MESOLITHIC SITES NEAR HAVELTE, PROVINCE OF DRENTHE (NETHERLANDS)

A preliminary report of the Havelte Project (Museum of Anthropology, University of Michigan – Biologisch-Archaeologisch Instituut, State University of Groningen)

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INTRODUCTION

The joint Project

In 1970 a program of archaeological survey and excavation of Mesolithic sites was begun near the village of Havelte in the province of Drenthe, Netherlands (Fig. 1). This program, originally initiated by Dr. R. R. Newell, is being undertaken jointly by the Biologisch-Archaeologisch Instituut of the State University of Groningen and the Museum of Anthropology of the University of Michigan. The initial fieldwork in the fall of 1970 was supported primarily by the Wenner-Gren Foundation for Anthropological Research. Subsequent field and laboratory programs have been largely funded by the National Science Foundation (Grant GS-29240X). The financial support of these foundations is gratefully acknowledged.

The Mesolithic sites of northwestern Europe are, for the most part, notoriously poor in content and small in size. These sites are virtually always located on well drained, sandy soils in which no organic materials other than charcoal are regularly preserved. Much of our knowledge of Mesolithic artifact assemblages comes from the study of surface collections. Only a few systematic excavations have been carried out. The general picture of Mesolithic society and economy has been built up from evidence provided by a small number of sites in England and Denmark. This general picture has been extended to most areas of Mesolithic occupation and has been unchallenged for many years (Clark, 1936; Schwabedissen, 1962). Suggested characteristics for the Mesolithic period are low population density, ephemeral settlement, small group size, and dependence upon a wide range of subsistence resources.

Most archaeological research on the Mesolithic period, accepting this general picture derived from other areas and constrained by the usual poverty of available material, has been primarily concerned with the typology and comparison of lithic assemblages. The chief aim of this approach has been to establish a chronological framework for these assemblages and secondarily to define "culture areas" from geographical variations in typological assemblages.

The cooperative project at Havelte is intended to obtain, from a number of Mesolithic sites, relatively complete and extensive data for the analysis of: the size of occupations; the number, kinds and contents of archaeological features; technological process of tool manufacture and use; functional and formal variation in the lithic assemblages; patterns of distribution of various categories of artifacts and features over the site area; and other factors relating to technological, subsistence, and perhaps social aspects of prehistoric human adaptation.

This information should make it possible to infer certain parameters of the subsistence-settlement systems characteristic of the Mesolithic in the northern Netherlands.

It seems clear from ethnographic research that small variations in group size, population density, and economic organization are adaptively responsive to environmental situation and are probably most intimately related to forms of social organization (Steward, 1938; Eggan, 1968; Birdsell, 1968; Yengoyan, 1968). It is therefore precisely these components that should define the operation of subsistence-settlement systems in the Mesolithic (Price, 1973).

Attention to archaeological details from which variability in group size economy, social organization, and population density can be inferred may be crucial to our ability to monitor the processes of cultural adaptation in this period. It has recently been shown, for example, that distributional patterns of artifacts and features can reflect patterns of human activity at prehistoric sites (Leroi-Gourhan and Brezillon, 1966; de Lumley, *et al.*, 1969; Binford, *et al.*, 1970; Hesse, 1971; Whallon, 1973). From the analysis of such patterning, information on group size, activity and composition may be derived.

This preliminary report is intended to outline some of the procedures and methods utilized in the investigation of these problems and to discuss some of the progress made, and the problems encountered, so far.

Fig. 1. Location of Havelte.

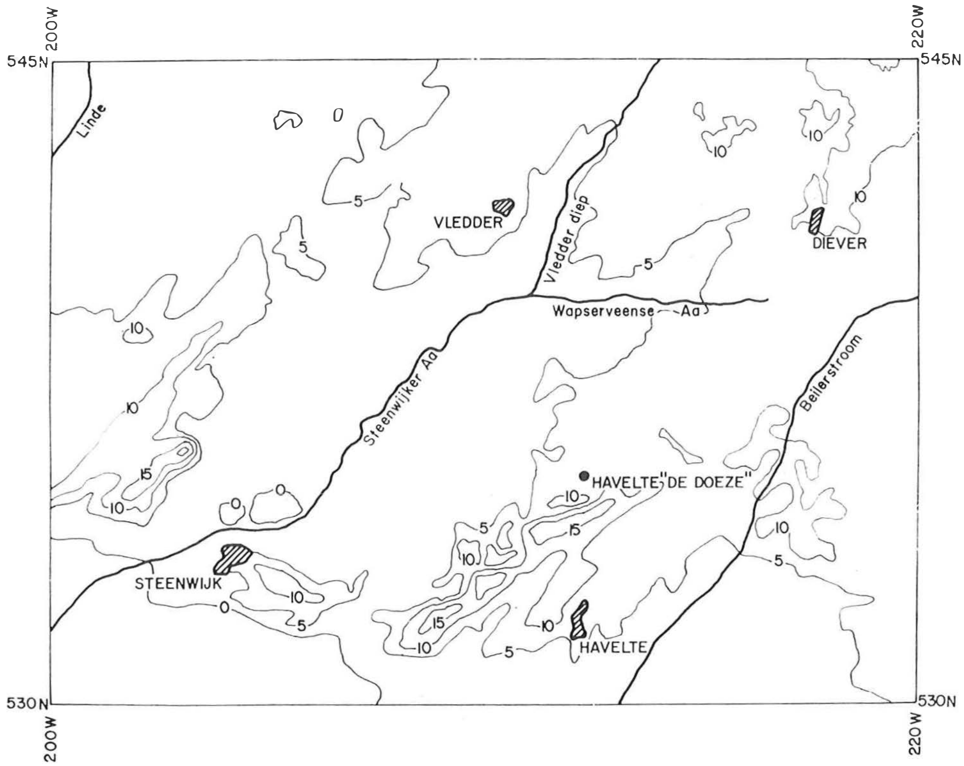

Fig. 2. Location of "de Doeze" near the village of Havelte.

The study area

The settlements from the Mesolithic period in the Netherlands are usually located on sandy elevations. These elevations generally consist of deposits of late glacial coversands forming ridges of varying height rising above flat, ground moraine lowlands. Clearly, an optimal area in which to begin a program of survey and excavation of Mesolithic sites would be where elevations of late glacial coversands remain relatively undisturbed to the present day.

A fairly large area meeting these criteria was found near the village of Havelte (Figs. 1 & 2) during a preliminary visit by Prof. H. T. Waterbolk and Whallon in 1969. This study area consists of a series of sand elevations and ridges approximately 3 kilometers long by 1½ kilometers wide. It is partially bounded on the southeast by a push moraine of Saalian age some 18 meters in height (Ter Wee, 1966) and is surrounded otherwise by low, wet fens and farmland. Most of the sands in this area are late Würm (Weichsel) glaciation coversands, deposited primarily during the Older and Younger Dryas periods, overlying boulder clay ground moraine (Ter Wee, 1966). Numerous circular or oval depressions with moderately high (1-5 meter) surrounding ridges are scattered throughout the area. These were apparently formed as blowouts, or perhaps in a few cases as pingos (ice-heave ridges), either during or shortly after the deposition of the coversands. Extensive modern blowouts are restricted to two major locations. Peat-cutting and roads have made only minor disturbances of the coversand topography. The original topography of these sands is generally indicated by a deeply developed soil horizon, discussed below. The widespread, intact occurrence of this soil horizon indicates the preservation of the old topography over much of the study area. The area is now set aside as a nature preserve and military training ground.

These thus exists a higher and relatively drier, sandy area here which has persisted and been propitious for human occupation from the latest phases of the Upper Paleolithic (Waterbolk, 1962). The ridges within the study area seem to have been preferred locations for settlement, particularly in earlier periods, due presumably to their drier nature and perhaps to the tendency for forest clearings to be more common on higher areas. The area around Havelte has long been known to amateurs and professional archaeologists alike as a location rich in prehistoric materials. A late Upper Paleolithic (Hamburgian) assemblage has been collected from the area (Voerman, 1937). Extensive collections of Mesolithic artifacts have been made from blowouts and roadcuts. Both Neolithic and Bronze Age materials are also frequently encountered. As an area of known antiquity with relatively little recent disturbance of the landscape upon which Mesolithic people would have lived, it seemed to provide an excellent location at which to begin a program of intensive investigation of Mesolithic settlements.

FIELDWORK

Mapping the prehistoric landscape

The postglacial landscape upon which undisturbed Mesolithic sites might be found has been somewhat altered. The most significant alteration is due to the movement of sand by wind action, eroding in some spots, depositing in others. This sometimes results in a sort of "reversed" topography. Sand is blown from the higher, drier points of the landscape and deposited in lower, moister and therefore more vegetated areas. Original elevations are truncated and original depressions are built up as high spots. In addition to this particular process, normal deflation and wind deposition of sand is common and other factors such as erosion by water and the growth of peat have played a role in changing the face of the postglacial terrain.

The surface of what is generally presumed to have been the original postglacial landscape is easily recognized, however, by a deeply developed soil. This soil is a podzol, formed under the heath that appeared after initial deforestation in this area, probably beginning in the Bronze Age. Podzols are formed under temperate climatic regimes by intense leaching under acidic conditions. Heather growing on sand with good drainage provides ideal conditions for the formation of deep, well-developed podzols (Dimbleby, 1962).

There is little or no evidence for significant changes in the topography of the study area from the early postglacial (Preboreal) to the first deforestation and the formation of the podzol. This buried podzol is assumed to be on the surface of the postglacial landscape and thus to provide an excellent indicator of this early topography. There is generally one major period of podzol formation in the coversand areas of the northern Netherlands. Near Havelte, however, some localities are known for the development of a double podzol profile (Waterbolk and van Andel, 1951), representing two major periods of soil formation under heather. At such localities the lower or earlier of these two podzols is more deeply developed and is assumed to most closely represent the postglacial land surface.

A pronounced circular ridge surrounding a depression which appeared to have been formerly a lake or marsh was chosen as the location at which to begin the topographic mapping of the buried podzol. It was thought that a high ridge around a lake or marsh would have been a particularly propitious place for Mesolithic occupation. This area is known locally today as "de Doeze". The peripheral ridge is not a recent development and is clearly reflected in the contours of the podzol. In some places the postglacial and modern topography are identical. In other areas there has been substantial erosion or deposition of sands. It could sometimes be seen that the more marked relief of the earlier landscape had been slightly smoothed through time.

A typical soil profile from the area of investigation can be seen in Figure 5. There is a deposit of recent blown sands overlying the original podzol. A black, humic *A1* horizon overlies the heavily leached grey-white *A2*, characteristic of a strongly podzolized soil. At the base of the *A2* zone, there is an abrupt change in the color, consistency, and texture of the soil. This layer is here called the *B2B* horizon (A-B horizon in other terminologies), the zone of accumulation of humic materials leached from the *A2*. Mesolithic artifacts are generally found in the lower *A2* and upper *B2B* horizons of this soil. A true hardpan marks the boundary between the *B2B* and the orange-brown, iron-enriched *B2*. The *B2* horizon gradually grades into parent *C* material, generally Younger Dryas coversands. At varying depths in the *C* horizon, there is usually seen an irregular, whitish, leached horizon. Occasional black flecks of charcoal appear in this lens.

This horizon is known as the Usselo layer and dates to the Allerød interstadial (van der Hammen, 1951). The Usselo layer formed in the surface of Older Dryas coversands and was subsequently buried by coversands during the Younger Dryas Period. The Older Dryas coversands are distinguished by a greater loam content and stronger bedding.

The aim of the geological survey was to locate and trace the deep podzol described above. Through observations made in numerous sections and borings, a detailed topographic map of the clearly identifiable surface of the *B2B* horizon was compiled for de Doeze ridge and adjacent areas. It is felt that this map

Fig. 3. Havelte "de Doeze": Location of excavation units and test pits on the contour of the *B2B* soil horizon. Elevations are relative to an arbitrary excavation datum.

fairly closely represents the early postglacial topography – the landscape occupied during the Mesolithic (Fig. 3).

The major portion of the rim or ridge surrounding de Doeze was continuous. It was speculated that this feature might be a pingo. Pingos begin as small hills formed during periglacial conditions by the accumulation of ground water in subterranean ice domes (Embleton and King, 1968). Earth eroded from these hills is deposited as a ridge around the periphery of the hill. When the ice dome melts during warmer conditions, it leaves a crater with a pronounced peripheral ridge. Such a crater then becames filled with water to form a small lake. The geological survey revealed, however, that the bottom of the de Doeze depression was sand and relatively flat. This seemed to argue against this feature having been a water-filled pingo. A lake would have left distinctive bottom sediments and a pingo would have been deep relative to its diameter, rather than having a shallow, flat bottom.

The prehistoric vegetation

The investigation of the local postglacial pollen sequence and its implications for local environments is being carried out by Dr. W. A. Casparie of the Biologisch-Archaeologisch Instituut. Pollen cores were taken in and around de Doeze in the winter of 1971. A complete description of the results of this work will be presented by Dr. Casparie in the final report. Preliminary indications are that peat formation began here in the latter part of the Boreal period. Pollen of heather (*Calluna*), some hazel (*Corylus*) and pine (*Pinus*) is preserved. In this section of the core there is also wind blown sand present, indicating somewhat open, dry conditions. Thus, in the late Boreal period the depression would have been filled with open vegetation, probably heather, with some pine and hazel around the periphery of the depression. The probable seasonal occurrence of standing water in the depression at this time is indicated by the formation of the peat deposits. The early Atlantic period is represented in the sequence by a rise in alder (*Alnus*) and oak (*Quercus)* pollen with a relative disappearance of heather and pine. Wetter conditions are indicated by the formation *Sphagnum* peat deposits in the depression during this period. Perhaps the depression bottom was effectively sealed during the Boreal period and this permitted the accumulation of more open water with a dense vegetation of *Corylus*, *Quercus*, and *Betula* in the surrounding area. The geological mapping and the pollen analysis together seem to indicate that this topographic feature is most likely not a pingo but rather a Younger Dryas or Preboreal period "blowout" that was partially covered with heather during the Boreal period, gradually filling with water and *Sphagnum* peat during the early Atlantic period.

