bore traces of both scraping and grooving antler.

STONE- AND SHELL-WORKING

From archaeological unit M1 originate a few interesting miscellanea. One borer seems to have been used on soft stone (*figs. 66d, 67c*). It has an extremely rounded tip and exhibits virtually no polish. Stones with perforations are unknown from Hekelingen III or other VL sites, with the exception of some jet and amber beads from Voorschoten and Leidschendam. A possible alternative is that the tool was used on pyrite in order to start a fire. Another interesting implement was a borer interpreted as having been used on shell; the polish has the 'streaky' distribution characteristic for this contact-material (*figs. 66c, 67d*).

THE USE OF PROJECTILE-POINTS

Three PUAs on two projectile points displayed damage in the form of impact fractures at their tip. This feature seems to occur rather consistently on projectile points (Moss 1983a; Fisher et al. 1984; Odell/ Cowan 1986). One barbed point from unit B3 (B3/5, see *fig. 67a*) had an impact fracture on its tip. In addition, it also had extremely rounded edges at the barbs. No clear polish was visible on them but these traces are reminiscent of what Crabtree and Davis (1968) have already described. These authors suggest that projectile point edges were sometimes intentionally ground, not only to stabilize them, but also to protect the binding of hafts. Unit A1g produced a flake of a polished axe with a small amount of retouch along its edges (*fig. 67e*) which, at least typologically, we would hesitate to classify as a projectile point. Nevertheless this tool displayed an impact fracture at its tip and MLITS on another edge, as well as traces of hafting on its lateral sides. One barbed arrow head from H2 displays a possible impact fracture, while one transverse specimen from M1 was too abraded to allow an interpretation of its former use.

WORKING HARD AND SOFT MATERIAL

On some implements it was possible, on the basis of polish-distribution and the nature of the edge-removals, to differentiate between contact with soft material (on 14 PUAs) and hard material (10 PUAs). Inferred motions include cutting, scraping, boring and 'unknown'.

WORKING UNKNOWN MATERIAL

From a considerable number of used zones (22 AUAs or 13.3% of all AUAs) the substance which had been worked could not be specified. Motions inferred encompassed cutting (N = 1), scraping (N = 3), boring (N = 4), projectile (N = 3), hafting (N = 2) and unsure (N = 9) (*figs. 66f, 67b, 67f*).

HAFTING

Microscopic traces of hafting have been observed on 12 used zones representing seven tools; in five instances it concerned an 'uncertain' interpretation. On six zones a smooth 'plant-like' polish was visible, interpreted as being

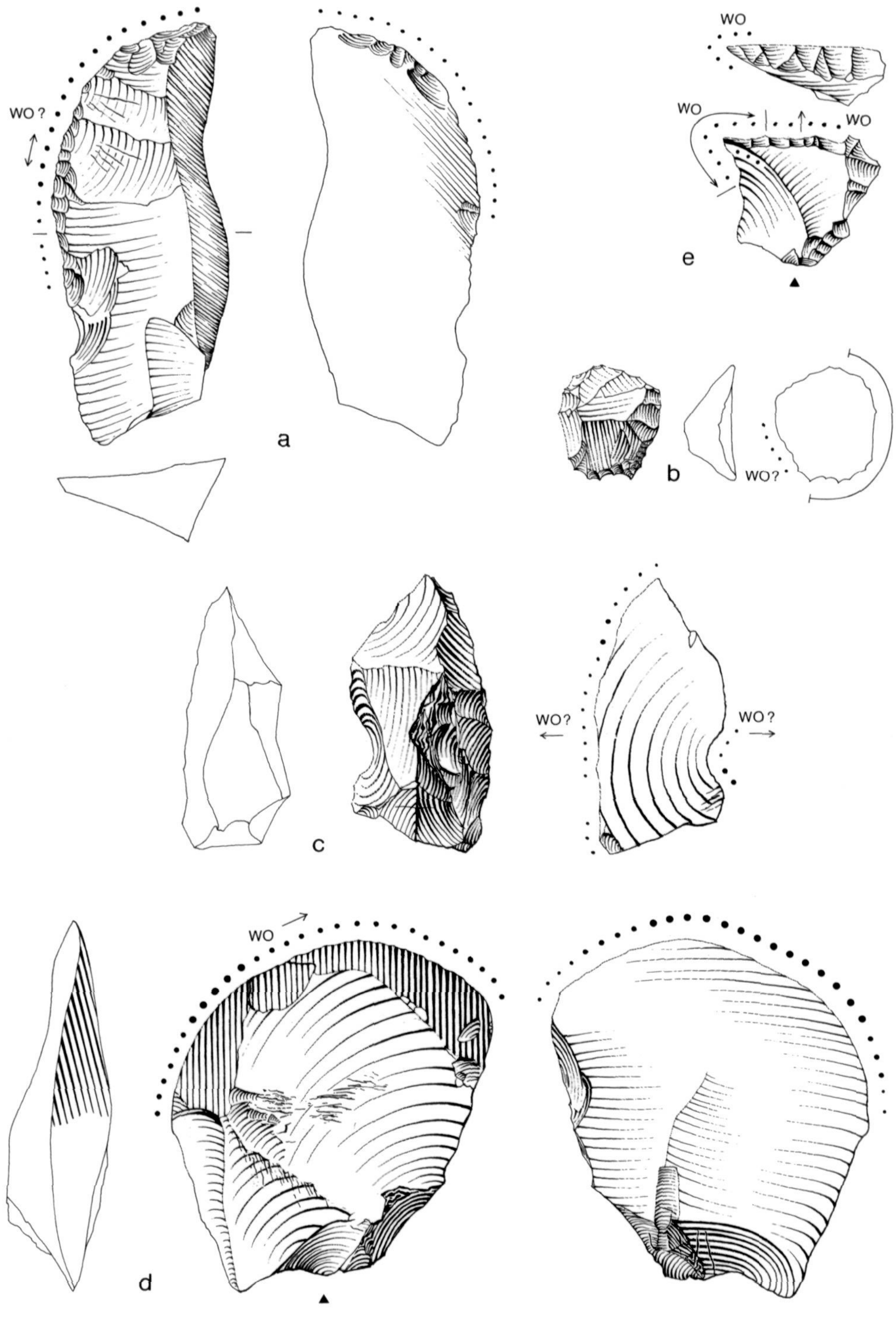


Fig. 65 Artefacts from Hekelingen III showing wear interpreted as being the result of working wood. a) cutting/ sawing (E3/1), b) scraping tool A1g/16, possibly showing traces of hafting, c) scraping (H2/10), d) cutting (D3/14), e) boring (F3/3). (1:1)

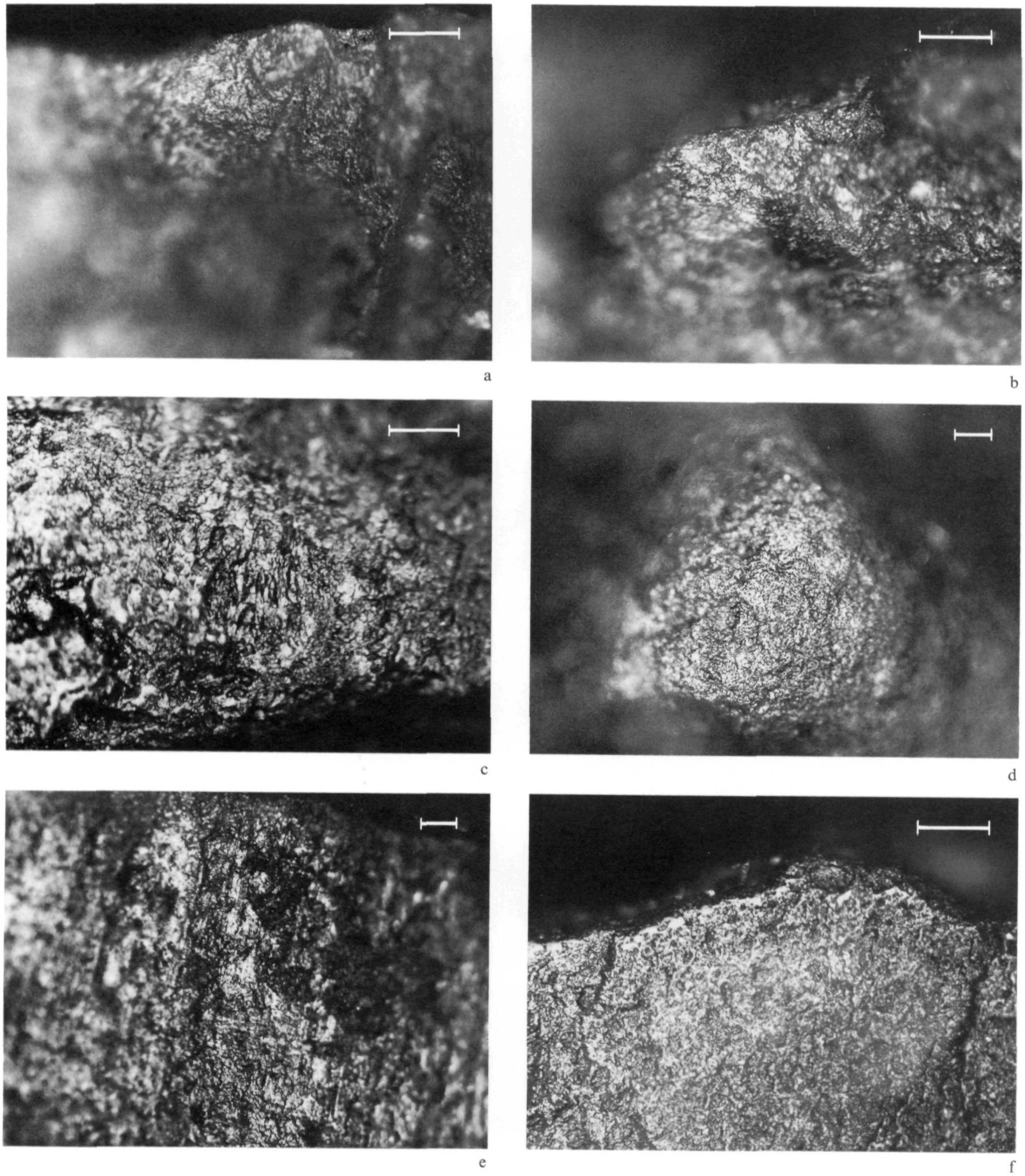


Fig. 66 Hekelingen III: micrographs of inferred tool uses (see *figs. 65, 67*). All scale bars equal 50 μ. a) E3/1; wood sawing (200x), b) H2/10; wood-whittling (200x), c) M1/22; shell-boring (200x), d) M1/3; soft stone-boring (100x), e) A1g/55; hafting traces (100x), f) B1/1: scraping unsure material (200x).

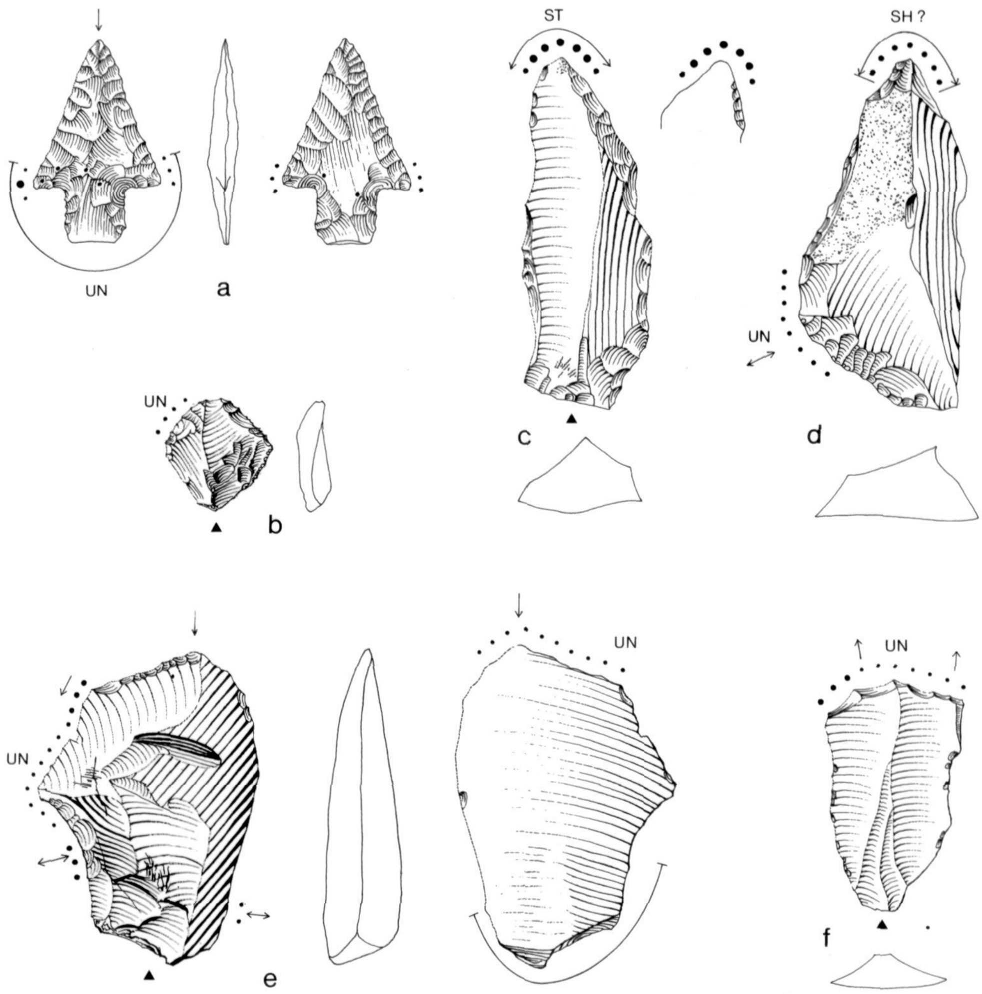


Fig. 67 Hekelingen III: artefacts displaying traces of use. a) projectile (B3/5), b) scraper (A1g/30) used on unknown material, c) borer (M1/3) used on soft stone, d) borer (M1/22) used on shell, e) flake used as projectile (A1g/55), f) steeply retouched flake used on unknown substance (B1/1). (1:1)

the result of binding with plant fibres. Four used zones displayed a 'hide-polish' distributed in such a fashion, i.e. perpendicularly oriented and located on the dorsal ridges and lateral edges alike, as to infer that the flint insert was bound with leather onto the haft. Lastly, two PUAs exhibit streaks of a bright matt polish, oriented perpendicular to the edge, caused by an unknown substance (see *fig. 66e*). Traces of, for example, bone-polish caused by a 'jam haft' (Keeley 1982) were not observed.

The relative scarceness of microscopic traces of hafting in the form of polish and striations is not surprising for a number of reasons. Firstly, experiments with hafting (Keeley 1982, 1987; Moss 1983a, 1987b) have indicated that the associated traces do not develop on a 100% basis. It depends to a large extent on the type of haft used and the relative 'fit' of the flint insert (and thus how much the tool can move within its haft) as to whether or not wear-traces result. If mastic, such as resin or tar, is used to fasten the flint, little damage is inflicted because the flint is immobilized and no friction occurs during work[2]. A 'jam haft', in contrast, can cause quite a bit of damage, due to the friction between haft and flint tool upon contact with a worked material. We do not know what sort of hafts, i.e. bone, antler or wood, were used at Hekelingen III because none was found.