Archaeological sampling

It was expected that Mesolithic sites would be found on the highest, sandy elevations, as has been the case with most sites discovered near Havelte and elsewhere in the northern Netherlands. However, in order to systematically investigate, with no bias from prior experience, all possibilities for locating prehistoric occupation in the study area, the archaeological survey was begun as a procedure of stratified random sampling. An area of approximately 400 meters by 80 meters in size was sampled in this manner. This area comprised roughly one-fourth of the blowout rim and its immediately surrounding area.

The archaeological testing was done using 2 x 2 meter pits excavated through the podzol into the lower *B2* or upper *C* horizon. Random sampling was accomplished by drawing a grid over each sub-area to be tested and selecting the coordinates for the placement of each test pit from a table of random numbers. The sample was stratified, meaning that the area was not treated as a homogeneous unit but was broken into sub-areas which were sampled separately. These sub-areas were defined by topographic criteria. The number of test pits placed in each sub-area was made proportional to the area covered by the sub-areas. The locations of some of the test pits are indicated in Figure 3.

Five topographic sub-areas were defined from the map of the podzol *B2B* surface: ridge peaks, high ridge, terrace inside ridge, low ridge, and low rise outside ridge. The depression floor was considered to have been uninhabitable and was not sampled. The results of this sampling program indicated, as was anticipated, that Mesolithic materials concentrated primarily or exclusively on ridge peaks and high ridge areas. The artifact counts from this testing are given in Table 1. The major excavations, subsequently undertaken in this study area, were opened up around the most productive test pits (Nos. 1, 3, and 7), which seemed to indicate the presence of substantial, relatively undisturbed Mesolithic occupation.

TABLE 1. STRATIFIED RANDOM SAMPLING PROGRAM

Test Pit No.	*Stratum*	*Artifact Count*
1	Ridge Peak	11
2	Low Rise	0
3	Ridge Peak	20
4	Low Ridge	1
5	Terrace	0
6	Terrace	0
7	High Ridge	12

Time did not permit a statistical sampling of the entire study area, but the conclusions drawn from the small, stratified random sample are probably relatively reliable in indicating the general distribution of Mesolithic sites. General testing was continued, however, along the high ridge and ridge peaks of the rim of de Doeze and on several similar, neighboring ridges. Thirteen additional test pits were excavated outside the area of the statistical sample. This testing did not provide statistically reliable coverage of so large an area but it does allow general picture to be obtained of the amount and distribution of Mesolithic occupation in the study area as a whole. The locations of some of these pits may be seen in Figure 3. The results of the testing are presented in Table 2.

TABLE 2. TEST PITS

Test Pit No.	*Artifact Count*	*Remarks*
10	5	
11	5	
12	37	Badly disturbed
13	1	
14	17	
15	0	
16	24	Possible burned area
17	6	
18	5	
19	1	
20	0	
21	0	
22	20	

Excavations

Three major excavation units were opened on the high ridge and ridge peaks along the east side of the blowout rim. Each unit was expanded to enclose the entire concentration of Mesolithic artifacts. These excavation units were labeled H (Havelte) 1, H2, and H3. Excavations were undertaken for three field seasons of approximately 10 weeks each. The first, exploratory season was carried out by a crew of four, while the field crew consisted of approximately 24 members in the remaning two seasons in 1971 and 1972. The plan and situation of the final excavation units is shown in Figure 3. Within these excavation units, a total of six separate concentrations of material were uncovered. These concentrations have been designated as sites H1:I, H1:II, H1:III, H2:I, H2:II, and H3 (Figure 4). Table 3 indicates the areas excavated and the number of potential features encountered during the three field seasons.

TABLE 3. EXCAVATION UNIT AREAS AND FEATURES

	H1	*H2*	*H3*
Excavation unit area in m^2	225.5	367.75	172.0
Number of Features	20	26	11

Portions of the excavated areas had been severely disturbed by localized military activity. A large bomb crater determined the southern limit of H1, and numerous slit trenches had been cut through portions of this unit. These disturbances were carefully mapped on the floor plan of the excavation and those artifacts recovered from disturbed areas were retained but not assigned individual field numbers. The extensive disturbances in H1:I and H1:II were perhaps the most unfortunate as they centered on the areas of highest artifact density.

The excavations were generally begun with five by five meter squares. Extensions of varying size were added to follow the concentration of artifacts. Excavation units were always carried to the limits of the concentrations and trenches generally extended from these borders to insure that the entire concentration had been recovered.

In the excavation of a square, vegetation and recent blown sands were removed from above the buried podzol. This overburden varied in depth from 15 centimeters to approximately one meter. The surface of the podzol was then excavated by shovel-skimming until the first artifacts were encountered. After the first artifacts were located, trowels were used exclusively to gradually remove the soil. As each artifact was located, it was assigned a field number and placed in a small envelope. On the envelope was recorded the excavation unit, the sequential object number, the dip of the artifact relative to the *B2B* horizon, and the orientation of the object with respect to compass direction. A numbered nail was then used to mark the location of the object. After a series of artifacts had been collected, the horizontal coordinates were measured to the nearest centimeter and a transit used to record the vertical elevation of each item.

Precise horizontal location was considered to be important for the eventual detection of prehistoric patterns of activity at these sites. Elevations were taken to maintain a thorough control on possible stratigraphic relations among the

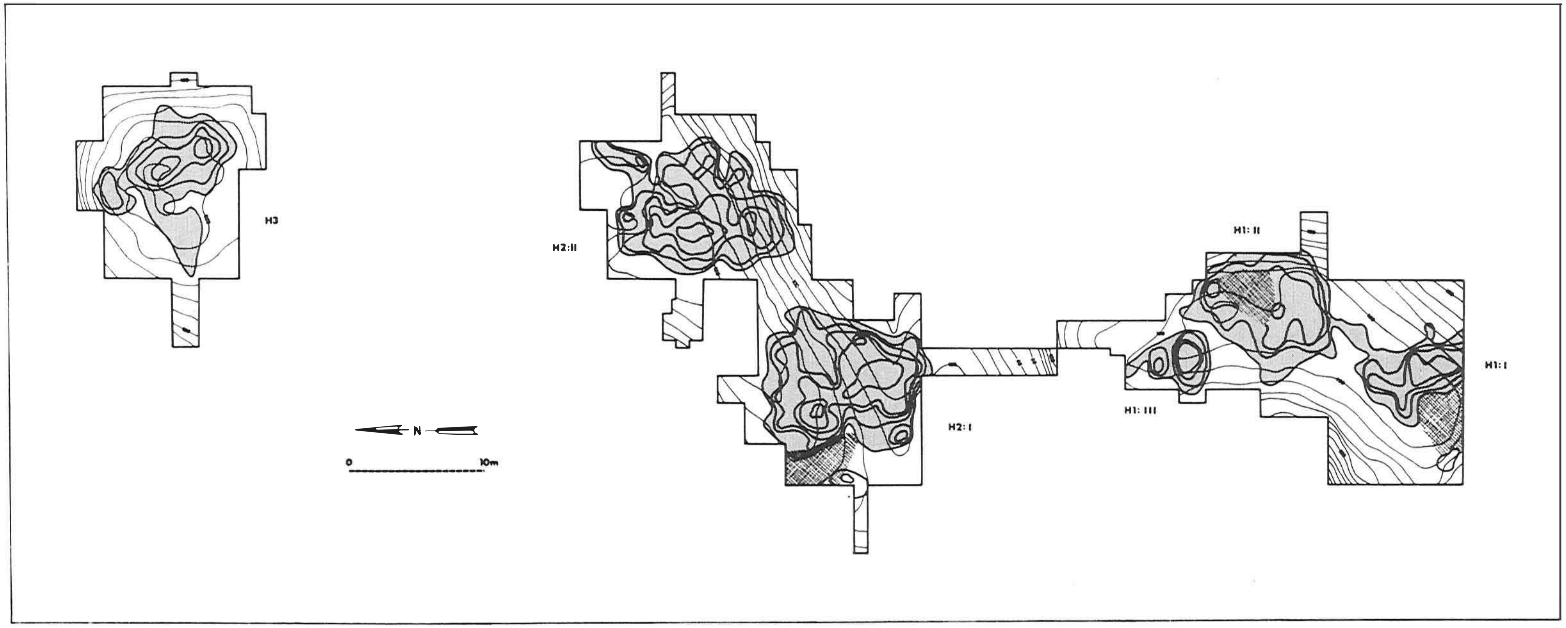

Fig. 4. Artifact concentrations on contours of the *B2B* soil horizon within excavation units. Intervals of artifact density contours are 10, 20, 40, 80, 160, 320. Contour elevations of the *B2B* soil horizon are relative to an arbitrary excavation datum. Contour interval – 10 cm.

artifacts, even though these might not be noticeable in the field. The degree to which artifacts exhibited significant tendencies to be tilted, with respect to the marker soil horizon (the *B2B*), was thought to perhaps be indicative of the degree of disturbance or stability of the occupation horizon subsequent to deposition. Moreover, the disposition of these artifacts could outline pits or features that were not observed in the field. Tendencies to dip would naturally be considered in conjunction with variations in the depth of the artifacts and with the evidence from "backplotted" sections for the reconstruction of an occupation "floor" running through the sands. The orientation of artifacts with a definite longitudinal axis was considered useful in the detection and definition of patterns of movement or activity on such "floors". These data were recorded according to a system which would allow manipulation by computer and anticipated statistical analyses.

In areas where relatively high concentrations of artifacts were found, the back dirt from the troweling was sieved through a 4 mm screen to recover the smaller objects. This screening procedure indicated that careful trowelling was approximately 95% effective in the recovery of artifacts. The backdirt from H2 was screened in its entirety as a further check on the accuracy of recovery in units H1 and H3. In addition to flint artifacts, several other classes of material were assigned individual field numbers and their exact proveniences were recorded. Rocks, pebbles, and pieces of charcoal were all treated as individual items using the same recording procedures.

In the field laboratory, the following information was recorded on permanent record forms. This information has since been transferred to computer storage files to provide more rapid access to the data: 1) the excavation unit and object number; 2) the coordinates and elevation of the object; 3) the weight of the object; 4) the dip and orientation of the object; and, 5) the class of material (flint, rock, pebble, charcoal, etc.). For flint artifacts, the following information was also noted: 6) waste material type or retouched tool; 7) presence or absence of cortex and/or patina; 8) the type of heat alteration; and, 9) the condition of the artifact (i.e., complete or broken). This information seemed adequate for a preliminary coding of the artifacts and was easily recorded in the field. It must be noted here that this system was designed specifically for this field situation and is not intended as a generalized scheme for recording field data.

The "marker" soil horizon, the surface of the *B2B*, was mapped in detail throughout the excavation units (Figure 4). This map very clearly demonstrates the presence of a well-defined ridge, roughly 5-8 meters in width, running through the series of excavation units with marked saddles or low areas between the sites. The artifacts tend to concentrate along this ridge as indicated by the contours of artifact density within the excavation area (Figure 4). Profiles were drawn of all walls of the excvations to maintain a control on vertical stratigraphy, concomitant with the mapping of the*B2B* horizon.

Soil samples of roughly 500 grams were taken in a checkerboard pattern throughout the excavations from the *A2*, *B2B*, and *B2* horizons of the buried podzol. These samples were intended for use in phosphate determinations and for locating possible concentrations of bird gastroliths. The phosphate analysis has not yet begun for these samples, but the results for phosphate samples from the features will be discussed below.

Pollen samples were taken from the occupation level as well. Generally, pollen is not well preserved under soil conditions such as those present at Havelte. Samples were, therefore, taken from beneath large artifacts and stones in the hope of obtaining uncontaminated, reliable pollen samples. The samples were submitted to Dr. W. A. Casparie and will be fully described in the final report. These samples were analyzable but showed great variation. More importantly, the samples generally indicated a pollen spectrum representative of what might be expected for a surface of Atlantic/Subboreal age, considerably later than the probable date of the Mesolithic occupation. It would appear, therefore, that this method will not prove useful in attempting to distinguish areas of plant processing or hut construction on the Mesolithic occupation floor.

Features

A number of features were uncovered in the course of the excavations. These features (hearths, pits, etc.) are regarded as an important component of the total information which an archaeological site holds. The features represent an additional source of data regarding human activities in the past, complementary to the distribution and function of the lithic artifacts. Because of their importance, the features were carefully excavated with a standardized procedure to ensure accurate and comparable data. For our purposes, any object or material that could not be adequately coded using the data recording system was treated as a feature.

Features were generally not discernible until the *B2B* horizon and hardpan of the podzol had been removed. Features then normally showed up as dark grey-green-black stains in the yellow coversands and were relatively easy to outline and draw. Any stain with a roughly clear outline in plan was treated as a feature until further examination proved otherwise.

Ultraviolet, infra-red, and black and white photographs were taken of various portions of the *B2B* horizon with the help of Mr. J. A. Brongers of the Rijksdienst voor het Oudheidkundig Bodemonderzoek. It was hoped that these photographs might reveal postmolds or other features that are not discernible with the naked eye in such soils (Brongers, 1965/66). Unfortunately the results of this experiment showed no clear new features.

The following procedure was used whenever a feature was encountered. As soon as the outline of a feature became visible, a drawing was made of the plan view, color readings were made using a Munsell color chart, and black and white, infra-red, and color photographs were taken. The infra-red photographs helped sometimes to better define the boundaries of the feature. Infra-red film records sharper contrasts between organic and inorganic materials and proved especially useful in the detection of the few features that were excavated with a complete section to the modern ground surface. Although these features had not been visible in the *A2* and *B2B* horizons, once the location was known beneath the *B2B* horizon, the photographs gave a good indication of the shape of the feature through the *B2B* and *A2* soil horizons. In this way it is possible to accurately reconstruct the original surface level of the feature in question.