The second reason why hafting traces are scarce in the assemblage, is the character of the raw material. Although some of the flint is relatively fine-grained, it is coarse in comparison to the North-European chalk flint. The latter type of flint exhibits traces of wear much more quickly than coarser grained varieties of flint (see *2.2.6*). As well as the slow formation rate of microscopic hafting traces and the relative invisibility of these traces on the types of flint predominating at Hekelingen III, the secondary modifications (see *chapter 4*) mask incipient wear-traces.

With so little positive evidence for hafting coming from the microscopic analysis, we can turn to morphological attributes of the tools for indications of hafting. These would include morphological facilities for hafting such as a notch, a retouched concave edge or the presence of bitumen (cf. *2.6.1*). However, it should be remembered that such morphological indications were considered 'hypotheses-to-be-tested' (see again *2.6.1*). Of the 337 artefacts examined, 21 were retouched in such a way that this might possibly be to facilitate hafting, while 13 had a notch, presumably for the same purpose. On three artefacts traces of bitumen were preserved. Of these 37 tools with macroscopic features possibly related to hafting, only five actually displayed microscopic traces (sometimes on two PUAs) attributable to the former presence of a haft. Therefore, in only these latter instances was the term 'possibly hafted' justified.

Another indication for hafting are traces of resharpening. Examining this feature seems to be, at least when discussing hafting, only relevant for the very small tools. The proposition is that one cannot resharpen a very small tool, such as a thumb-nail scraper, unless it is hafted. Resharpening can be inferred when the polish appears to be fragmented and removed by subsequent retouching. This was observed in six cases (four of which derived from unit A1 or A1 creek). Another indication for resharpening is formed by steep overhanging dorsal edges, i.e. with an excessively steep edge angle being larger than 90°; only five tools display such an edge.

It can be concluded, that traces of hafting, both microscopic and macroscopic, are rare. This might mean several things. Firstly, hafting traces were really absent because the hafts were fastened so tightly to the flint that the latter did not get damaged. Possible traces of hafting might also have been obscured by post-depositional surface modifications. Another possiblity is that most tools were used unhafted; this might very well be feasible for the larger implements. However, the tiny scrapers and some of the borers seem too small to be effectively used in such a way, while projectile points can only be used when hafted. Moreover, in those cases where traces of hafting were observed, it was always on such small tools. It is also possible that retooling did not take place at Hekelingen III on an extensive scale.

NOTEWORTHY 'ABSENTEES'

Two activities which might have been expected to be present are lacking: cereal-harvesting and fish-processing. It is obvious that one should never consider the absence of certain traces as proof that the associated task was not carried out. First of all, only a sample of the total assemblage has been studied and it can never be excluded that such traces are extant in the remaining of the excavated material. Secondly, during an excavation one already 'samples' the total variability present in the man-land relationship. Many activities will have taken place outside the excavated area, especially those related to the subsistence-quest, or 'dirty' and space-demanding work like the processing of hides. The absence of implements with sickle-gloss at Hekelingen III, i.e. evidence for cereal-harvesting, is therefore not significant in itself. Such tools could have been discarded near the agricultural fields upon completion of the harvesting task. However, other avenues of research, especially the palaeobotanical research, indicate that cereals were probably not cultivated locally (Bakels 1986, 1988). The absence of sickle blades provides support for the assumption, based on palaeobotanical results, that cereal cultivation was not practised in the area of Hekelingen III.

The absence of 'fish-polish' is much more surprising and clearly requires an explanation. Hekelingen III has yielded ample evidence for the exploitation of fish: obviously its location was ideal for this purpose. It has even been suggested that the site owed its very existence to the capture of sturgeon (Louwe Kooijmans 1983b). The sturgeon is an anadromous fish which, in early summer enters freshwater streams in order to spawn. The flooded backswamps behind the levees of the main creek provided excellent spawning-grounds and could be reached by way of the small tributaries such as the one beside archaeological unit F3. In this narrow side-creek a cluster of poles has been found, which, in analogy with the site of Vlaardingen was interpreted as a fish-trap, apparently intended for catching sturgeon (cf. Boddeke 1971).

Characteristic for anadromous fishes such as sturgeon and salmon is their sudden arrival in great masses. Consequently, they can only be caught during a brief period, but then in large quantities. A fish-trap can be interpreted as a tended facility (*sensu* Oswalt 1976). The location of the trap at Hekelingen III, right within the settled area, enables the occupants to keep an eye on the imminent arrival of the sturgeon. We find a similar situation, for example, among the Netsilik Eskimo, who set up camp close to their weirs in order to spot the fish runs (Balicki 1970). Once the sturgeon had been caught the inhabitants are unlikely to have hauled the large (1.5 to 2.5 m long) fishes to a far-off location for cleaning. I assume they would process the catch right next to the trap, just as for instance the Kutchin set up their cutting tables and drying racks adjacent to their fish-traps (Nelson 1973). The rows of postholes adjacent to the main creek of Hekelingen III might be an indication for the presence of such racks.

All these considerations taken into account it seems strange that no flint tools interpretable as having been used on fish were encountered. Several authors have drawn attention to the fact that in very few archaeological cases traces of 'fish-polish' have been found, despite its distinctive character (Juel Jensen 1986: 25; Moss 1988). In a previous paper I have attributed this absence of evidence to the fact that the distinctive 'fish-polish' only occurs on tools used for scaling fish. As catching such fish usually concerns individual specimens, it is imaginable that either insufficient wear has developed for us to discern (especially recalling secondary use and/or abrasion), or that the scaling occurred outside the settled area at the catch-spot itself with tools being discarded there. As far as the processing of sturgeon is concerned, experiments have shown that, generally, regular 'bone-polish' developed; such tools might therefore be 'hidden' among the bone-sawing/ -cutting implements (Van Gijn 1986a).

6.2.4 INTRA- AND INTER-UNIT VARIABILITY

In this paragraph I will first examine whether activity areas can be differentiated within the occupation zone. Next, I will address possible variation in the range of demonstrated activities between the archaeological units analyzed. Lastly, possible changes through time (i.e. between the three VL occupation phases) will be discussed.

The possible existence of activity areas and the related topic of refuse-management (Hayden/ Cannon 1983) is a hotly debated issue. Primary refuse is scarce in activity areas of sedentary communities: because people have to use their house and the area immediately adjacent to it continuously, they regularly clean up and deposit the vestiges of their activities in dumps (hence secondary refuse) (Schiffer 1985). It is clear, however, that (semi-)permanent features, such as walls, benches or hearths, to a large extent structure the inhabitants behaviour, causing activities to regularly take place in designated spots (Cribb 1983). This would theoretically result in set activity areas, but how activity-specific such areas would be is another matter and depends on a great many variables. These include, among others, an anticipated future re-use of a spot (Siegel/ Roe 1986), the need to schedule certain activities concurrently because of 'time-stress' (Torrence 1983) and certain cultural preferences.

Whatever the outcome of such theoretical considerations, the fact remains that use-wear analysts have been able to demonstrate the existence of activity areas on the basis of the wear-traces present on the flint tools. In the Mesolithic site of Vaenget Nord, Denmark, Juel Jensen and Brinch Petersen (1985) have distinguished hide-working activites in the peripheral zone of the site, while minor crafts such as bone-working took place around the hearths. Keeley located a bone and antler workshop at the settlement of Meer, Belgium (Cahen et al. 1979).

When we examine the situation at Hekelingen III, the situation is less clear. Figures 68-73 depict the spatial distribution by 1 × 1 m squares of the inferred contact-materials for the various archaeological units. This distribution

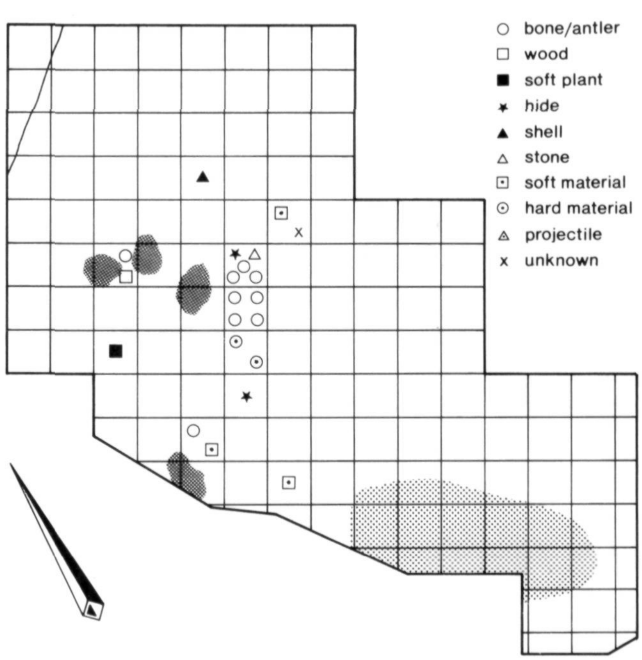


Fig. 68 Hekelingen III archaeological unit M1: spatial distribution of inferred contact materials. Note that on figs. 68-73 the dark-toned spots indicate hearth-areas, while the lighter-toned surfaces locate various disturbances. The wavy line (not present on all figures) gives the approximate edge of the main creek and/or its tributaries.

conforms roughly to the one derived from pottery densities (Van de Velde *in prep.*). The units have rather clearcut boundaries within which all settlement activities are confined, whether they be 'dirty' work like cleaning raw hides, or minor, 'clean' crafts such as bone-tool manufacturing. The location of the find clusters coincides with that of the posthole clusters, seen as evidence for the presence of round or oval huts (Louwe Kooijmans 1986: 18).

Unit M1 is a typical example of this confined distribution. When we look at figure 68 we observe that all bone-/antler- and wood-working tools are clustered around the hearth areas, but so are the few hide-working tools inferred. Obviously we can explain the presence of hide-scrapers close to a hearth by assuming that retooling took place here: exhausted scrapers were removed from their hafts and replaced by fresh specimens (Keeley 1982). Examination of the M1 hide-scrapers for traces of exhaustion such as overhanging dorsal edges, however, suggests that this cannot have been the case as the edges are still usable. A more likely explanation for the characteristic find-distribution of M1 can be found in the circumstance that it might concern a short-lived settlement, possibly revisited several times (see *6.2.6.2*). Unit A1 displays much the same structure as M1 with all used

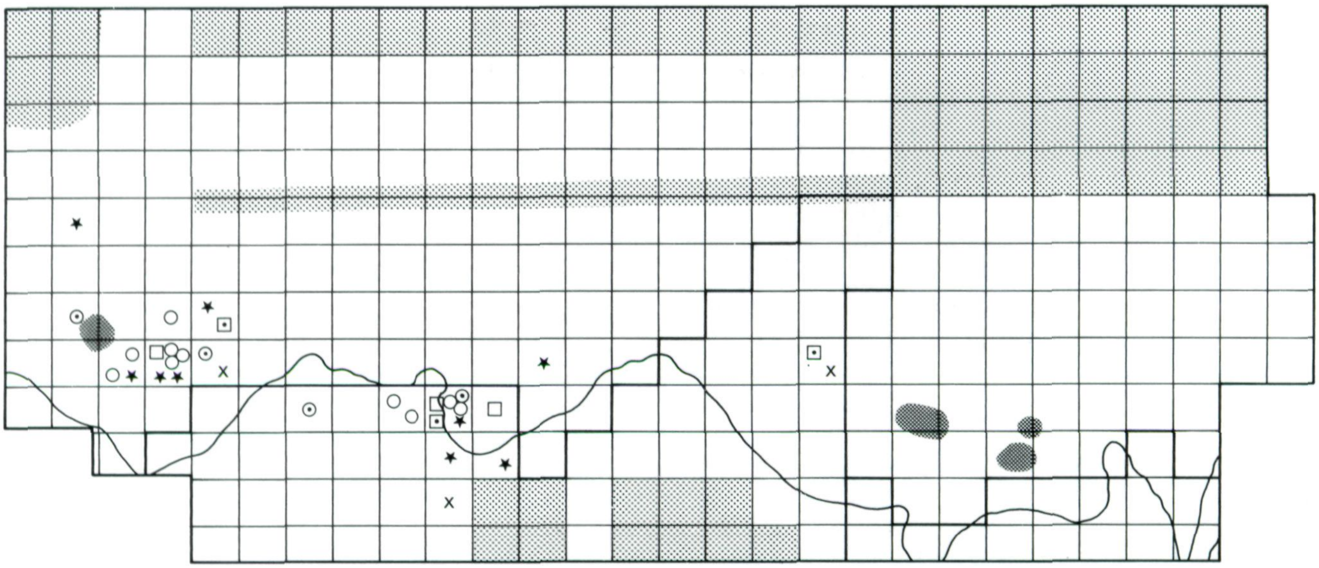


Fig. 69 Hekelingen III archaeological unit A1 and A1g: spatial distribution of inferred contact materials.

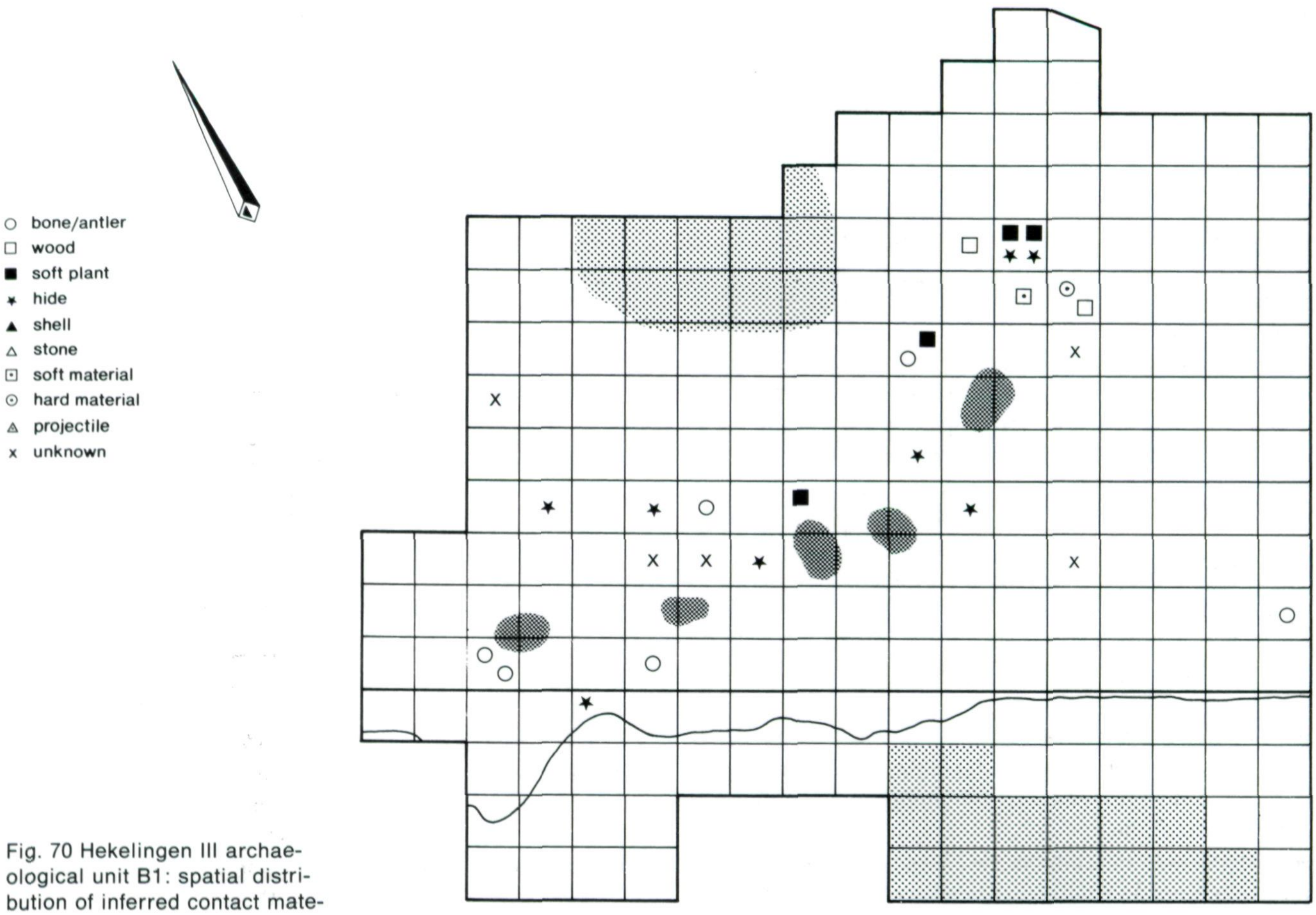


Fig. 70 Hekelingen III archaeological unit B1: spatial distribution of inferred contact materials.