Features were removed in quadrats whenever this was possible. This was done to provide clear sections in two directions. The possibility exists that some of these features might have been re-utilized in subsequent occupations during the Mesolithic. Adequate profiles of such features may give indications of such re-use. Any artifacts recovered in the feature were assigned field numbers and recorded in the same manner as all other objects in the excavation. Munsell color readings were taken on all distinct units of fill within the feature. Pollen and phosphate samples were taken at five centimeter intervals from one of the profiles of the feature. Possible radiocarbon samples were collected and all charcoal was retained for species determination. One quadrant was removed, the profile drawn, and the fill bagged for storage. The second quadrant was removed and the fill was saved for flotation; profiles were again drawn and photographs taken. The remaining half of the feature was taken out in two quadrants; one quadrant was removed in levels, arbitrary 5 cm. levels, if natural levels were not observed. In this manner we hoped to obtain as much information as possible about the size, shape, contents, and function of each feature.

Three major classes of features were distinguished: hearths, small pits, and "shallow pits". A general description of each type of feature is given here. Individual features will be described in the final report.

The hearths are pits scooped out in the coversands. These features are normally circular or oval in plan view, with an average diameter of 70 centimeters. The basin-shaped profile of a hearth has an average depth of 25 centimeters below the *B2B* horizon. The surface of the few hearths that were found in full profile appeared in roughly the center of the *A2* horizon. This indicated that the original dimensions of the features would have been roughly 80-100 cm. in diameter and 40 cm. in depth. The fill of the pit hearths is generally black, compacted sand with numerous flecks of charcoal and occasionally larger carbonized pieces of wood. Large stones occur very rarely in hearths and there was no indication of stone-lined or stone-ringed fireplaces in our excavations. Occasional flint artifacts were found in these hearths. There was, however, no indication that lithic material had been intentionally placed in the hearths for altering flint, cooking, or any other purpose. Generally, two color zones were observed in such a feature: the black, charcoal-flecked fill of the hearth; and a lighter, grey-brown area of staining surrounding the hearth itself. This second zone did not appear to have been caused by heat but rather by leaching of some of the color from the original hearth into the surrounding sands. In several features, the remains of intact, carbonized logs were recovered and thick (5-10 cm.) ash lenses were present.

The small pits varied much more in size and shape than the hearths. These depressions were generally circular or elliptical features of varying depth. The small pits were distinguished from hearths in the field by less regular shape, the lighter color of the fill, and a lower density and smaller size of charcoal pieces. The phosphate analysis described below generally confirmed this field distinction and was very useful in distinguishing small pits from hearths in questionable cases. The function of the small pits is unclear. They may have served as refuse or storage pits.

Three "shallow pits" were uncovered. These pits are generally egg-shaped and 2-3 meters in length, approximately 1.5-2 m. in width and 30-50 cm. deep. The fill is a dark brown sand (Munsell color 10 YR 4/2) that was clearly distinguishable from the yellow sand of the *C* horizon. Flint artifacts and charcoal flecks were found in the fill but the density of such finds was quite low. In one of the pits, the distribution of the flint artifacts appeared to follow the bottom contour of the pit. It is difficult, however, to determine if these shallow pits are contemporaneous with the Mesolithic floors. "Shallow pits", very similar to those found at Havelte, are known from several other sites in the northern Netherlands (Waterbolk, 1962). Two of the pits at Havelte were very similar in size and shape. The orientation of the long axes of these two pits was roughly parallel and they were located close together between artifact concentrations H1:I and H1:II. The third shallow pit, similar to the other two, was somewhat isolated from any concentration of artifacts and its stratigraphic situation indicated that the profile of the feature truncated the primary deep podzol. These shallow pits, therefore, may have been created by uprooted trees or later human disturbance. The age and function of these features can perhaps be more clearly ascertained in future investigations.

In addition to these major classes, other potentially important features were designated. These included flint concentrations and charcoal concentrations. Particularly notable concentrations of flint artifacts were assigned a feature number in order to maintain good control on the relationship of the artifacts. For example, when an obvious concentration of pieces from the same original nodule was encountered in a small area, it was designated as a "flint concentration" or feature. In another instance, a cache of 13 blades was designated as a feature. Dense concentrations of charcoal in the *A2* or *B2B* soil horizons were also designated as features. Circular or oval concentrations of the charcoal pieces with no appreciable depth are interpreted as probable surface hearths.

Table 4 lists the features for each excavation unit.

TABLE 4. FEATURES

H1	*H2*	*H3*
TP 1 Hearth	1 Animal burrow	1 Hearth
1 Hearth	2 Animal burrow	2 Animal burrow
2 Shallow pit	3 Blade concentration	3 Small pit
3 Animal burrow	4 Charcoal concentration	4 Small pit
4 Treefall disturbance	5 Charcoal concentration	5 Small pit
5 Shallow pit	6 Animal burrow	6 Animal burrow
6 Animal burrow	7 Animal burrow	7 Small pit
7 Animal burrow	8 Hearth	8 Small pit
8 Small pit	9 Hearth	9 Animal burrow
9 Flint concentration	10 Pebble concentration	10 Small pit
10 Flint concentration	11 Post-Mesolithic flat grave	11 Surface hearth
11 Hearth	12 Animal burrow	
12 Hearth	13 Post-Mesolithic pit	
13 Hearth	14 Animal burrow	
14 Flint concentration	15 Animal burrow	
15 Small pit	16 Animal burrow	
16 Hearth	17 Animal burrow	
17 Hearth	18 Animal burrow	
18 Surface hearth	19 Small pit	
19 Charcoal concentration	20 Post-Mesolithic pit	
20 Charcoal concentration	21 Post-Mesolithic pit	
	22 Small pit	
	23 Animal burrow	
	24 Post-Mesolithic pit	
	25 Animal burrow	
	26 Post-Mesolithic pit	

PRELIMINARY ANALYSIS

Stratigraphy and topography

The most prominent stratigraphic feature of the excavations was the deeply developed podzol described earlier. The modern coversand overburden varied in depth over this buried podzol throughout the excavation units. Generally, on the higher areas, particularly in H2:II, there was very little recent deposition and in some profiles it appeared that the *A1* and the *A2* horizons of the buried podzol had been partially eroded. In most areas of the excavation, however, the overburden averaged 30 cm., gradually increasing in depth toward the lower areas. The stratigraphy of the highest areas of the ridge was complicated as well by the presence of a number of unusual features that disturbed a small portion of the occupation floor, primarily again in H2:II. These features were the result of human activity followed by animal burrowing and the slumping of the soil horizon. The man/animal-made features were circular or rectangular in shape and in some cases contained ash lenses in the fill. These features had been excavated through the buried podzol to depths of more than one meter in some cases. No artifacts were found which might have indicated a possible date for these features. However, since they had been excavated through the podzol, they must post-date the Mesolithic occupations and the formation of the podzol. Fortunately, these features did not disrupt the primary concentration of Mesolithic occupation in H2:II.

Artifacts were generally distributed in a relatively shallow zone, 5-10 cm. thick, but ranging up to as much as 25 cm. in thickness. "Backplots" of the vertical distribution of the artifacts were prepared for 20 cm. wide strips across the excavation area. These plots are produced by a computer program which allows plotting of strips of any length or width in any direction over an excavation area. Obviously, these plots would be almost impossible to produce in quantity by hand but they are most useful in studying the relationship of the artifacts to the soil horizon, in analyzing the possibilities of re-occupation or disturbance, and in searching for features which were not visible in the course of excavation. Figure 6 is a typical backplot produced by the computer. Note that the vertical scale is greatly exaggerated.

The backplots typically indicate that the vertical dispersal of artifacts is closely related to the density of artifacts. In areas of few artifacts, these are distributed in a relatively narrow band which seems to represent the original living surface. As the density of artifacts increases, so does the vertical dispersal of the artifacts. In most instances, however, the majority of the horizontal artifacts define a relatively narrow zone.

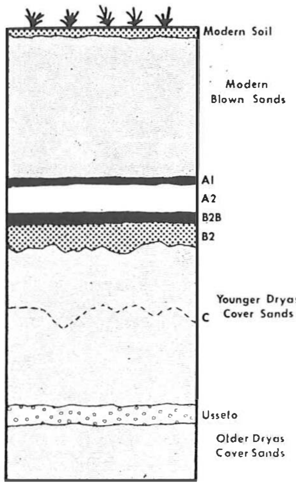

Fig. 5. Schematic profile of natural stratigraphy at Havelte "de Doeze".

The stratigraphic position of the podzol was indicated on the backplots by the surface of the *B2B* soil horizon. Although there is a tendency for the occupation zone to parallel the soil horizon, this relationship is not exact. Along the crest of the ridge, the artifact zone parallels the *B2B*. However, as the artifact zone descends the ridge slope, it no longer follows the *B2B*, but crosses this surface and continues beneath the podzol.

There are two possible processes which might explain the discordance between the artifact zone and the soil horizon along the ridge slope: differential soil development or a slight shift in the position of the ridge crest. The podzol might have been more developed on the ridge top than on the slope. This conflicts, however, with field observations that the podzol was always thicker on the slopes and in the low areas of the ridge. A slight change in the topography of the ridge between the time of Mesolithic occupation and the formation of the podzol seems more probable. Such a change in relief is understandable if the podzol were formed under heather after a former forest had been cleared from this area. There would have been ample time for erosion to slightly shift the crest of the ridge.

The problem of the stratigraphic position of the occupation at Havelte, as at other Mesolithic sites, is not totally resolved. It is still possible to question whether or not the archaeological materials are precisely *in situ*. It is hoped that the analysis of the vertical distribution of artifact weights will shed some light on this question. However, all of the information which we have collected and analyzed to date indicates that the original horizontal position of the majority of the artifacts has not been significantly disrupted.

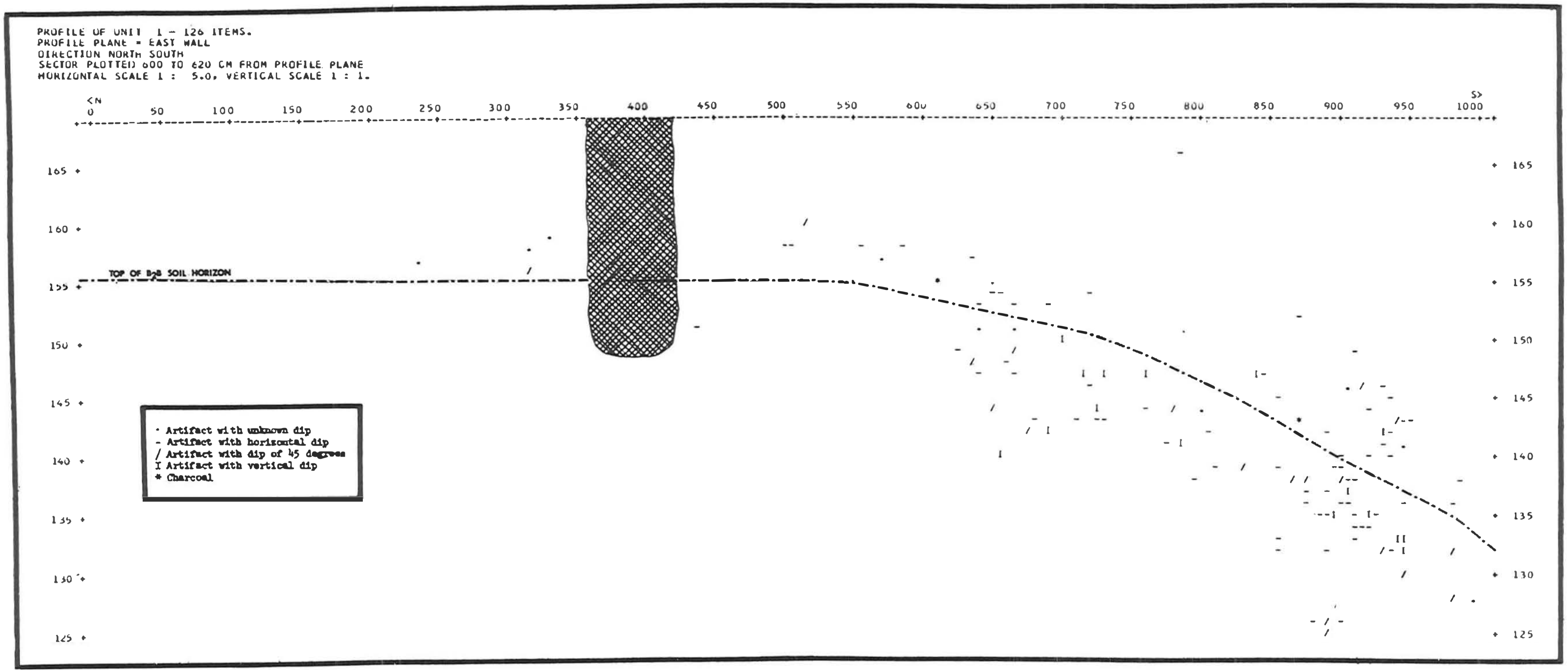

Fig. 6. Backplot through site H1:I.

Typology

Table 5 gives the composition of the six artifact concentrations at Havelte according to the traditional typology as presented by Newell. The type numbers correspond to Newell's system (1972). This typology is derived from Bohmers' classification (1956, 1963) and is generally compatible with typologies employed in other areas of north-western Europe. Many of the specific types used in the Netherlands, however, have not yet been adequately described. A comparison of the list presented by Newell (1972: 20-35) with the type descriptions of Rozoy (1968), the Group d'Étude de l'Epipaléolithique – Mésolithique (1969), Brinch Petersen (1966), and Taute (n.d.) provides an approximate definition for most of the types.