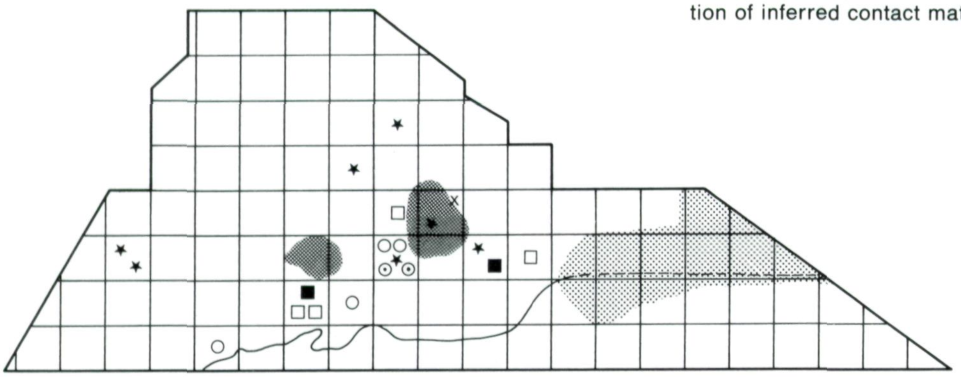
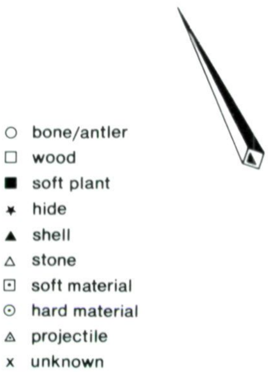


Fig. 71 Hekelingen III archaeological unit H2: spatial distribution of inferred contact materials.



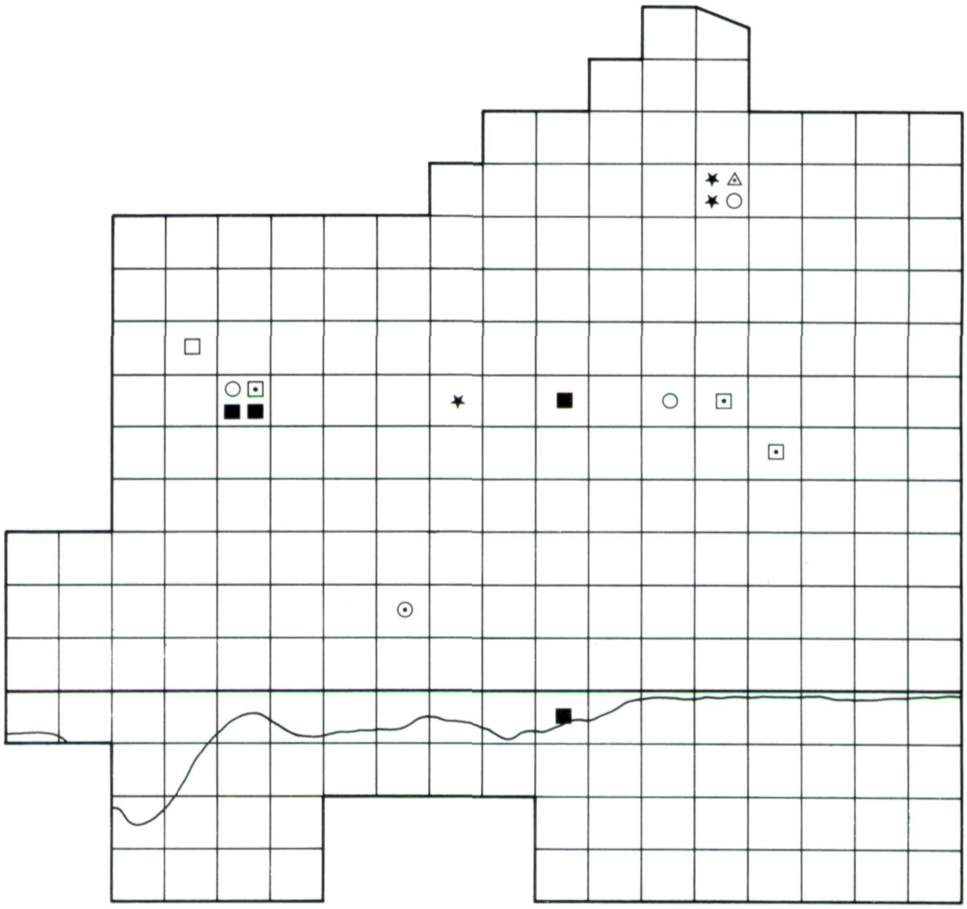


Fig. 72 Hekelingen III archaeological unit B3: spatial distribution of inferred contact materials.

tools clustered around the hearth (*fig. 69*). Unit B1 (*fig. 70*) demonstrates a more diffuse configuration; no concentrations are evident. At unit H2 bone- and wood-working tools are found near the hearths, with four of the six hide-working tools in the periphery. Although the number of tools is too small to carry out a significance test for this distribution, it might be suggested that in unit H2 we have a hint at spatially separate activities (*fig. 71*). Archaeological unit B3, like B1 also exhibits a random and rather wide distribution in which concentrations of tools for specific activities could not be distinguished (*fig. 72*). The same applies to units D, E and F, all attributed to phase 3, with the additional difficulty here that the number of PUAs which could be interpreted is so small that talking about

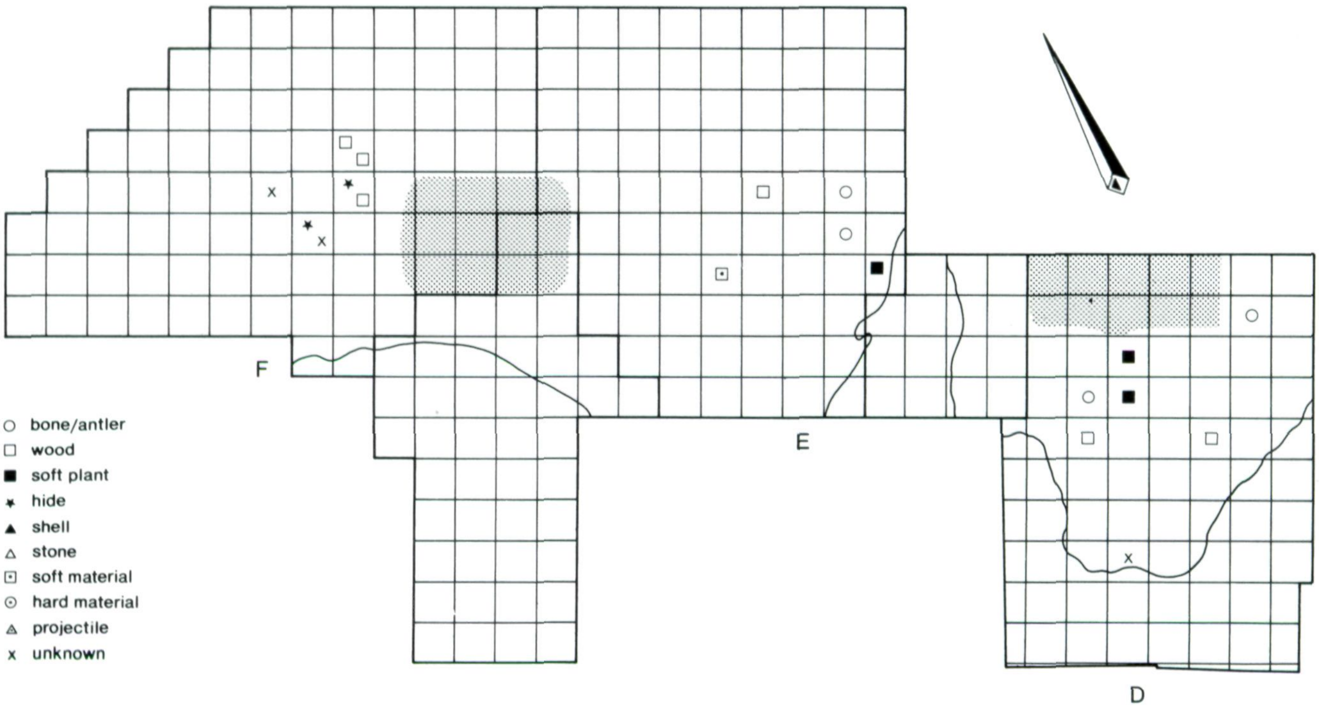


Fig. 73 Hekelingen III archaeological unit DEF/3: spatial distribution of inferred contact materials.

activity areas becomes rather pointless (*fig. 73*).

As far as the question about variability in activities between units is concerned, it should be clear that the numbers involved are really extremely small and, quantitatively, we cannot conclude too much (*table 32*). It is evident that a wide range of activities has been carried out at each unit. Some differences can be noted. Compared with units A1, A1g, B1 and H2, unit M1 has yielded remarkably little evidence for hide-working; instead a number of antler-working tools were encountered, absent, or rarely occurring at the other units. The significance of this last observation is doubtful as not only M1, but most other units as well, yielded small quantities of worked antler (Bodegraven 1986). Unit A1 and A1g display mainly hide- and bone-working tools, soft plant-working apparently being absent. H2 is remarkable because of a significantly higher number of wood-working zones. B3 displays evidence for a variety of performed activities, whilst the number of used zones at DEF/3 is too small to observe any trends.

If the units are grouped into the three habitation phases differentiated at Hekelingen III, the above-mentioned differences become slightly more pronounced, although the numbers are still too small for clear-cut statements (*table 33*). During phase 1 activities involving animal substances such as bone, antler and hide predominate. During phase 2, represented by unit H2 only, plant- en especially wood-working become more important, while during phase 3 tasks involving soft plants seem to become even more prominent, at the expense of hide-processing. I am hesitant, however, to attach behavioural implications to these observations as the numbers are so small. Such conclusions must await the results of other lines of research; a combination of all sources of information can test the above observations.

6.2.5 Aspects of form and function

In the following paragraphs various morphological characteristics of potentially used edges will be examined with respect to the motion in which they were used, the inferred contact-material, and the intensity of wear evident on them (see also *5.5*). It should be stressed that one morphological aspect, the form of the cross-section of the edge, constituted a sampling criterium (cf. *2.3.1*) and was therefore omitted from this analysis (388 of the 455 PUAs had such a straight cross-section). As the type of raw material used appeared to be related to habitation phases at Hekelingen III (cf. Verhart 1983), this was also omitted from further examination. It was considered to be more relevant to examine possible changes in use-patterns between the three phases than between raw materials (see previous paragraph).

Table 32 Hekelingen III: contact-material inferred per archaeological unit by actually used area (AUA).

	M1	A1	A1g	B1	H2	B3	D3	E3	F3	total
hide	2	7	11	9	7	3	–	–	2	41
soft plant	2	–	–	4	3	4	2	1	–	16
wood	1	1	3	2	7	1	2	1	3	21
wood/bone/antler	3	–	–	1	–	–	–	–	–	4
bone	1	5	5	5	5	2	2	2	–	27
antler	5	1	–	–	–	1	–	–	1	8
soft stone	1	–	–	–	–	–	–	–	–	1
shell	1	–	–	–	–	–	–	–	–	1
hard material	2	2	2	1	2	1	–	–	–	10
soft material	3	1	5	1	–	3	–	–	–	14
unknown	1	1	10	5	2	1	1	1	1	22
total	22	18	36	28	26	16	7	5	7	165

6.2.5.1 Edge angle

As has previously been observed in the case of Beek-Molensteeg, edge angle can be considered a determinate factor for the motion in which an implement is used (*table 34*). Edges with angles between 40-99°, with a peak in the 60-79° range, were mostly used for scraping. Cutting edges, on the other hand, have edges of 20-59° for the most part. Tools inferred as having been employed in a splitting motion display angles between 20-59°, while those apparently used for carving are more sturdy, having angles between 40-79°. It should be noted here that the three instances of carving, and the 17 cases of boring, in the edge angle range below 20°, concern points for which no edge angle measurements could be taken (cf. *2.6.2*).

When examining inferred contact-material in relation to the edge angle (*table 35*), there is very little relationship. Omitting angles of 20° and less, because of the inclusion of 17 boring implements in this category, it can be seen that edges with angles between 40-79° display wear-traces of a variety of contact-materials. Exceptions include instances of soft plant-cutting tools with angles mostly falling in the 20-39° range, and some hide-woking implements with an angle between 80 and 99°. It is clear that edge angle primarily defines the motion to which an implement is put, and only secondarily the contact-materials. A relationship between edge angle and contact substance is therefore only evident where a correlation exists between motion and contact-material such as for instance between soft plant and cutting (low edge angles). These results contradict to some extent suggestions made by Tainter (1979) and Wilmsen (1968).

With reference to the intensity of wear in relation to edge angle, again, few differences can be noted between the various edge angle classes (*table 36*). The relatively low percentage of lightly, medium and heavily worn edges in the 80-99° range, is compensated by a higher frequency of 'unsure' inferences. The high percentage of worn edges in general, and heavily worn ones in particular in the < 20° class, can be attributed to the inclusion of boring tools. The percentage of PUAs without traces of wear is, however, about equal for all categories differentiated.

Table 33 Hekelingen III: contact-material inferred, per phase by actually used area (AUA).

	phase 1	phase 2	phase 3
hide	29 (27.9%)	7 (26.9%)	5 (14.3%)
soft plant	6 (5.8%)	3 (11.5%)	7 (20.0%)
wood	7 (6.7%)	7 (26.9%)	7 (20.0%)
wood/bone/antler	4 (3.8%)	–	–
bone	16 (15.4%)	5 (19.2%)	6 (17.1%)
antler	6 (5.8%)	–	2 (5.7%)
soft stone	1 (1.0%)	–	–
shell	1 (1.0%)	–	–
hard material	7 (6.7%)	2 (7.7%)	1 (2.9%)
soft material	10 (9.6%)	–	4 (11.4%)
unknown	17 (16.3%)	2 (7.7%)	3 (8.6%)
total	104	26	35

6.2.5.2 Shape of the edge

A second question to ask is whether a relationship can be demonstrated between the shape of the edge (see *2.6.2*) and the inferred motion to which the tool was put. Five edge-categories were differentiated: straight, slightly convex, slightly concave, pointed and irregular. It is clear that a relationship does indeed exist: convex edges are mostly used for scraping and only secondarily for cutting. Straight edges, for the greater part, serve cutting purposes, while whittling required a concave edge. Carving was performed with either straight or concave edges, splitting with a straight edge (*table 37*). The results confirm what we would intuitively expect. If we examine how the shape of the edge relates to worked material, the picture is less clear: straight, convex, pointed and, to a lesser extent, concave edges display evidence for virtually all contact-materials. There is only a relationship between hide and convex edges (*table 38*). Neither is there much correlation between shape of the edge and intensity of wear, with the exception of the category 'pointed'. This category includes the borers, many of which were intentionally modified for use as such (*table 39*).

Table 34 Hekelingen III: edge-angle, divided into classes, versus inferred motion by actually used area (AUA).

	<20°	20-39°	40-59°	60-79°	80-99°	≥100°	total
scraping	2	2	8	20	8	–	40
whittling	1	1	2	2	–	–	6
cutting	3	14	17	3	–	–	37
carving	3	–	6	2	–	–	11
splitting	–	4	2	–	–	–	6
boring	17	–	–	–	–	–	17
projectile	1	–	–	2	–	–	3
hafting	–	–	4	4	4	–	12
unknown	3	3	9	12	6	–	33
total	29	24	49	45	18	–	165

Table 35 Hekelingen III: edge-angle, divided into classes, versus inferred contact-material by actually used area (AUA).

	<20°	20-39°	40-59°	60-79°	80-99°	≥100°	total
hide	5	3	14	14	5	–	41
soft plant	1	7	4	2	2	–	16
wood	3	3	11	3	1	–	21
wood/bone/antler	1	–	1	2	–	–	4
bone	4	4	10	7	2	–	27
antler	1	–	3	2	2	–	8
soft stone	1	–	–	–	–	–	1
shell	1	–	–	–	–	–	1
hard material	3	5	1	–	1	–	10
soft material	4	1	3	4	2	–	14
unknown	1	–	–	2	–	–	22
total	29	24	49	45	18	–	165

Table 36 Hekelingen III: edge-angle, divided into classes, versus inferred intensity of wear by potentially used area (PUA).

	<20°	20-39°	40-59°	60-79°	80-99°	≥100°	total
no traces	9	19	29	19	8	1	85
lightly worn	2	1	4	6	1	–	14
medium worn	7	7	11	4	1	–	30
heavily worn	12	6	8	10	1	–	37
resharpened	–	–	–	6	–	–	6
probably used	7	13	17	12	5	–	54
not interpretable	10	31	44	49	17	1	152
unsure	8	10	25	19	15	–	77
total	55	87	138	125	48	2	455

Table 37 Hekelingen III: shape of the edge versus inferred motion by actually used area (AUA).

	straight	convex	concave	pointed	irregular	total
scraping	4	34	–	1	1	40
whittling	2	1	3	–	–	6
cutting	14	19	2	1	1	37
carving	6	1	3	1	–	11
splitting	5	1	–	–	–	6
boring	1	–	–	16	–	17
projectile	1	1	–	1	–	3
hafting	5	5	1	1	–	12
unknown	8	23	1	1	–	33
total	46	85	10	22	2	165

Table 38 Hekelingen III: shape of the edge versus inferred worked material by actually used area (AUA).

	straight	convex	concave	pointed	irregular	total
hide	7	27	1	5	1	41
soft plant	9	5	1	1	–	16
wood	6	7	6	2	–	21
wood/bone/antler	1	2	–	1	–	4
bone	9	13	2	3	–	27
antler	2	6	–	–	–	8
soft stone	–	–	–	1	–	1
shell	–	–	–	1	–	1
hard material	3	6	–	1	–	10
soft material	3	8	–	3	–	14
unknown	6	11	–	4	1	22
total	46	85	10	22	2	165

Table 39 Hekelingen III: shape of the edge versus inferred intensity of wear by potentially used area (PUA).

	straight	convex	concave	pointed	irregular	total
no traces	45	36	2	1	1	85
lightly worn	1	11	–	2	–	14
medium worn	11	12	2	5	–	30
heavily worn	10	12	5	9	1	37
resharpened	–	6	–	–	–	6
probably used	21	21	10	1	1	54
not intrepretable	64	74	9	2	3	152
unsure	23	44	4	5	1	77
total	175	216	31	26	7	455

6.2.5.3 Shape of the aspect surfaces

Another morphological attribute recorded was the shape of the surfaces constituting an edge (see *2.6.2*). It was assumed that an edge with one convex and one straight plane would be more suitable for scraping, while an edge straight on both aspects would possess good cutting properties. From table 40 we can see that the relationship is not so straightforward, although there appears to be a tendency for some of the edges with one convex aspect (categories 12, 21 and 32) to have been used more often for scraping purposes. When this morphological attribute is studied for inferred substance, an even greater variability is evident. On those combinations occurring most frequently, i.e. 11 and 12 (resp. N = 35 and N = 81), the entire range of contact-materials is represented. The same variability is present when comparing intensity of wear and shape of the aspect surfaces. Consequently, no tables were produced.

6.2.5.4 Tool type

In the previous paragraphs emphasis lay on morphological attributes of individual PUAs. In the following, the question will be asked whether tool types are homogeneous in terms of function.

Not less than 22 of the 37 AUAs on convex scrapers were indeed used in a scraping motion, while straight edges on retouched flakes were selected for cutting purposes (*table 41*). As might be expected, borers were employed in boring

Table 40 Hekelingen III: shape of the aspect surfaces versus inferred motion by actually used area (AUA).

	11	12	13	21	22	23	31	32	absent	total
scraping	3	20	1	4	1	–	–	11	–	40
whittling	2	1	1	1	–	–	–	1	–	6
cutting	8	23	–	2	2	–	–	1	1	37
carving	4	5	–	1	–	–	–	–	1	11
splitting	3	2	–	–	–	–	1	–	–	6
boring	4	3	–	–	7	–	1	–	2	17
projectile	–	2	–	–	1	–	–	–	–	3
hafting	3	7	–	–	2	–	–	–	–	12
unknown	8	18	1	1	–	2	1	2	–	33
total	35	81	3	9	12	2	3	15	4	165

or piercing. Otherwise, most tool types seem to have functioned in a number of motions. Especially retouched and unretouched flakes, multiple scrapers, and *encoches* were apparently quite versatile. It should be noted that the registration system used, with its emphasis on edges rather than entire tools, may result in some confusion. Obviously, an *encoche* cannot have been used for boring (see *table 41*). However, apart from a retouched concave edge (which led to the tool's typological classification as *encoche*), the tool possessed another edge which was unretouched, but suitable for boring. In a sense, tables 41-43 are therefore somewhat misleading, because not all the PUAs represented were responsible for the type into which they were classified. To be

Table 41 Hekelingen III: relationship between tool typology and inferred motion by actually used area (AUA).

	scraping	whittling	cutting	carving	splitting	boring	projectile	hafting	unknown	total
unretouched blades	–	–	1	–	–	–	–	–	1	2
unretouched flakes	3	1	4	–	1	–	–	–	4	13
unretouched waste	–	–	1	1	–	–	–	–	1	3
retouched blades	–	–	2	2	–	–	–	–	1	5
retouched flakes	6	1	22	1	5	–	–	–	7	42
retouched waste	3	–	–	–	–	–	–	–	–	3
cores	1	–	–	1	–	–	–	–	–	2
convex scrapers	22	1	3	–	–	–	–	–	11	37
thumbnail scrapers	1	-	–	–	–	—	–	2	2	5
multiple scapers	1	1	3	2	–	–	2	2	3	14
composite tools	1	–	–	–	–	2	–	–	–	3
encoches	–	1	1	2	–	1	–	2	–	7
borers	2	1	–	2	–	14	–	4	1	24
points	–	–	–	–	–	–	–	–	2	2
barbed arrow heads	–	–	–	–	–	–	1	2	–	3
total	40	6	37	11	6	17	3	12	33	165

Table 42 Hekelingen III: relationship between tool typology and inferred contact-material by actually used area (AUA).

	hide	soft plant	wood	wood/bone antler	bone	antler	soft stone	shell	hard material	soft material	unknown	total
unretouched blades	–	1	–	–	–	1	–	–	–	–	–	2
unretouched flakes	4	3	2	–	–	–	–	–	1	1	2	13
unretouched waste	–	–	–	–	2	–	–	–	–	1	–	3
retouched blades	2	–	–	1	2	–	–	–	–	–	–	5
retouched flakes	6	6	7	–	7	2	–	–	7	4	3	42
retouched waste	1	–	1	–	1	–	–	–	–	–	–	3
cores	–	–	–	–	–	2	–	–	–	–	–	2
convex scrapers	17	–	1	2	5	3	–	–	1	2	6	37
thumbnail scrapers	3	–	1	–	–	–	–	–	–	1	–	5
multiple scrapers	2	–	1	–	5	–	–	–	–	1	5	14
composite tools	1	–	–	–	1	–	–	1	–	–	–	3
encoches	–	2	3	–	1	–	–	–	–	1	–	7
borers	3	4	5	1	3	–	1	–	1	2	4	24
points	–	–	–	–	–	–	–	–	–	1	1	2
barbed arrow heads	2	–	–	–	–	–	–	–	–	–	1	3
total	41	16	21	4	27	8	1	1	10	14	22	165

more concrete, several unretouched edges which are present on convex scrapers in addition to the intentionally retouched convex, scraping edge are included among the 37 AUAs on convex scrapers. Despite of its slightly misleading character, table 41 illustrates that we should be prudent about the functional significance of the types differentiated: a convex scraper may have usable edges other than the edge which led to its typological classification.

When examining the relationship between tool type and inferred contact-material, the variability is even more evident. Although a large number of PUAs on convex scrapers were employed on hide, more resistant materials such as bone and antler were worked as well. PUAs on other tool types, most notably multiple scrapers, retouched flakes and borers, display wear-traces from many different contact substances (*table 42*). With respect to degree of wear it can be observed that PUAs on borers are significantly more heavily worn than PUAs on other tool types (*table 43*).

6.2.5.5 Discussion

Finally, I would like to draw attention to the fact that a certain number of unretouched edges nevertheless exhibit traces of use (*table 44*). Although only 9% of the unmodified edges could be interpreted as having been used, this sample includes some crucial information. Sometimes the bone-carving-polish, presumably indicative of the manufacture of bone awls and chisels was observed on artefacts without any trace of modification (*fig. 56d*). Also, four of the six implements interpreted as having been employed in splitting plants appear to be flakes lacking either retouch or 'use-retouch' (*fig. 60c, 60e-g*). The evidence for both bone-tool production and plant-working adds considerably to our

Table 43 Hekelingen III: relationship between tool typology and inferred intensity of wear by potentially used area (PUA).

	no traces	lightly worn	medium worn	heavily worn	resharpened	probably used	not interpretable	unsure	total
unretouched blades	5	–	2	–	–	3	1	–	11
unretouched flakes	29	2	4	–	–	6	32	7	80
unretouched waste	2	–	–	–	–	1	1	3	7
retouched blades	–	–	1	2	–	2	8	1	14
retouched flakes	13	4	8	13	–	8	47	17	110
retouched waste	4	1	–	–	–	1	8	2	16
cores	2	–	2	–	–	1	–	–	5
convex scrapers	18	4	3	4	5	14	31	21	100
thumbnail scrapers	1	1	1	–	1	2	–	2	8
multiple scrapers	3	–	1	2	–	8	7	11	32
composite tools	2	1	1	1	–	1	1	–	7
encoches	–	1	2	4	–	2	4	–	13
borers	–	–	5	11	–	3	2	8	29
points	–	–	–	–	–	–	3	2	5
barbed arrow heads	3	–	–	–	–	–	1	3	7
transverse arrow heads	–	–	–	–	–	2	6	–	8
polished axes	3	–	–	–	–	–	–	–	3
total	85	14	30	37	6	54	152	77	455

Table 44 Hekelingen III: intensity of wear per observed phenomenon.

	retouch ⩾ 1mm	retouch < 1mm	unretouched straight	polished fragments	points	total
no traces	27 (14.1%)	17 (11.5%)	38 (34.2%)	3	–	85
used	38 (19.9%)	37 (25.0%)	10 (9.0%)	–	2	87
possibly used	21 (11.0%)	20 (13.5%)	13 (11.7%)	–	–	54
not interpretable	63 (33.0%)	53 (35.8%)	36 (32.4%)	–	–	152
unsure	42 (22.0%)	21 (14.2%)	14 (12.6%)	–	–	77
total	191 (100 %)	148 (100 %)	111 (100 %)	3	2	455

picture of the site Hekelingen III. As has already been outlined in chapter 3, many activities, if executed in a skilled way and if suitable edges are selected, induce very little, if any, use-retouch on the tools. Moreover, it has also been demonstrated that even long-term work does not necessarily produce polish on the tools. This implies that an even higher percentage of unretouched flakes than the 9% demonstrated for the Hekelingen III assemblage, might have been used but cannot be detected.

From the preceding paragraphs it can be concluded that shape, especially edge angle, was of importance to the kind of motion to which the artefacts were put. Even though the flint technology practised at Hekelingen III appeared to be haphazard and the tool types not clearly defined and standardized, edges were apparently carefully scrutinised for their possible suitability. The decisions the users made were consistent; however, is was the shape of any individual edge that prevailed above the appearance of the total artefact. Tool types were therefore extremely heterogeneous in terms of the use to which they were put (*6.2.5.4*).

6.2.6 Duration of occupancy at Hekelingen III

One of the questions raised by the examination of settlements such as Hekelingen III, is whether or not these sites in the Rhine/ Meuse delta were occupied yearround during the Late Neolithic and the extent to which they were dependent upon hunting and gathering. It appears that people occupied Hekelingen III during various seasons and it would therefore seem unlikely that we are dealing with a special purpose camp ('station'), only briefly visited to exploit one particular resource. Such camps are common in Palaeolithic times, but were also present in fully Neolithic societies and even during the Bronze Age (cf. Bergschenhoek and Oldeboorn). Hekelingen III was located in an area which was, at least from an economic point of view, attractive in different seasons and offered the opportunity of extracting a variety of resources. Were these exploited from a permanently inhabited settlement on the spot, or is the diversity in finds a reflection of recurrent shorter or longer visits?