By grouping the types into major general classes, a number of similarities and differences among the six concentrations at Havelte can be seen (Table 6). The major "type groups" are as follows: points (including triangles and trapezes), backed blades, borers, end scrapers, side scrapers, knives, retouched flakes and retouched blades (including truncated blades).

Most of the concentrations have only a few borers and burins. The ratio of points to backed blades is generally less than 1.0, and retouched flakes tend to average 25% on all the sites. The proportion of points varies widely between sites, however, and end scrapers have a bimodal distribution of percentages as do retouched blades.

H1:I is most notable for the complete absence of borers from the assemblage. H1:II has a relatively low percentage of points (only 3.7%) compared to backed blades (16.6%), along with a high percentage of end scrapers. H1:III is clearly the smallest assemblage with only 21 total retouched tools – obviously, the percentage figures here are biased by the small sample. H2:I is, in contrast, the largest assemblage with 307 tools, and it is also the most markedly different from the other concentrations. Most obvious is the very high number of borers (7.8%) and the high proportion of side scrapers (9.4%). The number of points is also quite low relative to the number of backed blades. H2:II contrasts strongly with H2:I in the relative number of points. This is due in part to the large number of triangles present at H2:II. The proportion of scrapers is low at H2:II. H3 has a strikingly high percentage of knives and the proportion of retouched flakes and blades is very low.

An ordered matrix of correlation coefficients from type-group counts (Table 7) indicates relationships among the six sites. This matrix indicates that the strongest relationship is among H2:I, H1:II, and H1:III. A second group of H1:I and H2:II also includes H1:III. H3 is most similar to H2:II on the basis of tool-group counts.

TABLE 5. HAVELTE TOOL COUNTS

Tool Type	*H1:I*	*H1:II*	*H1:III*	*H2:I*	*H2:II*	*H3*	*Total*
Points:							
4 A point	1	1	0	2	0	0	4
5 B point	4	0	0	0	5	0	9
6 C point	1	0	0	0	2	0	3
7 D point	0	0	0	1	1	0	2
16 Lancette point	4	0	0	4	12	1	21
26 Broken point	1	0	0	3	6	1	11
Triangles:							
8 Isosceles triangle	0	0	1	0	2	0	3
9a Short scalene triangle	0	0	1	5	15	4	25
9b Long scalene triangle	0	0	0	1	0	1	2
Trapezes:							
13a Broad symmetric trapeze	1	0	0	0	0	1	2
13b Broad asymmetric trapeze	1	0	0	0	0	0	1
13d Broad rhombic trapeze	0	0	0	2	0	0	2
13f Broken trapeze	0	1	0	1	0	0	2
Backed Blades:							
27 Backed blade	15	5	3	42	28	10	103
28 Triangular backed blade	3	3	1	2	5	5	19
29 Rectangular backed blade	0	1	1	0	0	1	3
Borers:							
30 Short blade borer	0	1	0	0	0	2	3
31 Long blade borer	0	0	0	1	1	1	3
32 Short flake borer	0	0	0	19	3	0	22
33 Long flake borer	0	1	0	4	0	0	5
Burins (37-40):	0	1	0	6	2	1	10

End Scrapers:								
41	Circular scraper	2	2	2	4	1	0	11
42	Simple flake scraper	3	8	2	22	6	2	43
43	Double scraper	0	0	0	1	1	0	2
44a	Short convex end scraper	1	0	0	8	3	1	13
44b	Short concave end scraper	0	0	0	1	2	0	3
44d	Short straight end scraper	0	0	0	7	0	0	7
45	Broken end scraper	0	0	0	2	1	0	3
46a	Long convex end scraper	1	0	0	0	0	0	1
47c	Small keeled discoid scraper	0	0	0	2	3	2	7
Side Scrapers:								
48	Convex side scrapers	3	2	0	21	5	3	34
49	Concave side scrapers	0	0	0	8	4	2	14
Knives:								
51	Flake knives	1	2	1	15	9	5	33
52	Blade knives	2	3	0	7	5	6	23
Retouched Pieces:								
60	Retouched flakes	13	13	6	76	32	5	145
61	Notched flakes	1	1	0	14	14	5	35
62	Retouched blades	8	8	3	15	8	3	45
63	Notched blades	1	0	0	3	2	0	5
64	Truncated blades	4	1	0	8	4	0	17
	Total	71	54	21	307	182	62	697

The relative chronological position of the Havelte sites can be determined on typological grounds by the presence of trapezes. Triangles are replaced by trapezes in the stratigraphic sequences of several cave sites in southern Germany. This succession is confirmed by radiocarbon dating (Taute, n.d.). Newell has shown through a "seriation" of point types (1973: graph 3) that in the Netherlands the appearance of broad trapezes does not occur until the Late Mesolithic phase, concomitant with a slight decrease in the proportion of scalene triangles.

TABLE 6. HAVELTE: TYPE GROUPS-COUNTS AND PERCENTAGES

	H1:I		H1:II		H1:III		H2:I		H2:II		H3	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Points	13	18.3	2	3.7	2	9.5	19	6.1	43	23.6	8	12.9
Backed Blades	18	25.3	9	16.6	5	23.8	44	14.3	33	18.1	16	25.8
Borers	0	0	2	3.7	0	0	24	7.8	4	2.1	3	4.8
Burins	0	0	1	1.8	0	0	6	1.9	2	1.0	1	1.6
End Scrapers	7	9.8	10	18.5	4	19.0	47	15.3	17	9.3	5	8.0
Side Scrapers	3	4.2	2	3.7	0	0	29	9.4	9	4.9	5	8.0
Knives	3	4.2	5	9.2	1	4.7	22	7.1	14	7.6	11	17.7
Retouched Flakes	14	19.7	14	25.9	6	28.5	90	29.3	46	25.2	10	16.1
Retouched Blades	13	18.3	9	16.6	3	14.2	26	8.4	14	7.6	3	4.8
Total	71	99.8	54	100	21	99.9	307	99.8	182	99.9	62	99.9

This sequence is again confirmed by radiocarbon dates. Based on the exclusive presence of triangles at H1:III and H2:II, therefore, these two concentrations can be provisionally interpreted as pre-dating the other assemblages. Sites H2:I and H3 contain both scalene triangles and trapezes. The assemblages of H1:I and H1:II contain only trapezes.

This typological dating does not correspond well, however, with the radiocarbon dates for the Havelte sites. H2:I is dated to 9145 BP and H1: Feature 12 (associated with either H1:II or H1:III) is dated to 8725 BP. Both dates appear to be quite early. The date for H1: Feature 12 may indicate the association of this hearth with the concentration of artifacts in H1:III on typological grounds. However, the early date for H2:I does not coincide with

TABLE 7. CORRELATION OF ARTIFACT CONCENTRATIONS BY TOOL GROUP COUNTS

N=9 DF=7 R@.9500=.66 R@.9900=.80

	H2:I	*H1:II*	*H1:III*	*H1:I*	*H2:II*	*H3*
H2:I	1.00	.86	.83	.53	.64	.45
H1:II	.86	1.00	.93	.66	.54	.43
H1:III	.83	.93	1.00	.84	.75	.59
H1:I	.53	.66	.84	1.00	.82	.64
H2:II	.64	.54	.75	.82	1.00	.67
H3	.45	.43	.59	.64	.67	1.00

TABLE 8. HAVELTE: PERCENTAGES OF WASTE MATERIAL CLASSES

	H1:III	*H1:II*	*H2:I*	*H2:II*	*H3*
Block	7.8	13.9	11.2	14.8	5.5
Unretouched flake	69.5	65.1	68.4	68.6	72.3
Unretouched blade	7.2	7.0	5.2	6.9	8.4
Potlid	6.6	3.4	6.4	3.4	2.2
Blade core	0.1	1.0	0.6	0.6	0.4
Flake core	2.1	2.5	2.0	1.5	2.9
Microburin	0.0	0.0	0.0	0.0	0.1
"Burin spall"	0.1	0.1	0.2	0.1	0.3
Core face rejuvenation flake	2.2	3.1	1.9	0.7	2.3
Core edge rejuvenation flake	0.4	0.3	0.3	0.1	0.5
Core end rejuvenation flake	0.3	0.0	0.1	0.1	0.3
Nodule	0.4	0.6	0.4	0.3	1.4
Retouched tool	3.19	2.98	3.19	2.92	3.40
n =	1961	703	9618	6128	1820

the typological placement following Newell. This possible discrepancy may indicate that the date is too old, that the feature in H2:I is more likely associated with the concentration in H2:II, that H2:I is a site that has been re-occupied, or that revisions are necessary in the chronological and typological framework as presented by Newell. In any case, it is impossible to assign the assemblages with any certainty to a specific phase of the Mesolithic as defined by Newell (1973: graphs 2 & 3). Both of the radiocarbon dates indicate placement of the H1:III and H2:II concentrations in the "Basal Mesolithic" phase. However, certain expected types for this phase are entirely absent from the Havelte materials and other types that should not appear (e.g., lancette points) occur in large number. This raises a number of questions regarding the utility of the traditional typology from the standpoint of chronology.

The traditional typology has been highly biased by the selection of "tools" for classification. Through such selection only a very small proportion of the total lithic industry, some 2-5%, is considered. It is quite likely that these selected types are measuring spatial and chronological variation, but such a classification ignores much of the information inherent in the lithic material. "Waste material" has generally been ignored. Various studies, however, have shown that unretouched flakes and blades can comprise an important portion of the tools utilized by Stone Age man (Gould, Koster and Sontz, 1971; Allchin, 1957). Moreover, waste material is a good indicator of technology and provides a measure of this aspect of the variation in stone tool industries.

Table 8 gives the percentages of waste material classes for five of the six Havelte sites (site H1:I is approximately one-half disturbed). The differences between sites are quite small and generally due to high proportions of only one or two categories. For example, the high proportion of blocks, blade cores and core face rejuvenation flakes in H1:III causes a reduction in the percentage of unretouched flakes. The categories of waste material will be revised by further analysis of the lithic industries, but, in general, they reflect certain basic similarities and differences between the lithic industries of the various sites quite well.

Any typology is necessarily directed at the solution of a problem. For a number of years, archaeologists have been concerned with the "territorial" and chronological relationships between " cultural groups". Traditional typologies have generally been conceived with the questions of time and space relationships in mind and have been useful in pursuing such questions. These typologies, however, have concentrated on the formal morphology of certain classes of retouched stone tools. Such classifications measure not only chronological and spatial variation but attributes of function and technology as well. By combining all of this information summarily, numerous questions regarding within-site variation and regional relationships cannot be attacked. A typology must be constructed with specific questions in mind, intended as a problem-solving tool, to be put aside when new questions arise. In order to more fully investigate some of the questions discussed at the beginning of this report, several classifications (or "typologies") are being devised for specific problems.

The reconstruction of worked nodules, the analysis of lithic technology, functional analysis, distributional analysis, are also means to an end. That end is a more comprehensive understanding of the archaeological site as a focus of human activity, a location where a specific number of people carried out a specific repertoire of behavior for a specific period of time. The following sections describe preliminary steps in such a direction.

Reconstruction of flint nodules

The flint artifacts at Havelte were made from locally available flint nodules. It was possible to partially reconstruct a number of these nodules from the flint fragments found scattered over the occupation floors (Fig. 7). These reconstructions have provided valuable information on techniques and processes of stone tool manufacture. In addition, the spatial distribution of the pieces of a

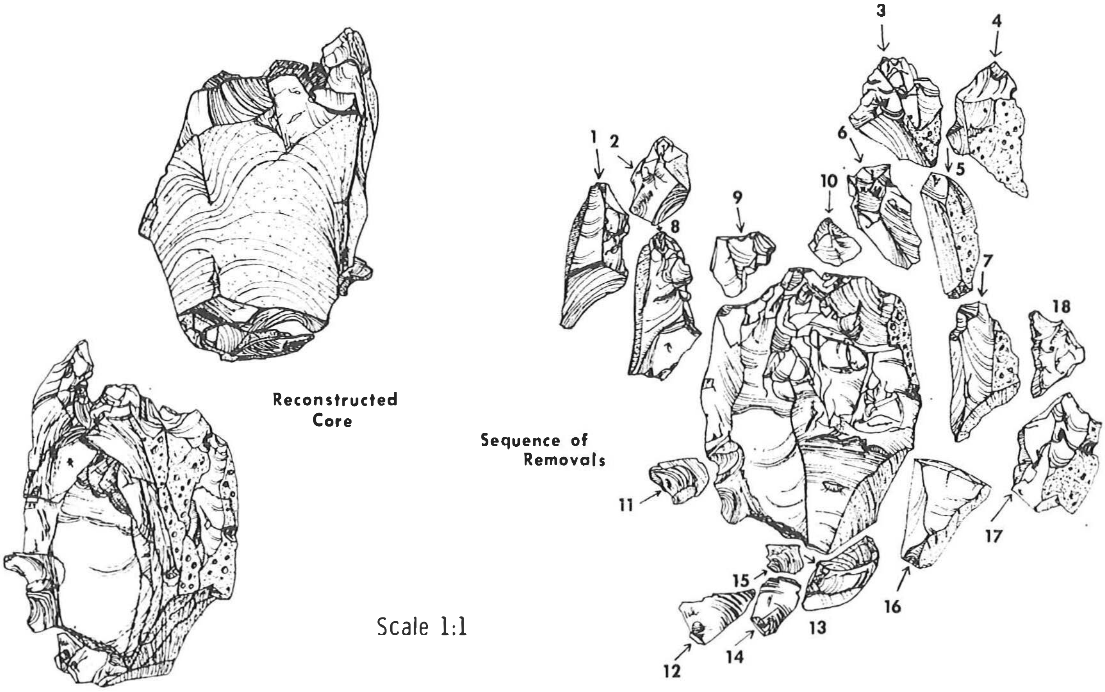

Fig. 7. Reconstructed core.

reconstructed nodule provides some evidence for the presence of functionally specific areas on the occupation floor. The distribution of the pieces of core 1 in H3 (Fig. 8), for example, shows an area of flint working outside the main artifact concentration.