6.2.6.1 Evidence from the use-wear analysis

There is a number of ways in which the use-wear analysis of the flint can contribute to the discussion about duration of occupancy. It has been postulated that labour-intensive activities, such as the processing of hides, wood- and bone-/antler-working, as well as retooling, would indicate long-term or even permanent occupation. It is only when people settle for an extended period, that they allocate time for executing such tasks. At 'stations', briefly visited to exploit a specific resource, all the available time must be devoted to subsistence tasks.

Hide-processing is often regarded as a task for which one has to be sedentary for quite some time. This is not an unreasonable assumption, as far as the tanning and softening stages of hide-working is concerned. Gallagher (1977), who has studied Ethiopian tanners, mentions that it takes six hours to scrape an entire cow hide, working without interruptions. However, cleaning and drying of fresh hides is often done on the kill site. Binford describes the butchering as being done on the raw hides; they are subsequently dried, held down to the grass by some stones (Binford 1983: fig. 71). These dried hides are very light and therefore easy to transport, even in great quantities. Wet hides on the contrary are quite unmanageable.

The analysis of the Hekelingen III assemblage has indicated the presence of scrapers with a matt polish and considerable edge-rounding, i.e. 'dry hide' working tools. It is often assumed that 'dry hide' scrapers have been used to soften tanned hides. The occurrence of such artefacts would, therefore, suggest that the site was inhabited for an extended period of time. Quite apart from the question as to how long such a stay would have to last before this task was accomplished (a month seems to be quite sufficient), there is yet another reason why we cannot draw this conclusion so easily: flint scrapers can display the same edge-rounding, perpendicular scratches and matt, rough polish as a result of working fresh hides if abrasives are added. Whether this is necessary depends on the presence of fat under the skin. Most fur-bearing animals such as bear, fox and badger have such a fatty layer, while deer, for example, do not. When skinning deer, the hide comes off cleanly (apart from some small scraps of meat adhering to it), and can be dried or processed immediately. However, a fresh fox hide is covered with a large quantity of grease. When attempting to scrape it off, I noticed that this was virtually impossible without adding flour or fine sand which could absorb the fatty moisture. Such a procedure would also prevent that fat accumulates on the scraping edge, hindring its effective use (cf. Brose 1975). Other researchers have also drawn attention to the problem of scraping fatty hides and have described the wear features resulting from the addition of what they call 'abrasives' (Brink 1978b; Mansur 1983). In chapter 3 I have already described the difficulties of differentiating the experimental wear-traces of the separate stages and variations in hide-processing. Here we have such a problem in an archaeological context: do we have to interpret the 'dry hide' scrapers of Hekelingen III as tools used for the labour-intensive softening activities or as implements for cleaning fresh hides with abrasives?

A large majority of the game animals identified at Hekelingen III consist of red deer; for the cleaning of their hides no abrasives were needed, so it would seem that the 'dry hide' scrapers were used in the softening process. However, the amount of scrapers is relatively small, whereas it is generally assumed that softening is very flint-consuming. Gallagher (1977) states that the Ethiopian tanners need four scrapers for softening one cow-hide (it must be noted that this concerns obsidian scrapers which might wear out at a different rate than flint scrapers). Furthermore, the use-wear analysis of the Beek-Molensteeg flint (cf. *chapter 5*) has revealed the presence of a large number of 'dry hide' scrapers, all of them much more rounded and exhibiting much more polish than those from Hekelingen III. The Beek-Molensteeg tools were interpreted as 'real' dry hide scrapers, i.e. used in the softening stage of hide-processing, while the lesser-worn scraping implements from Hekelingen III do not seem to have been employed that way.

The archaeozoological analysis has shown that small numbers of fur-bearing animals were also trapped or hunted. The 'dry hide' scrapers could thus possibly have been used to clean the fresh, fatty hides of bear and pine marten. The relative scarceness of 'dry hide' scrapers and the fact that they were not exhausted would support this hypothesis. One objection to this proposal could be that, in this case, one would expect to find the scrapers used and discarded at the kill sites (see above). However, this pertains mainly to a situation where large numbers of animals are killed simultaneously, such as is the case with reindeer (Binford 1983). The killing of fur-bearing animals, however, is an isolated occurrence probably taking place in the vicinity of the settlement. The cleaning of the fresh hides of fur-bearing animals is quite time-consuming and it seems likely that the animals were simply hauled back to the settlement before being butchered. Ethnographic accounts of Athabascan Indians, who still practise trapping in the forests of northern Canada, support this assumption (Brody 1981). To conclude, I suggest that the 'dry hide' scrapers of Hekelingen III were used in the fresh hide cleaning stage of fatty skins. If this is the case, then the presence of these tools cannot be considered as evidence of a long-term, let alone permanent, occupation of Hekelingen III.

The second activity which is often mentioned as being very time-consuming is bone-working. Ethnographic accounts of Eskimo communities describe how they fill the long and dark winter months with labour-intensive tasks such as the manufacturing of bone and antler objects. It is from such examples that the idea has sprang forth about, for instance, bone-working being associated with winter- or base-camps. Undoubtedly these kinds of activities do take place at sites only occupied during the winter. However, bone- and antler-working are not confined to such types of settlements. Torrence (1983) has rightly drawn attention to the fact that these tasks are eminently suitable to pass the time with, while, for example, waiting for game or for supper. The tools needed to produce bone and antler objects are few in number and small in size. As long as the projected bone or antler objects are relatively small (like the bone awls and chisels of Hekelingen III), it is easy to carry the entire toolkit and semi-manufactured products around for craft activities during short periods of leisure between other tasks, more directly related to the subsistence quest. To conclude, the presence of bone- and antler-working tools cannot be used to determine the type of settlement involved at Hekelingen III.

Recently, Juel Jensen has suggested that the relative frequency of wood-working tools may provide a clue for establishing the duration of occupancy of a site (Juel Jensen/ Brinch Petersen 1985). She states that wood-working is 'neutral' with respect to seasonality (in contrast to hide), and that wooden tools need repair throughout the year. She uses this argument for the interpretation of the Mesolithic settlement of Vaenget Nord (Denmark), where she was able to find only a small number of wood-working tools. Asserting that 'wood-polish is one of the clearer and more easily recognizable polishes' (Juel Jensen/ Brinch Petersen 1985: 52), she concludes that the relative scarcity of wood-working tools is 'real' and forms a reflection of the character of Vaenget Nord, i.e. a place which was visited briefly and for specialized purposes.

I would suggest that there is a stronger argument for wood-working as indicator of duration of occupancy, than its alleged neutrality in terms of seasonality. One would expect that the longer a site is occupied, the more elaborate the dwellings. In those areas where wood constitutes the main building material, one should find more wood-working implements on permanent settlements. The problem with all of the above arguments is, however, that it is not wood-working *per se* which suggests duration of stay, but its relative frequency; how are we to differentiate between wood-working implements produced by permanent inhabitants and those deposited by people who came to visit the site for a few weeks (hence, a shelter) year after year? Returning to Hekelingen III, it was seen that, especially during occupation phases 2 and 3, quite a number of wood-working implements were encountered. We can conclude that the site was therefore not visited briefly but that, instead, people stayed for some time. Whether this stay encompassed a few weeks during various seasons year after year (i.e. a palimpsest of occupations), or whether it concerned yearround settlement, is impossible to tell on the basis of relative frequencies.

Another criterium to determine the duration of habitation at Hekelingen III would be the relative frequency of hafting traces. Based on Yellen's (1977) observation that the longer a site is occupied, the more maintenance activities are carried out, Keeley (1982) has proposed that such settlements would yield a relatively high frequency of once-hafted tools. He argues that it is at those sites that people would repair their implements in preparation of special-purpose trips: when going out on a hunting expedition it is better to have one's toolkit ready in advance. At the base-camps or permanent settlements worn-out or broken tools would be removed from their hafts, while the latter are 'retooled'. The basic assumption is that the hafts require a lot of labour and are being re-used over and over again. Again, we have the problem that this criterium may enable us to differentiate a briefly occupied site from one inhabited for a longer period, but not between a so-called base-camp and a permanent settlement: retooling activities are likely to have taken place at both. There is an additional difficulty that hafting traces are not only frequently absent, but also notoriously difficult to interpret (cf. Stordeur 1987). With respect to Hekelingen III, hafting traces are relatively rare, but, due to the effect of pdsm, this should not be taken as reflecting the 'real' situation.

All in all, the spectrum of activities attested for at Hekelingen III on the basis of wear-traces present, confirms the suggestion that the site cannot have been a briefly-visited 'station'. Evidence for the performance of a variety of activities argues against such an interpretation. It seems quite beyond doubt that the site reflects a (series of) longer-term stay(s). Unfortunately, none of the demonstrated activities could be unequivocally attributed to either a permanent inhabitation or a 'long visit'. Alternative approaches towards solving the problem were therefore sought.

6.2.6.2 *Alternative evidence*

A different approach towards estimating the duration of occupancy at the site, not directly based on the spectrum of activities inferred from the use-wear analysis, is to determine to what extent evidence exists for economizing behaviour with regard to flint. When people inhabited a site such as Hekelingen III on a permanent basis, where plentiful supplies of raw materials are hard to come by in the immediate vicinity, we would expect them to be careful with discarding flint. There are several ways of resolving this question. Firstly, we could examine the degree of wear exhibited by the Hekelingen III tools: 85 (18.9%) of the 449 PUAs were interpreted as unused, while 159 (35.4%) were used to varying degrees. The evidence is not unequivocal: the flint seems neither to have been 'curated' nor wasted, but it should be mentioned that this result can have been distorted by the presence of pdsm.

Another avenue to approach the problem of economizing behaviour is the number of PUAs and AUAs per tool. When raw material is scarce it is assumed that more than one working edge per artefact would be created, i.e. the production of combination tools. At Hekelingen III generally only one PUA per tool was found (N = 242 or 72%) On 78 implements (23%) two PUAs were present, while three PUAs were observed in only 17 cases (5%). Of course these results could be a consequence of poor technology, or of faulty sampling on our own part, but still the number of PUAs per artefact is small and generally confined to one edge, most frequently one of the lateral edges (235 of the 449 PUAs). It would seem that the inhabitants of the site were not really concerned with the conservation of their flint. This would seem even more so when we examine the number of actually used areas (AUA) per PUA: evidence for multiple use-instances on the same edge was only present in six cases. I am sure this actually occurs more frequently but cannot be detected by the use-wear method, as traces for primary use on e.g. meat are masked by subsequent activities. The frequency of hafting traces is yet another indication of economizing behaviour (Keeley 1982), but will not been used here because of the under-representation of these traces in the case of Hekelingen III, due to the occurrence of pdsm (see *6.2.3.2*).

To conclude, we possess at Hekelingen III, evidence for a rather expedient way of dealing with the flint. It has definitely not been saved or used up, which is somewhat surprising when we recall that all material was imported. The pattern does conform, however, to what might be expected for a temporary habitation: a relatively small amount of flint, is taken along, enough to fulfill the necessary subsistence tasks and to practise some craft activities appropriate to the place (e.g. bone-working, basketry). When the objectives had been attained, the flint is left behind, even though most of it had not been exhausted. At Hekelingen III, probably all attention was focused on the catch of sturgeon or game and how this could be carried back to the main settlement; leaving usuable flint behind seems of no concern because of an anticipated future use of the site. As such, the place, or better the shelters present, form an 'artefact trap' where flint and other implements could accumulate over the years. Still usable objects were left behind because they were easy to replace back at the permanent settlement. I therefore tend to disagree with the idea that the evidence for a large number of vessels contradicts the interpretation of Hekelingen III as a seasonally occupied place (cf. Louwe Kooijmans 1986).

The interpretation of Hekelingen III as being the result of seasonal visits is corroborated by the character of the find-distributions. Ethnoarchaeological evidence suggests that in the case of permanent occupation find clusters will be less discrete, because the living areas are cleaned frequently. The more permanent the settlement, the more secondary refuse is present. Cleaning is less important if a 'task group' is inhabiting a place for just a limited amount of time (see also *6.2.4*). In Hekelingen III the find material is clustered around the hearths, gradually petering out further away from these central features, a distribution which is not so typical for houses occupied on a yearround basis: we would expect their central area to be more devoid of finds. If a clustered find-distribution is more characteristic of temporary encampments, it must be explained why activities took place at more or less the same spot, season after season. This is not impossible, as apparently shelters or houses were erected on the levee, as testified by the presence of postholes (Louwe Kooijmans 1986). Walls and hearths could structure the inhabitants' behaviour and discard patterns (Cribb 1983). Still usable objects are also likely to have been left behind within the structures. The presence of such dwellings is not surprising when it is recalled that one of the main reasons for coming to Hekelingen was the catch of sturgeon; this implies waiting at least some time for the fishes to arrive (see *6.2.3.2*). As the exploitation of this resource can be anticipated to occur every year, houses can be re-used. In ethnographic context, it is not uncommon to leave a temporarily occupied shelter more or less intact for some later reuse as evidenced by Northwest Coast Indian plank houses or the fishing cabins of the Huron Indians (Tooker 1964; Trigger 1967) (see also *3.7.1*).

6.2.7 Conclusion

The use-wear analysis of the Hekelingen III flint assemblage has provided additional insight into the activities of the site's former inhabitants. Crafts included basketry and matting, the making or repair of wooden objects, and the boring of shell, perhaps to make pendants. One borer used on stone might have been used for fire-making. It was already known that bone awls and chisels were produced locally; the use-wear analysis has shown which flint tools were employed in this task. There seemed to be no evidence for the rather time-consuming softening of dry or tanned hides. The hide-scraping tools present were interpreted as having been used for the removal of fat with abrasives from fur-bearing animals. The use-wear analysis has not provided much additional insight into the subsistence tasks: the hypothesis that cereals were not grown locally has not been falsified (i.e. no sickle-gloss has been observed). Fish-processing tools or butchering implements have not been encountered, probably due to various post-depositional processes.

At all archaeological units the used tools were situated around the hearths, irrespective of the kind of traces observed on them. The only exception is found in unit B1 where bone- and wood-working implements were found around the hearths, with hide-working tools located more at the periphery of the find concentration. When examining chronological trends in the wear-spectrum inferred, it can be noted that contact with bone, antler and hide is more frequent during phase 1, while during phase 3 plant-working seems to become more prominent, at the expense of hide-processing. Hekelingen phase 2, represented solely by unit H2, displays a high frequency of wood-working.

With respect to the relationship between form and function, the most noteworthy aspect is the rather high frequency of wear-traces on unmodified edges. Especially traces inferred as being the result of plant-splitting, and those of bone-carving, were often observed on unretouched artefacts. Another conclusion is that types are not functionally homogeneous: apparently the suitability of edges was of more concern than the total appearance of the implement. This seems to be common for Late Neolithic flint assemblages (see also Deckers 1985). The choice of implements was primarily dependant on edge angle and, to a lesser extent, on the shape of the edge when viewed from above.