When the pieces of all of the reconstructed nodules are plotted for the various excavation units it is clear that there is no overlap between the various artifact concentrations – that is, no pieces of a nodule flaked in one concentration occur in another concentration. Leroi-Gourhan and Brézillon (1966) have argued that the spread of individual nodule segments over several concentrations at Pincevent is evidence for contemporaneous occupation. Although it is possible that the relatively small number of pieces that do "cross over" at Pincevent could have been picked up by subsequent occupants and thus moved, the corrollary of the argument is even convincing in the case of the Havelte sites: the fact that fragments of the same nodule are never found in more than one concentration strongly suggests that the six concentrations are chronologically separate. The relatively cohesive distribution of individual nodule fragments at Havelte (cf., Fig. 8) is also good evidence for the absence of serious post-occupation disturbance of the artifacts and indicates the potential feasibility of locating and defining functionally specific artifact clusters on the occupation floor.

Lithic technology

Detailed analysis of the lithic industries recovered from the Havelte sites, including the reconstruction of flint nodules, illustrates the processes and procedures involved in the flint-working technology of the inhabitants of the sites. The resulting models of lithic manufacture can be compared for the six concentrations at Havelte and for other Mesolithic sites.

Generally, lithic assemblages have been analyzed simply on the basis of the presence and proportion of certain recognized tools. The forms of these tools and the relative frequency with which they occur vary greatly among assemblages. Such variation appears due in large part to stylistic and/or chronological differences among sites. However, the basic process of flint working, that is the sequence of actions taken to produce specific end-products, may be expected to remain stable over longer periods of time and to vary as a reflection of factors other than style or chronology. The analysis of similarities and differences among assemblages from this technological perspective may therefore prove useful in defining previously unsuspected and perhaps larger-scale patterns in lithic data.

The steps in the process of flint working were readily observable from the

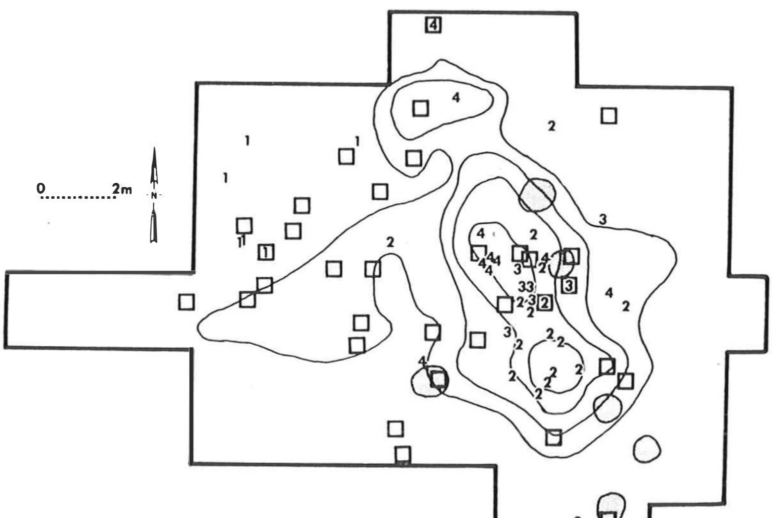

Fig. 8. H3: Distribution of cores and removals over artifact density contours. Scale 1:200. Hollow square = cores; hollow squares with number = reconstructed nodule; numbers = removals from numbered core; stippling = features.

reconstructed nodules. A series of categories of flint artifacts could be defined, representing the typical products of each step in the manufacturing process. Material from each category exhibited certain characteristic features. In analyzing the lithic materials from Havelte, every piece of flint was individually examined and classified on the basis of these features. The basic sequence of manufacturing steps proved to be similar in all six concentrations. A single, general and comprehensive description may thus be given.

The Mesolithic inhabitants of the site obtained flint in nodules of various sizes from the nearby push moraine or from locally exposed ground moraine. The largest nodules were generally broken to obtain smaller pieces, while the smaller nodules were worked in their original state. There is a possibility that the flint was altered by heat treatment prior to flaking. This is discussed in another section.

The flint industry can be divided into two major components, each with a different sequence of procedures, different types of waste material, and different end-products. These two components are termed "blade" and "small flake". Within each component, distinct steps in the manufacturing process may be outlined. These steps may sometimes be employed out of sequence or they may occasionally be skipped entirely, depending upon certain characteristics of the raw material (primarily shape and quality). The blade component seems to be predominant on all the occupation floors.

Blade component

To begin a series of steps that lead to the manufacture of blades, the flint workers selected a block or nodule. It is interesting to note that the stock of raw material varied greatly in quality, and in some cases raw nodules were not broken at all. Sometimes a generally rectangular nodule with patina, but without cortex, was used in making blades. Few or no removals were necessary before good blades could be produced. In other cases irregular blocks, with or without cortex, were utilized, and other steps in core preparation were necessary before blade production could begin.

For a generally round nodule of good quality flint with some outer cortex or patina, the first steps in the blade manufacturing process were as follows (Fig. 9): the initial removal, termed the lid, to open the core for further flaking was a round, often thick, flake with cortex covering the outer surface. The area on the nodule where this flake was removed generally became the platform for subsequent removals. If no major shaping of the nodule was necessary, a second flake, removed at a right angle to the lid, provided an initial flake scar to guide the removal of a series of decortication blades. These are generally blade-shaped pieces having cortex on approximately 50% of the dorsal surface. These blades are removed sequentially around the platform. This series of removals results in a large area of exposed surface, with parallel flake scars, on one or more sides of the core. Some decortication blades were subsequently used.

For irregular nodules, nodules with especially thick cortex, or nodules of poor quality flint, additional preparations were required before the core was ready for the production of blades. The major shaping of gross nodules required the removal of large, thick trimming flakes. These removals may or may not have heavy cortex present and they may be blade-shaped (longer than wide, but thicker and heavier than normal blades) or flake-shaped (length and width approximately the same, but still thick and heavy). These pieces show large bulbs of percussion and thick platforms, indicating that they were probably removed by direct percussion. Some of these pieces may have been subsequently used as cores; the assemblage includes several pieces with cortex covering the dorsal surface and evidence of blade removals on the original bulbar surface that can be interpreted in this way. Others have been heavily retouched along an edge to make large scrapers.

If the core needed further shaping, after large trimming flakes had been removed, smaller but thick fragments, without cortex, were removed to complete the final shaping. Flakes like these were probably also removed at other stages in the manufacturing process to renew the shape of the core, to remove rough corners, to improve the platform, or to provide a new platform.

When the core finally assumed its "prepared" form after shaping, a series of flake-blades were removed from the open face. These, as the term suggests, are a form intermediate between flakes and blades. They are long and have parallel sides like a blade, but are wider like flakes. These pieces are the first thin removals in the blade making process. Their narrow striking platforms and small bulbs of percussion indicate that the flakes were removed by indirect percussion or pressure flaking. These flake-blades are sometimes retouched into tools, sometimes utilized, and sometimes discarded with no evidence of use.

After the core had been subjected to some or all of the above steps, the next step was the removal of true blades, long and thin with parallel edges (Fig. 9). Many blades were probably utilized for general cutting activities, while some were retouched into points, knives, and other tools.

A number of distinctive removals occurred as by-products of blade manufacture. These include failed blades, blades that end abruptly in a hinge fracture (Fig. 9), or blades that are not parallel-sided. These failures result from errors in the amount of pressure applied or from defects in the core. However, many of these failed blades were probably utilized. Other by-products include several types of core renewal pieces, removed in order to rejuvenate "stepped areas" where the flint worker had tried to remove blades and had repeatedly failed

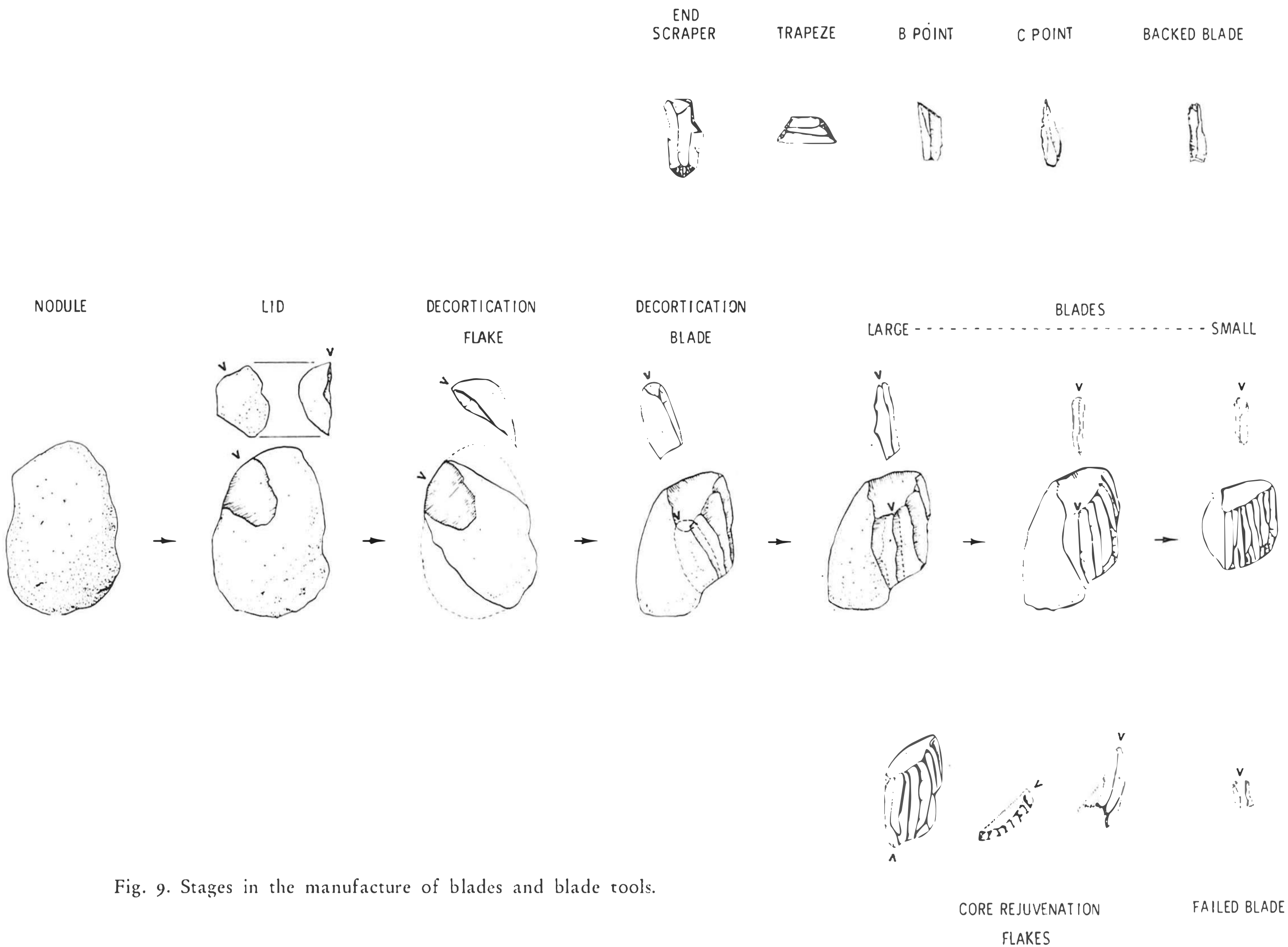

Fig. 9. Stages in the manufacture of blades and blade tools.

(Fig. 9). Three types of core rejuvenation pieces can be defined: 1 – the removal of the entire face of the core; 2 – the removal of a corner platform by turning the core 90° and removing a blade-shaped piece with the old platform edge as its central ridge; and 3 – the removal of an edge of the core, a piece thin at the bulbar end but flaring out to remove a portion of the platform and part of the face of the core, generally struck from the end of the core opposite the striking platform.

Eventually, a core would have been worked to a small size, and small blades (bladelets, microblades) were removed. These bladelets are the same shape as larger blades but only a fraction of their size. Bladelets were sometimes retouched to form backed blades.

Analysis of blades

Some preliminary results from the analysis of the blades found at the Havelte sites demonstrate the utility of more intensive investigation of lithic technology in this period. Blades are distinguished from flakes by the presence of parallel sides, ridges on the dorsal surface paralleling the sides, a relatively narrow striking platform, and a small bulb of percussion. For complete blades, the length should be at least twice the width according to standard definition. A number of attributes were measured on the blades. Maximum length, width, and thickness were recorded. The width and thickness of the striking platform, the angle of the striking platform, the number of flake scars on dorsal surface, the edge angles of the two lateral edges, and the proportion of cortex on the dorsal surface of the blade were also recorded. Relative curvature of the blade was measured according to a technique suggested by Wyatt (1970). Completeness was recorded as a qualitative attribute. These quantitative and qualitative attributes are considered basic indices of blade technology and use.

There were significant differences among the six concentrations at Havelte with respect to the proportion of complete blades and blade segments. Such differences may be due to changing patterns of intentional breakage or to accidental breakage caused by varying numbers of occupants on the site or possibly the length of time the site was occupied, or a combination of these factors. Because of these differences, only the complete blades were used for further comparison of the blade components of the total lithic industry among the six sites.

Statistical correlations among the quantitative attributes of all complete blades indicated a large number of expected mechanical relationships (Table 9). Much of the variation in the data can thus be explained as the result of interdependence among attributes.

An important observation is that there are no significant modalities in the

TABLE 9. H3: CORRELATION MATRIX FOR QUANTITATIVE ATTRIBUTES OF COMPLETE BLADES

N=88 DF=86 R@.9500=.21 R@.9900=.27

	TH	*PT*	*PW*	*PA*	*CO*	*EA*	*EA*	*CU*	*L/W*
Thickness	1.00	.67	.50	.00	−.14	.24	.37	.93	−.02
Platform thickness	.67	1.00	.71	−.11	−.32	0.5	.37	.56	−.10
Platform width	.50	.71	1.00	.28	−.32	−.05	.25	.38	−.14
Platform angle	.00	−.11	−.28	1.00	−.15	.26	.09	.04	−.19
Cortex	−.14	−.32	−.32	.15	1.00	.06	.03	−.18	.24
Edge angle – right	.24	.05	−.05	.26	.06	1.00	.15	.30	.09
Edge angle – left	.37	.37	.25	.09	.03	.15	1.00	.39	.29
Curvature	.93	.56	.38	.04	−.18	.30	.39	1.00	.13
Length/Width ratio	−.02	−.10	−.14	−.19	.24	.09	.29	.13	1.00

frequency distributions of the values for length and width. This indicates that, at least for the Havelte sites, the distinction of "microblades" from normal blades is meaningless. Rather, there is a continuous gradation in size from larger to smaller blades.

There are significant differences among the sites in the mean values and ratios of several of the attributes measured. These relate to both size and shape. The most evident differences are seen in, 1) the number of flake scars on the dorsal surface of the blades, 2) width, 3) length/width ratio, and 4) thickness/width ratio. The significance of these differences was tested with Student's t, accepting a 95% probability of significance. This simple, inductive statistic indicates the closest similarities among H1:I, H1:III, H1:II, and H3 in terms of blade characteristics. H2:I and H2:II are slightly different from each other and quite separate from the other occupations. Such differences among these assemblages may be related to time, technology, or function. The interpretation of these differences must be made in conjunction with other aspects of between-site differences. This summary will be presented in the final report.

Flake component

The second element of the flint industry is the flake component. The final product, a small round flake may also have occurred as an occasional by-product of the blade technique, but the presence of recognizable flake cores clearly indicates the existence of this component. Two distinct types of flake cores are present: the "globular core" and the "squat flake core". The squat flake core was worked in the same manner as a blade core, first creating a platform and then removing pieces sequentially. These cores are typically very short in comparison to blade cores of similar width. The removals from such flake cores are short and generally round flakes.

Globular cores, however, are worked in a different manner. The first removals from generally round nodules are thick, round or triangular shaped decortication flakes. Their function was to shape the core and remove thick cortex; they are removed using many different plane surfaces as striking platforms. Further shaping of the core was accomplished by removing thinner flakes without cortex apparently in the same random manner. The final stage of working of the globular core was the removal of thick, squat, round flakes from all sides. These flakes were frequently made into small flake or circular scrapers by retouching the edges. These flakes may also have been used, without retouching, as general purpose cutting tools.

Functional analysis of scrapers

In conformity with the contention that typologies must be created for specific purposes, to reflect certain aspect of the data to the relative exclusion of others, the development of a functional (rather than a "typological") classification of Mesolithic flintwork is one of the major aims of the Havelte project.

An initial step toward the creation of a classification reflecting the function of Mesolithic artifacts was made with the analysis of the "scraping" tools of site H2:I (Chappell, n.d.). The scraping tools were chosen for preliminary analysis because, along with the classically defined scrapers, a large number of obviously utilized but unretouched, or very irregularly retouched, artifacts could also be included. These pieces have formerly been ignored in the conventional tool typologies, but wear marks clearly indicate that they have been utilized and should therefore be included in any attempt to discover and define the nature of activities that took place on the site.

The first phase of the analysis was an attempt to discover groups or types of scraping *edges,* using quantitative attributes. For each edge of each scraping tool (many of the tools had several utilized edges), a series of attributes were measured. These attributes recorded those characteristics of the edges that were thought to be related most directly to function. The set of attributes includes the general shape of the edge (convex, concave, straight, etc.), its relative curvature (expressed as a radius measurement), length, edge angles at and just above the utilized edge (reflecting after- and before- use edge angles respectively), and the retouch and use-wear traits of the edge.

A statistical analysis of the individual attributes of the edges indicated a number of general characteristics for the scraping edges as a group. The majority of the edges exhibited angles of between 50-90° with an average around 65-78°. Very few edges had angles less than 50°. Experimental work has indicated that higher angles are more efficient and typical for the heavy scraping or planing of wood and bone, while lower angles (less than 50°) can be efficiently used for wood whittling and cutting (Wilmsen, 1970; Leudtke, n.d.). Thus, many of the scraping tools from H2:I can perhaps be interpreted as heavy bone and wood working tools. Additional evidence for this interpretation comes from use wear characteristics. Most of the edges show a type of use wear termed "step-flaking": tiny flakes, generally less than 2-3 mm, in height from the working edge, that end in hinge fractures just above the edge so that they appear relatively short and wide. On the basis of experimental evidence, step-flaking may be the result of wood or bone working.

A cluster analysis (Bonham-Carter, 1967) of the various attributes was used in an attempt to define groups of similar edges. The results of this analysis were not satisfactory, however, because of the apparently random variation of a number of the attributes. The next step was an attempt to define statistically significant groups of edges on the basis of one or two attributes using Student's t-test. This approach was more successful. The edges were first divided into three main groups on the basis of their overall shape (convex, concave, or straight). The groups of convex and concave edges could be further sub-divided on the basis of a combination of relative curvature and relative length. The straight edges divided significantly simply on the basis of length. The result of this analysis was the definition of six groups of convex edges, seven groups of concave edges, and four groups of straight edges. The classes of broad convex and long straight edges were most probably used for planing large, flat objects. The classes of narrow convex and short straight edges were likely utilized for smoothing smaller objects. The relationship between the size of the edge and the size of the object being worked is probably most direct in the case of the concave edges.

One method of checking the meaningfullness of these definitions of edge classes and also for studying functional areas of a site is to study the distribution of such classes on the occupation floor. Plots of the narrow and broad convex edge classes for single-edge tools are shown in Figure 10: a and b. Multiple-edge tools often have several different edge types and therefore were not included in these plots. The tools with smaller edges appear to be generally wide-spread over the site (Fig. 10: a). A clear concentration appears in the northeast portion of site H2:I, outside the main artifact concentration, and this argues for the presence of a specific activity area at this location. The broad edges seem to be more localized than the narrow edges and appear primarily in a small area in the southeast corner of the site (Fig. 10:b), possibly indicating an area of activity different from that observed in the northeast corner.

Generally, the presence of a large number of scraping tools on this site can

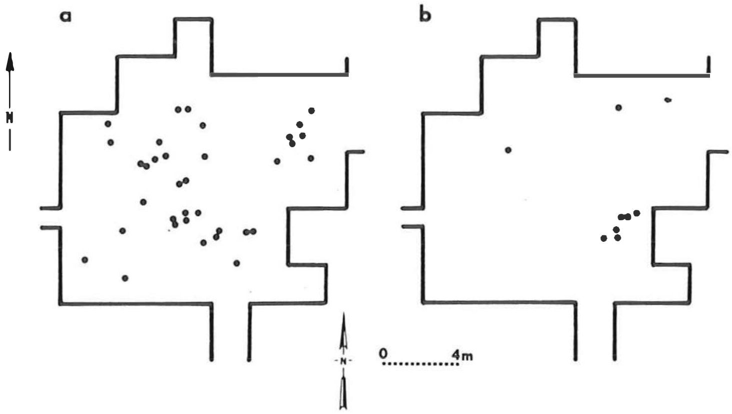

Fig. 10. Distribution of scraper edges in H2:I.
a) narrow convex edges
b) broad convex edges

be interpreted as indicating that wood, bone, and antler objects probably constituted an important part of the material culture of Mesolithic groups (cf. Louwe Kooijmans, 1970/71) – a portion that is unfortunately not preserved in the archaeological record at Havelte.

In sum, this preliminary analysis of functional classes of artifacts demonstrates the utility of a classification that measures, or attempts to measure, the function of artifacts, rather than a combination of functional, stylistic, mechanical, and chronological attributes. Similar analyses will be continued on the artifact material to provide more definitive data on the activities undertaken at the site and the tools or tool groups associated with such activities.

Thermal alteration

Many of the artifacts from the Havelte excavations exhibited potlidding, crazing (minute surface cracks), changes in color, and/or complete change in the original material to a granular, scaly, porcelain or chalky white, thought to be the result of intense dehydration (for a more complete description of these terms see Crabtree, 1972). These phenomena are not characteristic of the fresh raw material and are, in fact, the same phenomena reported by other researchers to result from heating of flint (Crabtree, 1972; Crabtree and Butler, 1964; Purdy and Brooks, 1971). Successful heat treatment of flint prior to flaking is known to improve the elasticity of the flint and provide sharper edges.

These observations led to investigations designed to determine: 1 – if these characteristics could be experimentally replicated by heating, 2 – what the sequence of change was, and 3 – if intentional heat treatment was a part of the technological repertoire of lithic manufacture used by Mesolithic groups. For the experiments, a variety of samples of the kinds of flint recognized as most common in the artifacts at the site were selected from exposed glacial till in the vicinity of de Doeze.

A number of experiments were performed on the flint samples both in the field and in the laboratory. In the field, open fires were used and the results of overheating (potlidding, fire cracking, crazing, material change) were easily duplicated. Successful heat treatment was accomplished only when the flints were protected from the heat by a thick layer of sand. This layer prevented a too rapid change in temperature of the material, which would cause potlidding and cracking through the expansion of intercrystalline water in the flint. Changes took place in the following order depending upon the intensity and duration of overheating: 1) color changes appear first; 2) potlidding or cracking depending upon the type of flint; and finally, 3) the flint underwent a complete loss of structural water resulting in white opacity and the porcelain texture of the remaining dehydrated silica.

In the laboratory, small furnaces in which time and temperature could be controlled more precisely were used. In these experiments, the critical variables were maximum temperature, the length of time the samples were kept at this maximum temperature, and the speed of heating and cooling.

The successfully heat treated specimens were analyzed both macro- and microscopically. On the macroscopic level, color changes to reddish hues were observed in many of the samples, especially those which exhibited yellowish areas in their unheated states. These color changes are the result of chemical changes in the impurities that exist in the intercrystalline spaces of the flint, and the change begins to take place at rather low temperatures (around 175° Centigrade). In addition, newly fractured surfaces of the treated flints exhibited a shininess or lustrousness not characteristic of untreated flint. This change occurred only at higher temperatures than those at which color change took place (beginning around 250° Centigrade depending upon the type of flint).

The textures of the newly fractured surfaces of the heat treated samples and unheated controls were compared with a Scanning Electron Microscope (SEM), after Purdy and Brooks (1971). At 3,000 x magnification, the structural changes in the flint that result from heat treatment and cause the shininess on the fractured surfaces of heated pieces are clearly visible. The original rough "bread-crumb" texture of untreated surfaces contrasts sharply with the smoother texture of newly flaked surfaces of the heat treated samples.

Several of the Havelte artifacts were examined under the SEM but there was no indication of alteration from thermal processes. In addition, it appears from a general survey of all the artifacts recovered from the site that most of the flints showing color change and lustrous characteristics also show the more

TABLE 10: HAVELTE: PERCENTAGES OF THERMAL ALTERATION CATEGORIES

	H1:II	*H1:III*	*H2:I*	*H2:II*	*H3*
Unaltered	71.2	83.3	70.1	71.6	77.5
Color Change	8.2	5.1	7.0	9.1	8.0
Overheated	20.6	11.6	22.9	19.3	14.5
n =	1187	671	8903	6088	1468

severe alterations resulting from overheating. The overheated material includes artifacts of all waste material classes and retouched tools. These artifacts can only be interpreted as pieces that were unintentionally burned after manufacture. There is no clear evidence to indicate deliberate thermal treatment of the Havelte artifacts at present.

The information from the experimental studies on the nature and sequence of changes in flint when subjected to heat is useful in comparing the various sites and in locating heat sources on the occupation floors. Table 10 presents the percentages of the various alteration categories for five of the excavated sites. In general, the sites with more deep hearths have a lower percentage of heat altered flint. This fact may be indicative of the predominance of surface hearths at the sites with higher proportions of altered material (e.g., sites H2:I and H2:II).

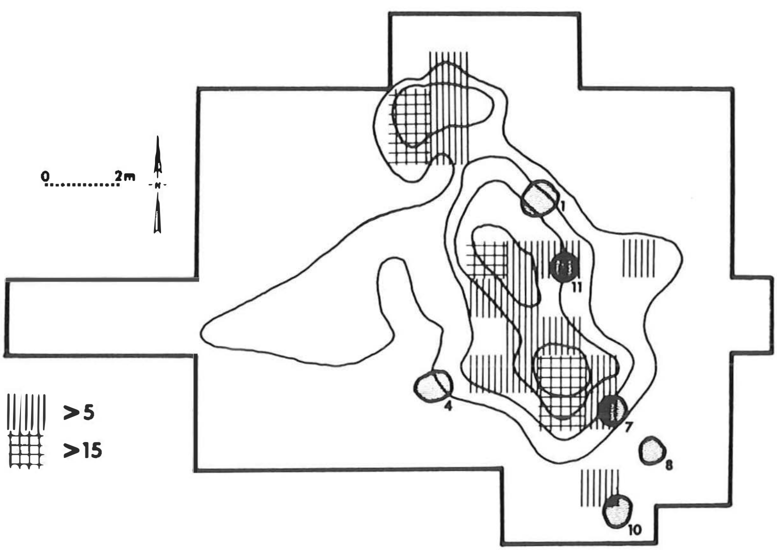

Fig. 11. Distribution of heat altered pieces per square meter over artifact density contours in H3.

Fig. 11 is a ground plan of H3 showing the features, the artifact density contours, and the density of heat-altered pieces. Several interesting observations can be made here. The distribution of thermally altered flint confirms, in some instances, the interpretation of features as hearths or small pits. Feature 11 is a surface hearth and there is a concentration of thermally altered flint around this feature. Small pits (Features 4, 8, and 10) have a relatively low density of altered material. Three unusual exceptions are noted however. Feature 7, a small pit, has relatively high density of altered flint. This may be explained, however, by the situation of Feature 7 adjacent to the area of highest artifact density. A plot of the *percentage* of altered flint (not shown) indicates that this is indeed the case. The absence of altered pieces around Feature 1, which is a basin-shaped hearth, is intriguing. Also interesting is the high density of altered flint in the northwest portion of the artifact concentration. No hearths were observed in this area but the presence of some heat source is clearly indicated, perhaps a surface hearth.