The last question to be addressed was that of seasonality, or the duration of occupancy at Hekelingen III: does it concern a permanently occupied settlement or was the site merely visited during various seasons? Neither the evidence for bone-tool manufacturing, nor for wood-working or hafting, provided sufficient grounds for establishing the character of the site. Softening dry or tanned hides is also frequently associated with a base camp or permanently occupied settlement. Despite the fact that a demonstration of this activity still does not provide an answer to our question, it was argued that the 'dry hide' scrapers from Hekelingen III were used to remove the subcutaneous fat from the hide of fur-bearing animals. The only clue about the question of permanent versus seasonal habitation comes from the apparently rather careless way in which the flint was consumed, especially considering the fact that all flint was of non-local origin and had to be imported. Had the inhabitants been living in the area on a yearround basis, one would expect them to either use up the imported flint more than they seem to have, or to have relied more on nearby flint sources (i.e. rolled pebbles from the Meuse). Yet another corroborative argument, not derived from the wear-trace analysis, comes from the find-distribution apparent at the various archaeological units: it was argued that one is more likely to encounter such a concentration of finds around hearths in a temporary, rather than in a permanent, shelter. In the latter case it seems that debris would be cleaned out from the hearth area, supposedly the most frequented part of the house. On the other hand, the dwellings present on the levee at Hekelingen III might have constituted an artefact-trap: implements, left behind in anticipation of a future use of the site, could accumulate here over the years.

To conclude, it is argued that the case for recurrent seasonal visits is the stronger one. Hekelingen III is interpreted as being the result of a strategy of logistic mobility embedded in a system of permanent farming settlements. The introduction of agriculture and animal husbandry, whether by a process of colonisation or by acceptance of the local hunter-gatherer groups at the northwestern margin of the European plain (Dennell 1985), was still a relatively recent phenomenon. Consequently, we might consider the situation to be the one of a static frontier (Alexander 1978), with all the associated stress phenomena. The prime areas for farming had been fully occupied earlier and the sea inhibited further expansion. The seemingly endless possibilities for expansion of the preceeding period had come to an end, causing the pioneer-farmers to develop a perception of the diminished productivity of their surroundings. Alexander has outlined a number of ways of alleviating such stress conditions. One strategy could be warfare, but a milder form of territorial behaviour seems more likely in our case. Another option might be migrating to new regions or, alternatively, starting to utilize marginal areas for farming. A fourth choice, which is of concern here, implies exploiting certain wild resources. It should be stressed that the area around Hekelingen constitutes an ecotone yielding resources from different environmental zones. As such it is, from a perspective of hunting-gathering-fishing, all but a marginal area. It is suggested that Hekelingen III represents a site from where auxiliary wild resources were obtained by a farming community, presumably located to the south. Such a situation might be somewhat analogous to what has been demonstrated for, for instance, the Danish TRB site of Sølager, located at the coast while an agricultural settlement has been found 3 km inland[3] (Skaarup 1973).

I am aware that this hypothesis remains to some extent a very speculative one. Clearly, with new data from specialized studies becoming available, or with a different theoretical perspective, a convincing argument may also be presented for an interpretation of Hekelingen III as a permanent settlement. In this respect, it might be useful to briefly draw attention to the nearby presence of Hekelingen I, where a much thicker occupation level was found. It has been suggested that Hekelingen I was the permanent settlement from which activities 'spilled over' into Hekelingen III (L.P.Louwe Kooijmans *pers.comm.*). However, if such had been the case, I would expect Hekelingen III to have displayed evidence for fewer performed activities, as well as a more equally-spread, thinner find-distribution. Whatever the outcome of these debates, other sites have posed for their researchers similar interpretative problems as for instance Swifterbant (Deckers et al. 1980) and Bistoft (Johansson 1981). It would definitely be worthwhile to further explore the question as to what exactly would differentiate a permanently inhabited settlement from a site recurrently visited. Evidence for specialized subsistence is by itself not the answer!

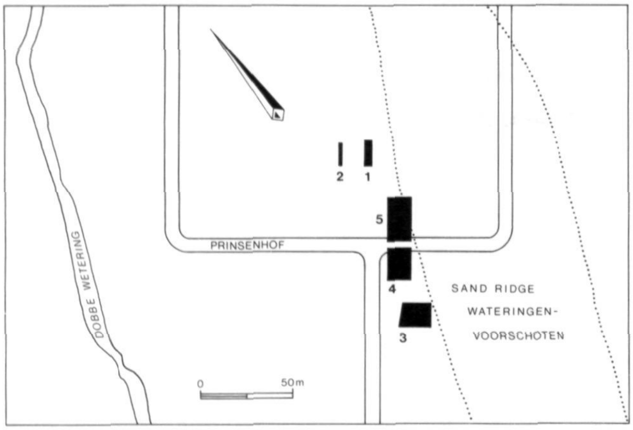


Fig. 74 Location of excavation trenches at Leidschendam (redrawn after Glasbergen et al. 1967: 98).

6.3 Leidschendam trench 4

6.3.1 Introduction

The site of Leidschendam is located northeast of The Hague on a former coastal dune ridge (*fig. 53*). Five trenches were excavated from September 1963 to March 1964 by Prof. Dr.W. Groenman-van Waateringe of the Institute for Prae- and Protohistory (IPP) in Amsterdam. The topsoil was removed with a backhoe and finds were collected in 1 x 1 m squares. This report will only deal with trench 4, totalling an area of c. 280 m² (*figs. 74, 75*). The use-wear analysis of the flint from Leidschendam was carried out in 1983 in the course of free-lance work for the research of drs. B.L. van Beek (Van Beek 1977, *in prep.*), who was to examine the habitation sequences of Leidschendam, Voorschoten and Vlaardingen, based on the pottery from certain trenches from each of the three sites. In the case of Leidschendam, trench 4 was selected. In what way, and to what extent, the concentration on one trench distorts our picture of the prehistoric activities is hard to tell, also because the site has not been entirely excavated (as is the case for all of the VL settlements). It would definitely be worthwhile to do an analysis of the entire assemblages from all three sites.

The landscape during the inhabitation of Leidschendam can be described as follows: underlying the Old Dune sand on which the occupation took place we find deposits of a coastal barrier. The barrier was blown over by sand, probably around 4800 BP, forming the 'Old Dune ridge'. This was a period of coastal aggradation, and the shoreline shifted 2-3 kms to the west. Here, the beach flats were protected from marine incursions by newly-formed coastal barriers. The flats, with occasional lakes and alder brushwood, formed a natural grazing area. The sandy dune soils, especially those along the dune edges, were relatively moist and easy to till, and as such constituted perfect arable land. The occupation remains are embedded in a c. 20 cm thick

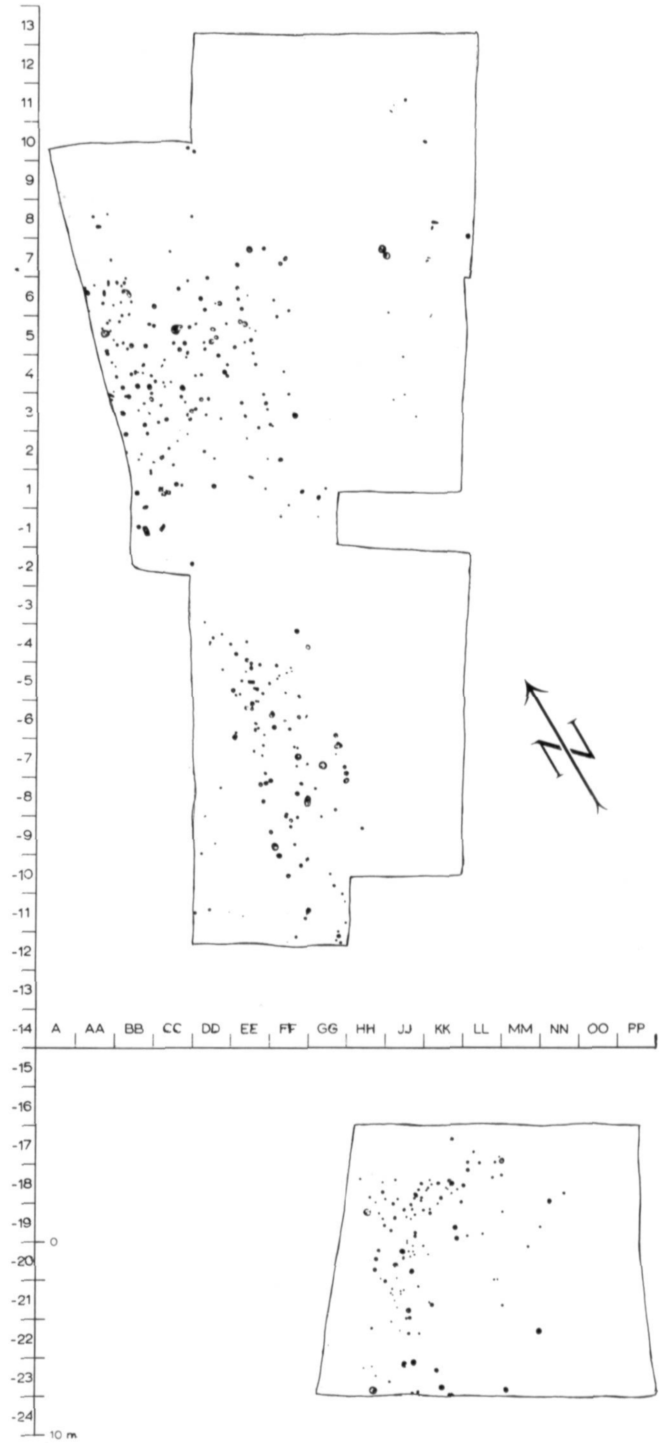


Fig. 75 Clusters of postholes observed in Leidschendam trenches 3,4 and 5 (after Glasbergen et al. 1967: 98).

ancient soil, formed on top of the dune ridge. Along the edges of the dunes, this layer was subsequently covered by peat which started to form on the beach flats as a result of a steady rise of the groundwater table.

Two ^{14}C dates are available for trench 4, both derived from charcoal: 3810 ± 60 BP (GrN-5828) and 3660 ± 80 BP (GrN-5029). These dates seem far too young. According to the pottery typology Leidschendam must be placed in VL phase Ib (Glasbergen et al. 1967: 115; Louwe Kooijmans 1974; Lanting/ Mook 1977).

During the occupation the dune ridge was covered with a deciduous forest consisting of oak (*Quercus*), lime (*Tilia*) and elm (*Corylus*). Hazel predominated at the periphery of the ridge, while on the edge of the adjacent beach flats an alder carr was present. There was no danger of flooding or getting wet feet: the top of the dune ridge lay up to c. 3 m above mean high water (Louwe Kooijmans 1974).

The analysis of the zoological material shows a reliance on animal husbandry rather than hunting (Groenman-van Waateringe et al. 1968), somewhat in contrast with the situation at Hekelingen III (Prummel 1987) and Vlaardingen (Glasbergen et al. 1961). Domestic animals included cattle, pigs and, to a lesser extent, sheep or goat. Red deer was the prevailing game-animal, followed by roedeer, grey seal and beaver. Very few sturgeon remains were encountered, perhaps because of the rather distant location of the site with respect to the Rhine and Meuse estuaries. Agriculture was practised on the dune ridge (Groenman-van Waateringe et al. 1968). Unlike at Zandwerven, ard marks have not been observed at Leidschendam, nor at any of the other VL sites within the environmental zone of the dune ridges.

Postholes were found in great abundance. The excavators report a rectangular concentration of postholes in trench 4, oriented SSW-NNE and measuring 16.75 x 4.75 m, which they interpret as a house plan (Glasbergen et al. 1967: 100) (*fig. 75*). However, even though the cluster of poles exhibits a definite directionality, the presence of a distinct house plan seems somewhat questionable. Hearths were absent and no other features such as an entrance-way were visible which could give an indication of its exact plan. Building wood must have been available in the vicinity, contrary to the situation at the levee sites.

The pottery, amongst which some clay disk fragments, was mostly quartz tempered. Both VL and PFB wares were represented, indicating that the occurrence of PFB sherds at the VL site of Zandwerven (Van Regteren Altena/ Bakker 1961) and Voorschoten (Glasbergen et al. 1967) is not an isolated occurrence. Other finds include jet beads and pieces of amber (Glasbergen et al. 1967). From trench 5, one bone awl and some perforated bone objects originate.

6.3.2 The flint assemblage

A total of 1773 flint artefacts, not counting splinters, was recovered from the five trenches, including 131 cores, 51 flakes with polished axe facets (11 of which were modified into convex scrapers), 116 scrapers, six borers, four blades and seven transverse arrow heads (Glasbergen et al. 1967: 110).

The total number of flint artefacts recovered from trench 4, amounts to 929, 215 (23.1%) of which had been burnt to varying degrees. The total weight comes to c. 2.5 kg, which results in a mean artefact weight of 2.7 g. The quantity of retouched tools is 57, including three retouched blades. In addition seven implements show 'dubious retouch'. This number disagrees with the original counts: on the distribution map published in the initial site report, 84 retouched/ 'used' tools are marked (Glasbergen et al. 1967: 104). This discrepancy can be partially attributed to a different perception as to what constitutes use-retouch, but also to the fact that in the past material has been removed for study or exposition. It is very unfortunate that a few prime pieces (Glasbergen et al. 1967: fig. 34) have disappeared, probably never to be traced again.

The raw material available to the occupants of Leidschendam consisted of very small-sized rolled pebbles of fine grained flint. The pebbles and core-fragments from trench 4 (N = 54) possess a mean size of 3.5 x 2.5 x 1.6 cm. This raw material appears to be of local origin. In contrast to Hekelingen III and Vlaardingen, more than half of the retouched artefacts had cortex (56.2%), indicating that the inhabitants used primary and secondary decortication flakes for the manufacturing of their tools. Only 21 (2.3%) axe fragments were found, whereas at Hekelingen III they constituted 12% of the assemblage. A blade technology is virtually absent; one blade has almost certainly been imported, as it is made from northern erratic flint and exceeds the size-range of the other artefacts (6.5 x 3.1 cm).

As to the reduction sequence practised, a bipolar technique appears to have been used (see a.o. Hayden 1980 and Callahan 1987 for a discussion of this technique). The pebbles are very small and totally rounded, and provide no natural platform to start reduction. The only way to open such a pebble would be to hit it with a stone hammer while supporting it on an anvil. Such a practice would also explain the lack of bulbs of percussion, platforms and percussion rings. The shattered nature of the debitage also points to bipolar reduction. Moreover, on some flakes we can observe traces of shattering on two opposite sides of the tool.