Analysis of spatial patterning

The analysis of patterns of spatial distribution of artifacts on prehistoric occupation floors is intended to define clusters of artifacts and other items that have been used together in specific activities. Hopefully, inferences concerning patterns of prehistoric human activity can be made by interpreting these clusters or groups in terms of their contents and their position on the occupation floor. Comparison of the distribution of these clusters between sites provides a means for investigating such problems as group size, duration of occupation, and variation in activity.

Preliminary visual inspection of the artifact distributions at the Havelte sites has indicated some intriguing patterns. One example of this was initially recognized after the 1970 field season. Only a ten by ten meter area had been opened during this season and our impressions from the field work were that this excavation had recovered all that remained of an artifact concentration (H1:I) adjacent to a large bomb crater. However, the ground plan indicated that there were two distinct clusters of cores and core rejuvenation flakes, one within the major artifact concentration (H1:I) and a second outside the artifact concentration in the northeast corner of the excavation unit. This information was used as grounds for extending the excavations of the following year to the north and led to the recovery of H1:II.

The distribution of cores in H3 is also of interest (Fig. 8). There are two primary groups of cores, one directly associated with the artifact concentration as indicated by the density contour lines, and a second group outside this concentration and to the west. The interpretation that there were two areas of flake and blade manufacture in H3 will be tested in future analysis. The patterning of certain classes of artifacts, for example, blocks, small shatter flakes, core rejuvenation flakes, etc., will determine if the distribution of these artifacts, thought to be associated with core preparation and working, coincides with these two groups of cores. Also in H3, points, backed blades, and notched flakes tend to concentrate in the center of the occupation horizon as defined by the artifact density contours. Scrapers are dispersed throughout, while the knives are grouped in two areas, one in the center of the occupation floor, and another a few meters to the south. As was observed in the other excavation units as well, the hearths and pits tend to occur around the periphery of the artifact concentration.

At H2:I, cores and points are scattered. Points, however, generally appear to occur in pairs. Scrapers occur primarily in two concentrations: a large, tightly clustered group of at least 30 scrapers in the southeast portion of the excavation and a smaller group of 6-8 scrapers in the northeast corner of the site. There is a smaller secondary group of scrapers just a few meters west of the large concentration in the southeast. Borers are associated almost exclusively with the two groups of scrapers in the southern portion of the site. Seven notched pieces also occur in this area; the remainder of the notched pieces are dispersed over the site. Backed blades tend to occur outside the area of scrapers and borers, primarily in a cluster of artifacts in the northwest corner of the occupation; backed blades also occur frequently in pairs or triplets dispersed over the site. There is a concentration of knives associated with the backed blades in the northwest corner; knives outside this concentration are generally in the northwest half of the excavation and no less than four pairs of knives occur on the ground plan. Retouched blades are rather widely scattered although there is a concentration in the northwest portion of the site; retouched flakes are generally dispersed around the three major artifact clusters seen on the ground plan.

Inspection of the ground plan of H2:II indicates that the majority of the retouched tools occur in the western half of the excavation. Cores are dispersed throughout the area. Points are generally dispersed with some indications of a few pairs. Scrapers occur primarily in the southwestern half of the occupation horizon. Backed blades are generally dispersed but at least five pairs of backed blades are observed. Knives are widespread over the area. Borers and retouched flakes occur primarily in the northwest half of the excavation. Notched pieces are generally widespread with a slight majority in the west-center of the site. The few retouched blades appear to cluster in two small groups at the northwest and southwest edges of the occupation. In general, it is difficult to observe associations between artifact types at this site because the individual artifact types are dispersed.

The points in H1:I clearly concentrated in the northern portion of the occupation outside the areas of densest artifact distribution. Scrapers and retouched flakes were generally found in the southern portion of the concentration along with a very tight cluster of backed blades. Cores were dispersed but appeared to occur more often in the areas of scrapers and backed blades.

H1:II is difficult to interpret because of a large disturbance located directly in the center of the artifact concentration. The low number of points from H1:II may, in fact, be due to this disturbance. Points tend to cluster tightly and generally occur near the center of densest concentration and thus may have been lost in the disturbance. Other observations may also be somewhat distorted by the location of this disturbance. Scrapers appear to be widely disturbed over the site. Cores occur most densely to the south, perhaps around the shallow pit (Feature 5). Backed blades are scattered through the southern portion of this concentration.

H1:III is a very small concentration (3 m. in diameter). The small number of retouched tools does not show any distinct patterning.

Clearly, the above discussion of artifact distribution at the Havelte sites is highly subjective, and it is very difficult to compare sites. The individual distributions are even more difficult to interpret. This raises an important point that has been discussed above regarding the relationship of the traditional typology and the analysis of spatial patterning. On many sites the small number of retouched tools, as classified by traditional typologies, is inadequate for any method of objective analysis. More specific thechnogical and functional classifications of both "waste" and retouched materials can provide more useful data for analysis by expanding the number and size of categories under investigation and by more accurately reflecting the function of stone tools. Moreover, names utilized in traditional typologies may have little or nothing to do with the actual function of stone tools. Some classes of "points", for example, may not have been used on projectiles. It has been suggested on the basis of certain patterns of use wear that some trapezes may have been used as knives. It is hoped that the technological and functional analysis of the Havelte materials, presently underway, will provide a more meaningful data set for the analysis of spatial patterning on Mesolithic occupation floors.

Virtually all archaeological examples of the analysis of spatial pattern have been based upon visual inspection and subjective interpretation (e.g., Leroi-Gourhan and Brézillon, 1966; Freeman and Butzer, 1966; de Lumley, *et al.*, 1969; Taute, 1968). Such visual inspection is of course useful and informative.

However, in order to be able to compare the distributions of two or more classes of artifacts, both within a single site and among sites, it is necessary to place the interpretation of the significance of spatial aggregation or clustering on a more objective, statistical basis (Whallon, 1973, 1974; Hesse, 1971).

Some tentative quantitative spatial analyses are presented here, using the traditional typology. A more complete analysis, using problem-specific classifications, will be presented in the final report.

A number of statistical methods are available for use in the analysis of spatial patterning. The majority of these have been adapted from those used by plant ecologists. Several methods will be described and compared in the following discussion.

Dimensional analysis of variance (Whallon, 1973) works with the data in the form of counts per grid unit. In general, dimensional analysis determines the "block size" at which one class of artifacts shows the greatest variance. Block size is determined by nesting the original grid units into larger blocks, doubling in size through each step. The block size at which the maximum number of artifact classes show the greatest variance is then used as the unit for the analysis of correlation between the various artifact classes. The optimum block size indicated by dimensional analysis of variance is a rough indicator of the size of the area at which various tool types are clustering and the significance of this clustering is statistically determinable. Optimum block size for correlation analysis can also be determined using Morisita's Index, I_δ (Morisita, 1962). I_δ changes systematically with block size and the nature of this change provides an indication of the average size of aggregations and the nature of the distribution within aggregations.

Fig. 12 graphically presents the preliminary results of dimensional analysis of the points type-group in site H2:I. Fig. 12:a is the index of aggregation as indicated by I_δ. Values greater than 1.0 (random distribution) indicate clustering. The confidence level for a 95% significance of this clustering is indicated by the lighter line. Points exhibit maximal clustering around a block size of 32 grid units. Fig. 12:b is a graph of relative variance (the variance/mean ratio) for the same data set. Again, a block size of 32 is indicated as the optimum cluster size using 95% confidence intervals. Table 11 gives an ordered matrix of correlation coefficients between "type-groups" for H2:I at block size 32. Three major associations can be defined from the ordered matrix. First a group of points, backed blades, retouched blades, and retouched flakes is clearly indicated. A second group overlaps somewhat with the first and is composed of retouched blades, retouched flakes, and knives. Notched pieces and scrapers are shown to be associated together, while borers are indicated as behaving independently from other artifact types. These groups of artifacts then are

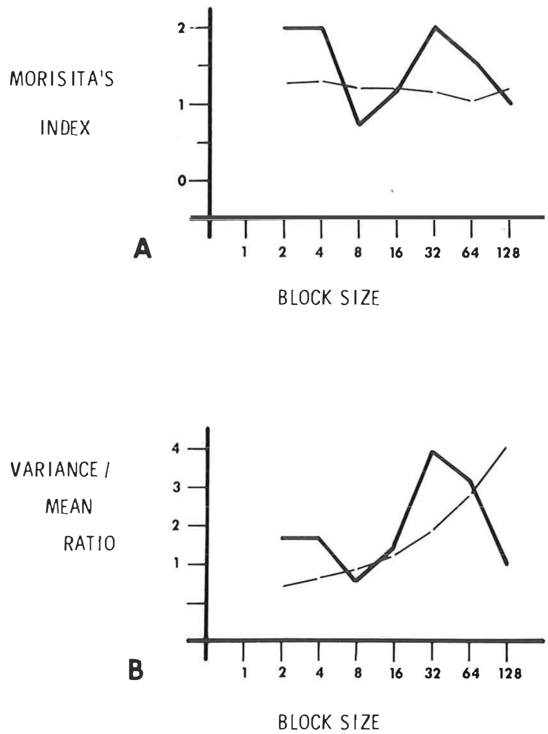

Fig. 12. Graphs of Morisita's Index and Variance/Mean ratio for the spatial analysis of points from H2:I. The lighter lines represent 95% confidence intervals.

indicated by this method of analysis as being spatially associated on the ground plan.

Morisita's index is more useful in assessing the impact of sample size on aggregation and the statistic produced is more easily interpretable as an index of clustering. One of the disadvantages of using either form of dimensional analysis is that a square or rectangular grid is necessary. More disturbing is the difficulty of defining the actual artifact cluster on the ground plan. An optimum block size of 32, for example, simply indicates that the size of the actual cluster is somewhere between 16 and 64 original grid units. Moreover, this method assumes that, if there is more than a single cluster of the same objects, these clusters will be of the same size. Obviously, this may not be the case for most archaeological data.

The use of the methods of nearest neighbor analysis provide certain advantages over dimensional analysis (Whallon, 1973, 1974). The nearest neighbor index, *R*, (Clark and Evans, 1954) is a measure of the tendency of one artifact class to cluster. This index varies from 0.0, complete clustering, through 1.0, random, to

TABLE 11. ORDERED MATRIX OF CORRELATION COEFFICIENTS FOR TOOL COUNTS FROM 8 x 4 m BLOCK SIZE AT SITE H2:I

N=8 DF=6 R@.95=.71 R@.99=.83 MC=1.11

	PT	*BB*	*RB*	*RF*	*KN*	*BO*	*NP*	*SC*
Points	1.00	.91	.83	.78	.45	–.14	.08	.01
Backed Blades	.91	1.00	.92	.83	.62	.17	.22	.04
Retouched Blades	.83	.92	1.00	.97	.71	.15	.00	.05
Retouched Flakes	.78	.83	.97	1.00	.93	.54	.28	.21
Knives	.45	.62	.71	.93	1.00	.37	–.16	.02
Borers	–.14	.17	.15	.53	.37	1.00	.65	.62
Notched Pieces	.08	.22	.00	.28	–.16	.65	1.00	.86
Scrapers	.01	.04	.05	.21	.02	.62	.86	1.00

2.15, completely uniform distribution. Nearest neighbor analysis requires the exact location of artifacts as raw data. Distances between individual artifacts are then measured. The average distance between objects divided by the expected random distance between objects is the nearest neighbor index. Table 12 presents the average nearest neighbor distances for four type groups at the Havelte sites. This measure permits quantitative comparison between sites as it is not affected by site size. There were not enough points in H1:II or H1:III to compute the statistic. The average distances between points are very similar for the remaining four sites. Backed blades show at least two modes for the average distance values. Scrapers have relatively high average distances except in the case of H2:I. Cores generally show low average nearest neighbor distances as would be expected from the visual inspection of the ground plans where it was noted that cores were numerous and occurred throughout the artifact concentration.

R, the nearest neighbor index, is affected by the size of the area under analysis. In order to be meaningfully comparative, this index must be weighted by some measure of the area of the occupation floor. For the Havelte sites, since

TABLE 12: HAVELTE: AVERAGE NEAREST NEIGHBOR DISTANCE (cm.)

	H1:I	*H1:II*	*H1:III*	*H2:I*	*H2:II*	*H3*
Points	98.4	–.–	–.–	98.3	82.9	95.0
Backed Blades	72.4	137.5	138.0	59.7	59.3	81.4
Scrapers	110.0	121.4	155.0	48.0	98.3	143.5
Cores	93.6	67.6	94.3	39.3	55.1	92.3

they were excavated in exactly the same way, artifact density can be used to define site size. However, there is a very real problem in attempting to compare site size for other excavated sites throughout western Europe. These sites have been excavated with appreciably different procedures and approaches. Thus, an artifact density of $20/m^2$ at one site may in fact be comparable to a density of 5 artifacts per meter square at a less meticulously excavated site. Clearly one of the problems facing archaeologists working on the Mesolithic period is the refinement and standardization of excavation techniques.

Nevertheless, the nearest neighbor index as presented in Table 13 is useful for a quantitative comparison of clustering within the individual sites at Havelte. Exact site size is not yet defined for the Havelte occupations so that these values have not yet been weighted by site area. The area of the excavation is used. The lower values indicate a higher degree of clustering. Values approaching 1.0 indicate approximately random distribution of an artifact type.