The typological range exhibited by the Leidschendam trench 4 flint is limited. Convex scrapers (N = 21) represent the most frequently occurring tool type (*fig. 76c, 76e*); there are also 11 scrapers of more irregular shape (*fig. 76f*). In addition, six 'thumbnail' scrapers of about 1 cm in diameter were encountered (*fig. 76g*). Attention must be drawn to four scrapers which display retouch along their entire cir-

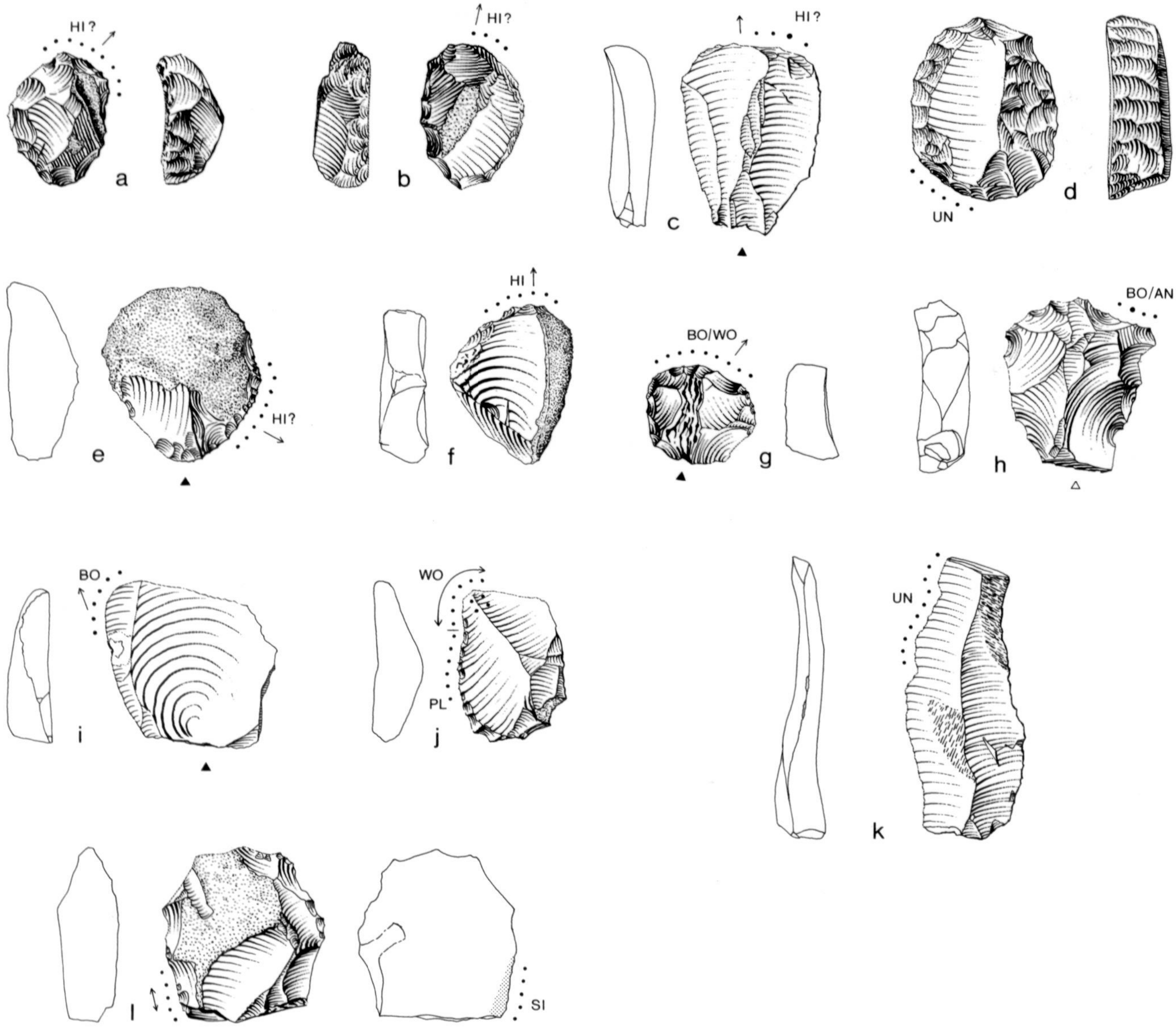


Fig. 76 Artefacts retrieved from Leidschendam trench 4. a-c) scrapers with traces inferred as being from hide: a) LSD27, b) LSD5, c) LSD17, d) scraper (LSD3) used on unknown material, e, f) tools LSD22 and LSD56 interpreted as having been employed to scrape hide, g) LSD49 with bone- or wood-working traces, h) LSD55 presumably used on bone or antler, i) LSD7 used for carving bone, j) LSD59 used for boring wood, k) blade LSD39 used on an unknown substance, l) LSD27 with sickle-gloss. (1:1)

cumference (*fig. 76a, 76b, 76d*). Their edge angle amounts to 84°, as compared with 70° for the remaining scrapers. Many of the scrapers have been resharpened as evidenced by the presence of overhanging dorsal edges. Two borers, two transverse arrow heads and one point were also retrieved from trench 4. The spatial distribution of the tools is depicted in *fig. 78* (cf. *6.3.3.2*).

6.3.3 THE FUNCTIONAL ANALYSIS

6.3.3.1 Sampling and methods

All intentionally retouched tools and the artefacts showing 'use-retouch', i.e. retouch < 1 mm, were studied for traces of wear. In many cases the 'use-retouch' actually consisted of damage inflicted on the edges by putting all the artefacts from each square meter into one paperbag. To make mat-

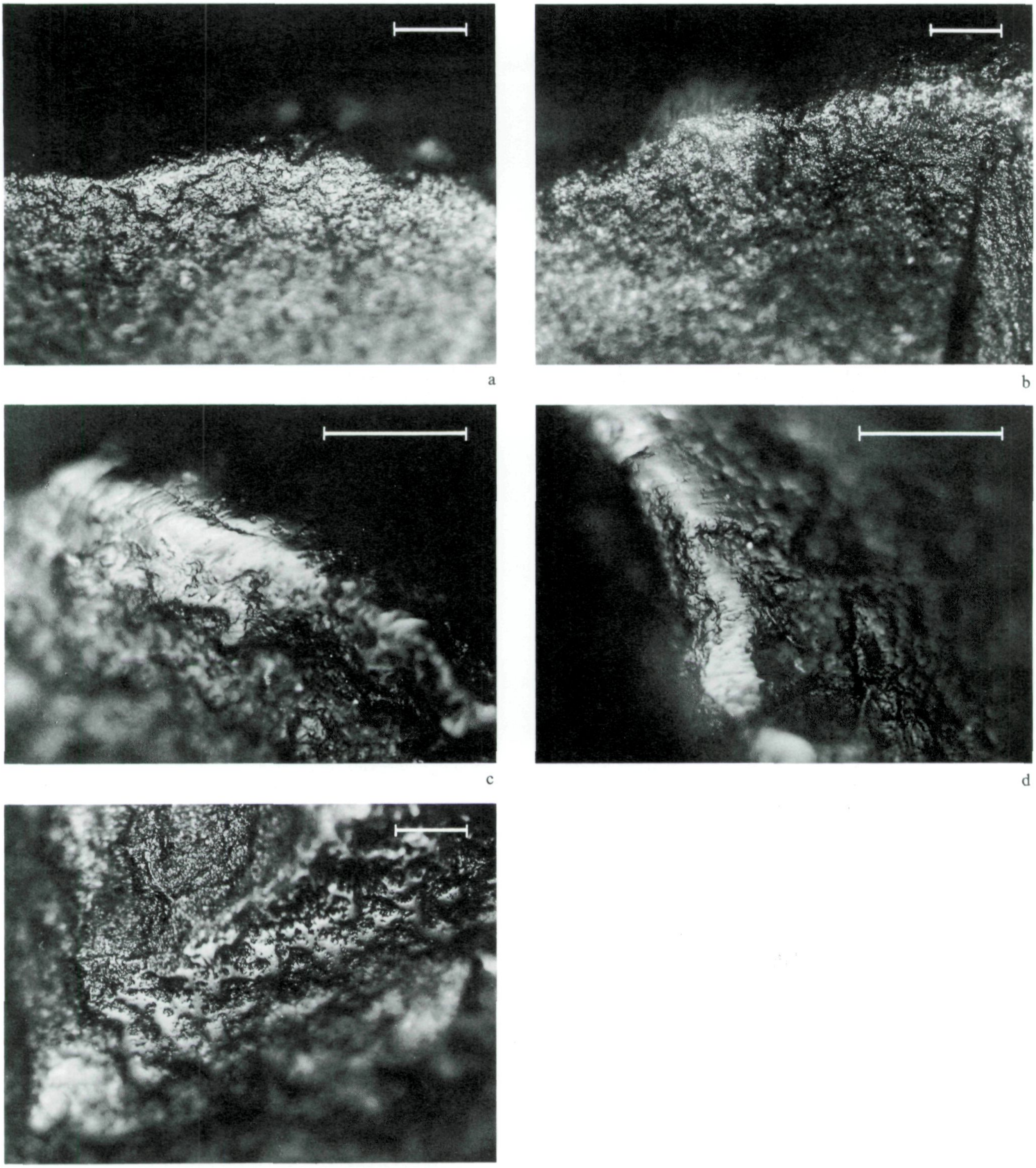


Fig. 77 Leidschendam trench 4: micrographs of observed wear-traces. All scale bars equal 50μ. a) LSD5 (200x), b) LSD56 (200x), c) LSD7 (400x), d) LSD59 (400x), e) LSD61 used on soft plant (200x).

ters worse, the material was used for educational purposes, and scattered onto tables and rebagged numerous times. When the assemblage was first examined in 1983, 64 artefacts were selected, all of them retouched ($\geqslant$ 1 mm and $<$ 1 mm). The interpretations were checked in 1985, and finally entered into the computer in 1987. During this last period the debitage was scrutinized for artefacts exhibiting a straight edge of $\geqslant$ 1.0 cm in cross-section: only two were found. They were added to the sample for use-wear analysis, plus seven pieces displaying dubious 'use-retouch', such as a core fragment with traces of battering on both ends. The mean length of the tools studied was 2.5 cm, mean width 2.1 cm and mean weight 4.6 g. A total of 73 implements was analyzed, resulting in 106 PUAs.

All tools were treated with HCl, rinsed in tap water but not neutralised with KOH. No use was made of an ultrasonic cleaning tank. The microscope available at the IPP in Amsterdam (where the initial analysis took place) was an Olympus BMH with magnifications ranging between 50-400x. The subsequent checking was done on Nikon-equipment (see *2.4*, *2.5*).

The examination of the wear-traces on the Leidschendam trench 4 implements was greatly hampered by the fact that a very high percentage of the tools was not analysable as a result of abrasion, probably due to trampling of the surface by the inhabitants. The matrix in which the tools were embedded, consisted of sand, which is a very effective abrasive agent: most 'sand-sites' have turned out not to be suitable for microwear analysis (cf. *chapter 4*). In addition, the rebagging during various stages of study has also affected the implements to some extent. At Leidschendam 59 of the 106 PUAs (55.7%) could not be analyzed. Apart from the problems with representativity raised by the examination of trench 4 only, the results presented here are severely biased by post-depositional surface modifications. Tools which were used for only a brief period of time will not be recognized as such because the wear-traces are not sufficiently developed to stand out from the general abrasion. Also, traces caused by, for instance, contact with meat, green plants and fresh hides, will be lacking altogether. The spectrum of activities presented in the following pages can not therefore be taken at face-value.

6.3.3.2 Activities inferred

Table 45 depicts the results of the wear analysis. A mere 30 PUAs displayed traces of wear, yielding 32 AUAs. The most common contact substance seems to have been hide (N = 10; 31.2% or 40.0% if we substract the category unknown). The very heavy edge-rounding and matt, rough polish (*figs. 77a, 77b*) suggests dry hide in eight cases. Two tools exhibit less edge-rounding and may have been used on either fresh or dry hide. Bone-working tools were also present (*figs. 76i, 77c*). It is assumed that the chance that bone-working tools are 'hidden' (*3.12*) is small; the four bone-working tools and three bone-/ antler-/ wood-working tools might thus approach the real number of such tools present in the sample. Two soft plant-working tools were attested and two artefacts displayed sickle-gloss (*fig. 76l*).

The range of activities performed seems therefore quite broad. Presence of 'sickle-gloss'[4] can be seen as a confirmation of the opinion that agriculture was practised locally. Maintenance tasks such as hide-processing were carried out; most probably it concerns softening activities of dried or processed hides. The manufacture of bone objects has been attested. The four bone-carving zones display a great similarity to those from Hekelingen III; perhaps they were employed for bone awl and chisel production (cf. Maarleveld 1985).

No clear-cut concentrations representing a distinct activity can be distinguished. The configuration of used tools conforms to the distribution of the flint artefacts in general, as evidenced by the plot of total weight per 1 x 1 m square (*fig. 79*). Tools with traces inferred as being the result of working hides are found across the entire trench. Bone-/ antler-working implements are mainly located in the northern part; however, the number dealt with here is obviously too small to attribute any behavioral significance to this observation.

6.3.4 Aspects of form and function

The number of PUAs for which an activity could be inferred is really too small to conclude much about the relationship between form and function. Of the 12 PUAs which were employed for scraping, 11 displayed a convex edge-shape. Straight edges had been used for a variety of activities and were not predominantly associated with cutting or sawing: of the four PUAs used for carving, three appeared to be straight. As to the shape of the aspect surfaces, the large majority of the scraping tools as well as the two cutting tools turned out to be plano-convex. Evidence of use for carving was found on tools varying in shape of the constituting aspects. A last morphological attribute of the PUAs is the form of the edge in cross-section. A variety of activities was performed with straight cross-sections. Convex cross-sections were limited to edges exhibiting traces of scraping or carving. The sample of unmodified flakes was small, because so few pieces exhibited a straight edge $\geqslant$ 1.0 cm. Nevertheless, of the five selected artefacts one was possibly used (*table 46*).

The Leidschendam trench 4 gives the impression that the correlation between the morphology of a tool and its working edges, and the motion to which it was put is not so clear-cut. Of course, maybe this has to be attributed to the fact that so few tools were interpretable (only 30 PUAs). On the other hand, the inferior quality of the raw material available to the inhabitants of Leidschendam might have led

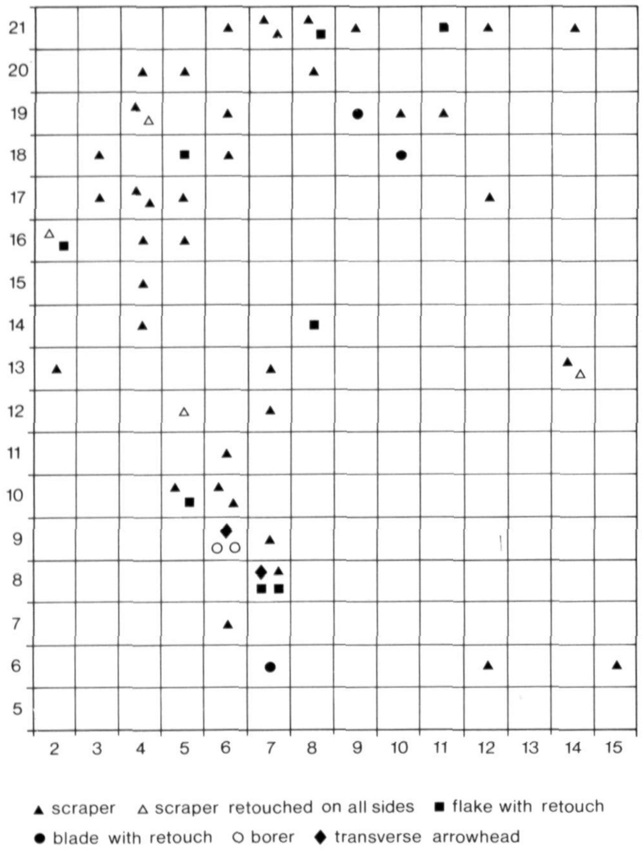


Fig. 78 Leidschendam trench 4: spatial configuration of the different tool types (point 2/5 corresponds with DD/10,50 of fig. 75).

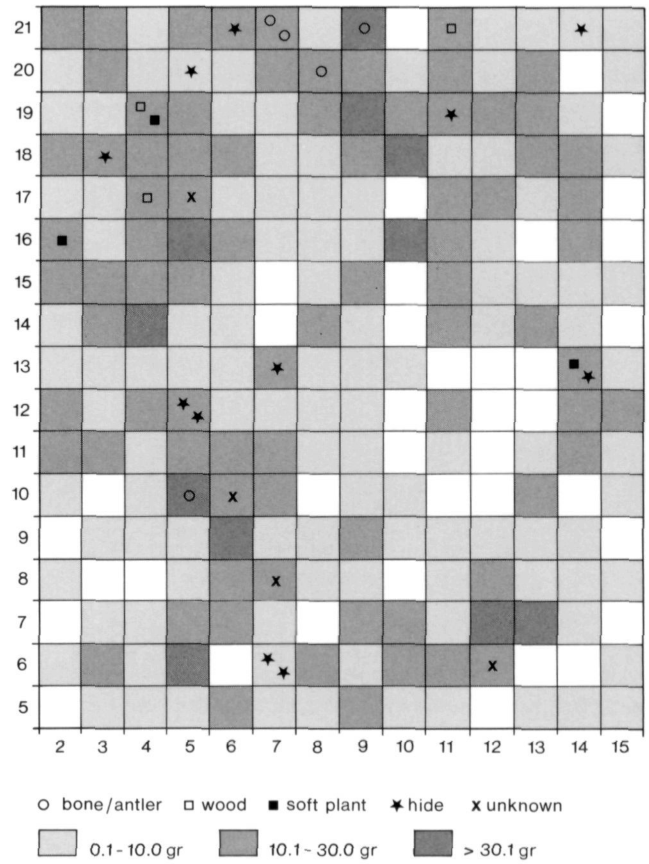


Fig. 79 Leidschendam trench 4: spatial distribution of implements with observable traces of wear. Weight-class distributions are indicated as well (per 1 x 1 m unit).

to a less critical examination of a tool and its edges, prior to use. The choices made are not so consistent.

6.3.5 Interpretation of the Leidschendam trench 4 assemblage

The Leidschendam trench 4 flint is not the most suitable material from which to derive conclusions, as the post-depositional surface modifications are extensive. Nevertheless we can catch a glimpse of daily life in the settlement, although the detail is less than at Hekelingen III. A diversity of activities was carried out at the site. Dry hide-working was one of the main tasks: the heavy edge-rounding on the scrapers suggests they were used intensively, possibly during the softening stage of hide-processing. This kind of work is generally assumed to have taken place at a base-camp or permanent settlement. Bone-working is not prominent but is nevertheless represented. Wood-working tools are very few in number. The two sickle blades provide additional support for the hypothesis that agriculture was practised locally.

Clear-cut activity areas were not evident, although bone/antler-working implements were confined to the northern part of the trench (*fig. 79*). Remarkable is that the middle section of the trench seems virtually devoid of finds. Such a configuration is suggestive of a central area within a relatively long-term or permanently inhabited dwelling, which was supposedly cleaned regularly (cf. *6.2.4*). However, assuming that the finds are indicating the approximate location of the walls, the inferred house would have a width of c. 10 m. Such a width is not only difficult to achieve technically, but also does not correspond with that of the only VL house plan known so far, of Haamstede (Louwe Kooijmans 1985: 50). An alternative explanation would be to postulate several overlapping building phases, with the house shifting in southwestern direction; in that case, however, there should have been more finds along the northeastern edge. All in all, the meaning of this empty section in trench 4 is not clear. It is hoped that the analysis of the other artefact categories will elucidate this (Van Beek *in prep.*).

The flint was used quite efficiently: 23 (31.5%) of the 73 tools examined possessed two PUAs. The scrapers which exhibited retouch around their entire circumference were counted as having one PUA, but obviously this represents

Table 45 Leidschendam trench 4: inferred motion and contact-material by actually used area (AUA).

	scraping	cutting	carving	boring	hafting	unknown	total
hide	10	–	–	–	–	1	11
soft plant	–	1	–	–	1	–	2
cereals	–	–	–	–	–	2	2
wood	1	–	–	1	–	1	3
bone/antler	1	–	4	–	–	2	7
unknown	–	1	–	–	–	6	7
total	12	2	4	1	1	12	32

Table 46 Leidschendam trench 4: degree of wear per observed phenomenon by potentially used area (PUA).

	retouch ⩾ 1mm	retouch < 1mm	unretouched straight edge	protruding point	total
no traces	5	8	4	–	17
used	10	2	–	1	13
possibly used	10	3	1	–	14
not interpretable	30	9	5	1	45
unsure	7	10	–	–	17
total	62	32	10	2	106

substantial activity as the entire edge cannot have been used simultaneously. The number of AUAs is not great: 28 PUAs (26.4%) had one AUA, while two PUAs displayed two AUAs (1.9%). Clearly, the relatively small amount of AUAs is largely due to the fact that traces of wear have been obscured by abrasion. The degree of use was often not interpretable due to pdsm (N = 45); 17 displayed no traces, 13 PUAs exhibited various degrees of use, 14 PUAs were possibly employed and 17 PUAs were listed as unsure. The most convincing argument for a thrifty attitude towards the flint comes from the presence of overhanging dorsal edges, a phenomenon which can be ascribed to recurrent resharpening. This morphological feature cannot be obscured by secondary modifications. Resharpening was observed on 15 scrapers; this inference is supported by the fact that on 18 used PUAs the polish had clearly been present but was partially removed by resharpening flakes. I would therefore argue that the amount of raw material available to the inhabitants of Leidschendam was not abundant and that curative measures such as resharpening had to be taken.
It seems that the problem of the shortage and the inferior quality of the locally available raw material could not be alleviated by an orientation towards imported flint. In this sense the people on the dune ridges appear to be more isolated than the ones living in or exploiting the freshwater tidal zone. A few blades and flakes are apparently imported and may be of northern origin which could suggest the direction in which the inhabitants of Leidschendam had contact with the 'outside world', i.e. possibly with the roughly contemporaneous PFB sites of Kolhorn, Aartswoud and the VL/PFB site of Zandwerven. This is supported by the presence of PFB-sherds at the sites located on the dune ridges.

6.4 Site differentiation within the Vlaardingen group

On the basis of similarities in, for instance, pottery assemblages, a number of sites are attributed to the VL group of which we already knew that they might differ in terms of their subsistence strategies. Sites belonging to this cultural group are situated in four different environmental zones. The sites on the dune-ridges such as Leidschendam and Voorschoten, have always been considered agricultural sites (Groenman-van Waateringe et al. 1968). On the other hand, Hekelingen III, located on the edge of the freshwater tidal area and the peat-zone, has, among other alternatives, been referred to as a semi-permanent camp for hunter-fishers-gatherers, who maintained contacts with agricultural settlements and exchanged products with them (Louwe Kooijmans 1985:103). The Hazendonk, the only site which has been investigated in the peat-area, could be a permanent settlement of fishers and hunters; in addition, the inhabitants apparently possessed livestock. It is unlikely that agriculture was practised here locally (Louwe Kooijmans 1985: 125-126). Lastly, sites in the river-clay zone, such as Ewijk, were, perhaps yearround, occupations of agricultural peoples (Asmussen/ Moree 1987). One of the objectives of the functional analysis of the flint was to address this diversity in subsistence strategies apparent among the VL sites.

The results of the present study demonstrate that Leidschendam indeed shows evidence, albeit not definitive, of having been a permanently settled agricultural community (see *6.3.5*). The inhabitants seem to have processed hides, manufactured bone or antler objects, and done some woodworking. Two tools displayed sickle-gloss, supporting the suggestion that cropping was done locally. Unfortunately, post-depositional surface modifications had affected a great many implements, so the results of the use-wear analysis cannot be considered representative. Additional evidence about the attitude of the inhabitants towards flint could be obtained from a study of certain morphological attributes of the implements. Use was made of locally available flint pebbles of very small size. A relatively high percentage of the tools turned out to be resharpened, whereas the number of PUAs per tool was high. These features are indicative of a relative scarcity of (suitable) raw material. There is virtually no evidence for import material to alleviate the shortage of good-quality flint. Leidschendam seems to have been quite isolated, at least from a 'lithic perspective'. What evidence exists for outside contacts points to the north: one blade strongly resembles northern moraine flint. Such flint is also present on the PFB sites of Kolhorn and Aartswoud (Van Iterson Scholten 1981). An orientation towards the PFB sites in the north by the Leidschendam occupants, is also supported by PFB cultural elements in the pottery assemblage (Glasbergen et al. 1967).

The functional analysis of the Hekelingen III flint assemblage resulted, at first glance, in a similar, albeit more detailed, spectrum of inferred activities as Leidschendam: evidence was present for the production of bone and antler objects, hide-processing, and wood-working. In addition, plants were splitted, probably for matting or basketry purposes. It was also shown which bone objects were manufactured with the flint tools displaying wear-traces indicative of bone. No sickle blades were found, supporting the assertion, based on palaeobotanical evidence (cf. Bakels 1988), that agriculture was not practised locally. Unlike the Leidschendam scrapers, the Hekelingen III hide-working implements were interpreted as having been involved in scraping the fresh hides of fur-bearing animals (cf. *6.2.6*). All flint was imported, most probably from the south (Verhart 1983). Nevertheless, the material was definitely not saved or intensively used up. The number of PUAs per tool is less than at Leidschendam, nor is there much evidence for the resharpening of implements. If Hekelingen III had been occupied on a permanent basis, one would expect the imported flint to have been used in a more thrifty manner, or else to have more evidence for the exploitation of more nearby sources of flint.

Although the interpretation of the function of Hekelingen III in a settlement system remains problematic, I favour the option that it concerned a recurrently visited place from where a variety of wild resources, such as sturgeon, birds, various game and plants, could be obtained. Remains the question whether the place was used by hunter-gatherers in their (yearly) seasonal round or by farmers for the acquisition of auxiliary resources. The fact that Hekelingen III also yielded remains of domestic animals, notably cattle, would argue for the latter possibility. Moreover, by the Late Neolithic all of the Netherlands shows evidence for farming, also the nearby VL sites of Leidschendam and Voorschoten, and the roughly contemporaneous PFB settlements of Kolhorn and Aartswoud to the north. This makes it unlikely that a group of hunter-gatherers could have maintained their traditional subsistence base, unaffected by the changes which had taken place all around them; the area in which they could maintain such a way of life became extremely limited. Hekelingen III can thus be interpreted as having been used by pastoralists/ agriculturalists who probably lived somewhere to the south: the type of flint used seems to point in that direction (Verhart 1983). From a lithic perspective there is no evidence that, for instance, the farmers of the coastal dune district were exploiting Hekelingen III, because the type of raw material is different for both sites.

Another site within the freshwater tidal zone concerns the type-site Vlaardingen. A preliminary use-wear analysis of the flint from trench 11 indicated a same range of performed activities as Hekelingen III and Leidschendam trench 4 (Van Gijn 1984). This study is currently being extended, and suggests a predominance of hide-working (31% of the implements were involved in this activity (R.Exaltus, *pers. comm.*). Two blade-like tools displayed a lustrous sheen, which could have been caused by cutting reeds. Evidence for the manufacture of bone and antler objects is present as well. The raw material used is of southern origin and closely resembles group 1 of Hekelingen III. The two flint assemblages also correspond in other respects: the size of the artefacts is similar, both display a high frequency of polished axe fragments, and the mean edge angle falls around 65°. It is, however, too early to tell whether the inhabitants of Vlaardingen exhibited a similar careless way of dealing with the imported flint as those of Hekelingen III; the Vlaardingen flint assemblage is only now being registered in terms of PUAs and AUAs. Despite the fact that the flint assemblages of Hekelingen III and Vlaardingen are similar, the sites are very different in other respects. At Vlaardingen much sturdier dwellings were erected than at Hekelingen III, requiring a considerable investment of time and materials. Also, evidence for PFB elements, such as a battle-axe, points to contacts with the north. As Vlaardingen is the topic of a dissertation in progress at present (van Beek *in prep.*), I will refrain from giving a 'functional' interpretation of the site.

Bienenfeld (1986) has studied a small sample of the VL assemblages from Hazendonk, the only site investigated in the peat-zone. From level VL-1a the number of pieces examined was too small to draw conclusions from. From VL-1b 41 of the 298 artefacts were studied, i.e. 13.8% of the collection; 16 of them showed no traces of use. A predominance of wood-working was attested, with some bone-/ antler-, soft plant- or hide-working having been practised as well. The absence of sickle blades supports the idea that no cropping took place on the dune.

From the fourth environmental zone, that of the river-clay deposits, no flint assemblages were examined for traces of wear. The material from Ewijk proved unsuitable for such an analysis. Other lines of evidence indicate that agriculture seemed to have been practised; whether the site was occupied on a yearround basis, is still open to question (Asmussen/ Moree 1987). The flint used includes some Valkenburg material, indicating contacts in southern direction, perhaps with the Stein-group.

What emerges is a picture of great variability between the various sites subsumed under the VL group. Leidschendam, and perhaps also Voorschoten, is interpreted as a permanently inhabited agricultural site with outside contacts towards the north (possibly the PFB sites of Aartswoud, Kolhorn and the VL/PFB site of Zandwerven). Hekelingen III, and perhaps also Vlaardingen and Hazendonk, can be seen as temporary settlements. As far as Hekelingen III is concerned, it is likely that the site was used by farmers living to the south, perhaps on the saltmarshes of Zeeland. Ewijk, located much further to the east is considered an agricultural settlement, probably occupied yearround and with an orientation towards Limburg (i.e. southeastern Netherlands). It can be suggested that, during the Late Neolithic, a mosaic of farming settlements was present in the Rhine/ Meuse delta. These were located on the dune-ridges, but perhaps also on the tidal flats. Further expansion had been arrested because all prime areas were occupied. To alleviate the perceived reduction of productivity[5], other avenues were sought: one option could have been the continued exploitation of the coastal areas for wild resources. Hekelingen III, and perhaps Hazendonk and Vlaardingen as well, might represent sites from where such activities were carried out.

notes

1 The fur of some animals, like caribou, is best during autumn instead of winter (Spiess 1979).

2 An exception form those cases of hafting in which use is made of a mixture of resin mixed with crushed stone particles. The latter is added to stabilize the resin and apparently cause some friction-gloss on the flint surface (H.Juel Jensen, *pers.comm.*).

3 Interestingly enough, local manufacture of bone implements has been demonstrated at Sølager (Skaarup 1973).

4 The term 'sickle-gloss' is generally used to refer to a polish clearly visible with the naked eye, with some width, and supposedly due to the reaping of cereals. It has been shown, however, that 'sickle-gloss' can also be caused by contact-materials other than silicious plants (a.o. Van Gijn 1988). At Leidschendam it concerns 'real' sickle-gloss.

5 The actual production, which can be approximated by us from an etic perspective, might have remained constant in the meantime.