Whallon (1974) suggests a method whereby significant clusters of an artifact class can be defined using nearest neighbor distances. Clusters of several artifact classes can then be compared quantitatively for association. In order to define the artifact clusters on the floor and to measure the degrees of association among these clusters, nearest neighbor distance can be used to outline the spatial pattern of each cluster of artifact groups. The area shared between two patterns, relative to the total areal pattern of each kind of item separately, is then used to determine the degree of similarity in spatial patterning between two items. A cluster is defined by drawing circles around every item. The radii of the circles are defined here as a distance of 1.65 standard deviations above the average nearest neighbor distance for the artifact class being analyzed. This encompasses 95% of the potentially significant distances between items in the spatial distribution. Figures 13 and 14 are examples of this approach, showing clusters of points, scrapers, and backed blades in site H3. The area of cross-hatching indicates the overlap of these clusters. The area over which the two clusters coincide can be measured as well as the area which each pattern covers independently of the other. An index of similarity can then be calculated as the

TABLE 13. HAVELTE: NEAREST NEIGHBOR INDEX (R)

	H1:I	*H1:II*	*H1:III*	*H2:I*	*H2:II*	*H3*
Points	.605	–	–	.560	.730	.279
Backed Blades	.529	.755	.930	.581	.513	.470
Scrapers	.552	.883	.935	.631	.745	.712
Cores	.831	.810	.752	.804	.918	.780

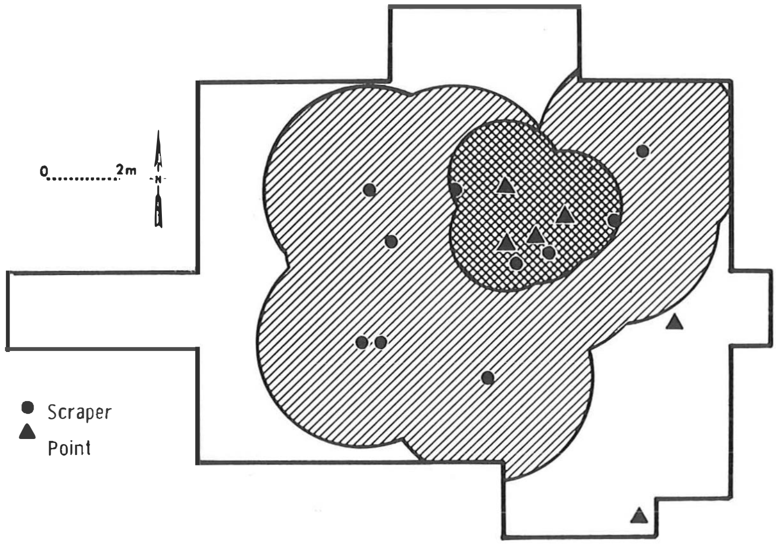

Fig. 13. Clusters of scrapers and points in H3.

percentage of shared area relative to the total area covered by both distributions. For H3, points and scrapers, this index is 11.70; for points and backed blades the index is 22.59. This kind of approach to spatial analysis will be more comprehensively discussed and applied in the final report.

Complementary to nearest neighbor analysis, an index of segregation, *S*, can be computed between pairs of artifact types (Pielou, 1961). This statistic is an index of the tendency for two artifact types to be aggregated or segregated. A four-fold table is tabulated for two different artifact types on the basis of whether the nearest neighbor to one item in a class is another item of the same type or in a different type category. *S* varies from -1.0 for complete aggregation to +1.0 for complete segregation. A value of 0.0 indicates that the two artifact types under consideration are randomly mixed. Unfortunately, the index of segregation can only be applied to two artifact types at a time, and it does not provide any information on the distribution of the items on the occupation floor. It is not biased by sample size or area, however, and is thus readily comparable from site to site. The index *S* is often difficult to interpret and is probably most useful as a complement to the nearest neighbor statistic. Table 14 presents the indices of segregation for pairs of four artifact type groups at the six Havelte sites. The only high negative value, indicative of a tendency for association, is for points and backed blades in H1:III. High positive values, for example between points and backed blades in H1:II, indicate disassociation of the two classes of artifacts.

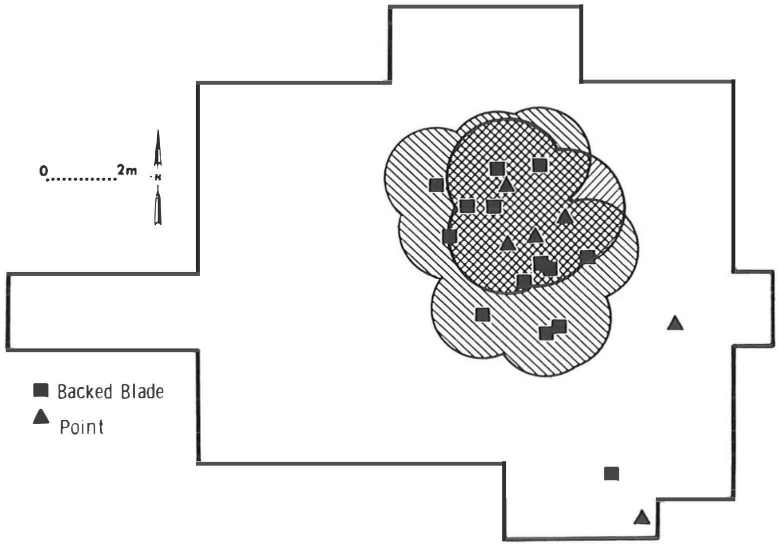

Fig. 14. Clusters of backed blades and points in H3.

TABLE 14. HAVELTE: INDEX OF SEGREGATION

	H1:I	*H1:II*	*H1:III*	*H2:I*	*H2:II*	*H3*
P/B	.320	.698	−.518	.141	.146	.294
P/S	.263	−.147	.323	.332	.278	−.044
P/C	−.117	−.050	−.316	0.62	.168	.255
B/S	.082	−.210	.098	.441	.327	.566
B/C	.140	.139	−.061	.179	.218	.245
S/C	.209	.291	.246	.370	.050	−.220

P = Points
B = Backed Blades
S = Scrapers
C = Cores

Gastroliths

In the course of trowelling in the occupation level, a number of small, polished pebbles were found. Most of these pebbles were noticably larger than the grains of the coversand and their appearance suggested that they had not been deposited at the sites by natural processes. The closest parallels to these pebbles seemed to be stones found in the gizzards of certain species of birds. These stones are termed gastroliths. They have been found elsewhere in geological situations where they are distinguished from wind or water-polished pebbles by their distinctive polishing to a glossy finish, even in the pits and indentations on the pebble, without facetting (Hoskin, Guthrie and Hoffman, 1971). If a large enough sample is available, both the species of the bird and the season in which the gastroliths were removed from the gizzard can often be determined.

Wildfowl of all sorts, but especially migratory waterfowl and forest species such as grouse, are thought to have been an important component of the subsistence of Mesolithic groups. At sites on sand, like those at Havelte, organic remains are almost never preserved. Direct evidence for economy is absent. The discovery of pebbles which appeared to be gastroliths seemed to provide the possibility for obtaining at least indirect evidence for one aspect of subsistence economy in such sites.

A systematic search was made for gastroliths at the Havelte sites. Soil samples of equal volume were taken from several soil horizons of the podzol in a "checkerboard" pattern over the 1971 excavation areas. These soil samples were screened through a standard sieve series, and the various size classes of particles were examined for pebbles resembling gastroliths. This procedure was intended to provide information on relative frequency of occurrence of such pebbles horizontally over the site areas and stratigraphically above, in, and below the level of occupation. In this way it could be determined whether probable gastroliths occurred here in significant numbers and whether they occurred in association with the Mesolithic occupation. A series of samples of gastroliths were also collected from some species of wildfowl present in northern and northwestern Europe today by Dr. S. Bottema of the Biologisch-Archaeologisch Instituut for comparison with the pebbles recovered at Havelte.

Processing of the soil samples failed to reveal a significant number of pebbles that could be considered gastroliths. Certainly, some gastroliths were found, but their number is altogether insufficient to argue for any important amount of fowling at this site. Two small but clear concentrations of gastroliths were uncovered but these were stratigraphically well above the level of the Mesolithic artifacts. It seems from the quantity and distribution of gastroliths on the site that they were probably deposited by natural processes not related to the activity of man.

The comparative samples from modern species seemed to indicate that there was a wide range of variation in the attributes of stones from bird gizzards. Gastroliths, then, may be rather hard to differentiate from other small stones occurring geologically in the coversands.

Although this aspect of the research at the Havelte sites has so far proven negative, it should not be neglected at other sites. The possibility of finding

TABLE 15. PHOSPHATE DETERMINATIONS

Sample	*ppm* P_2O_5	*Excavation Unit: Feature*
1	47	Control 1
2	69	Control 2
3	47	Control 3
4	197	H1:13 – Hearth
5	112	H1:11 – Hearth
6	72	H1:5 – Shallow Pit
7	75	H1:16 – Hearth
8	128	H1:12 – Hearth
9	111	H1:6 – Animal Burrow
10	125	H2:8 – Hearth
11	91	H2:9 – Hearth
12	259	H3:4 – Small Pit
13	67	H3:5 – Small Pit
14	89	H3:7 – Small Pit
15	137	H3:1 – Hearth
16	55	H3:10 – Small Pit

remains indicative of Mesolithic subsistence activities in the sand areas of northwestern Europe is an exciting one which should not be overlooked even if the preliminary results are not obvious.

Phosphate levels in the features

Sixteen samples were very kindly analyzed by S. van der Leeuw and A. Voorrips of the Instituut voor Prae- en Protohistorie of the University of Amsterdam. The results of these analyses are presented in Table 15. (For a discussion of approaches to this kind of chemical analysis see Moinereau, 1970). Three of the samples were controls taken outside the features. The remaining samples were taken from the profiles of designated features. These initial phosphate (P_2O_5) determinations provide some interesting results and raise some intriguing questions for future investigation.

The differences between pits and hearths, already defined, are supported by phosphate analysis. The mean phosphate values are 123.6 ppm for hearths and 70.8 ppm for pits. (The mean for pits does not include the aberrant value of 250 ppm for sample 12.) The histogram of the phosphate values (Fig. 15)

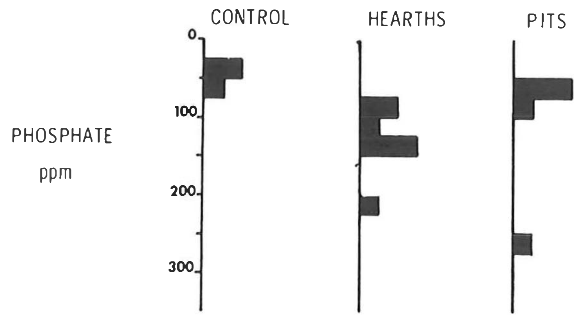

Fig. 15. Histograms of phosphate ppm values for various features types.

show this difference clearly. The amount of phosphate present in the shallow pit H1: Feature 5 falls within the range for pits in general and suggests that such shallow pits may also be associated with the Mesolithic occupation, although more evidence is necessary to confirm this.

Many questions demanding further research have been raised by the results of these phosphate measurements. How much variation exists among samples from the same feature? This is unknown and should be investigated. It may be necessary to utilize special techniques, such as the splitting of column samples, or making several determinations from each feature to ensure accurate measurements. There seems to be variation among samples from the same type of feature. For example, samples 10 and 11 come from two virtually identical Mesolithic hearths less than one meter apart and yet the phosphate values for these two features are 125 ppm and 91 ppm, respectively.

The basic question is, of course, what exactly do the differences in ppm values of phosphate mean? Are the higher values indicative of more recent deposition of organic matter, more intensive utilization, both of these, or something entirely different? Another interesting question arises from the variation in values among the control samples. Two of the controls (1 and 2) were taken from the sterile C horizon underlying the occupation level. Can the observed variation be caused by differential distribution of Mesolithic organic materials, from which phosphates have been leached into the C horizon? The investigation of phosphate concentrations over one site in Sweden, Dalkarstroop, indicated the presence of higher phosphate values in areas with artifacts known to be associated with seal hunting. Lower phosphate values over the remainder of the site were correlated with tools related to inland hunting activities (S. Welinder, personal communication). It might therefore be most interesting to analyze some of the soil samples from the checkerboard sampling of the 1971 excavations to see if such areal variation is present on these sand-ridge sites in the Netherlands. This analysis will be begun in the coming year.

Obviously, much remains to be discovered about variations in phosphate values within features, among features, over site areas, and among sites. Present results look promising and this approach has much potential for the investigation of Mesolithic sites.

Identification of charcoal

The larger pieces of charcoal collected from the excavation are being identified by Dr. W. A. Casparie. A preliminary summary of the charcoal determinations now available is presented in Table 16.

The species of wood present in hearths and pits is considered to be useful in a complete analysis of the site for a number of reasons. Differences in the type of wood used in fires may reflect differences in the function of fires. Certain woods may be preferred for cooking and others for heat, light or smoke (cf. Metzger and Williams, 1966). The presence of birch in H1: TP 1 hearth contrasts with its absence in the other hearths and provides a possible example of such differential hearth function. Variation in the kind of charcoal on the occupation floor, outside the features, may also reflect functional areas of a site. A patterned distribution of one or more species of wood charcoal might be indicative of the presence of a hut or other structure. Finally, the difference in species present may also be useful as a rough chronological indicator, for example, H1: Feature 20 was a concentration of oak charcoal

TABLE 16. CHARCOAL DETERMINATIONS

Sample Location	*Species*
H1:Feature 1	*Pinus*
H1:TP 1 Hearth	49% *Pinus*/ 50% *Betula*/ 1% *Quercus*
H1:Feature 11	*Pinus*
H1:Feature 12	*Pinus*
H1:Feature 13	*Pinus*
H1:Feature 17	*Quercus*
H1:Feature 20	*Quercus*
H2:Feature 5	*Pinus*
H2:Feature 8	*Pinus*
H3:Feature 4	*Pinus*
H3:Feature 1	*Pinus*

and the radiocarbon date from this feature is considered too young to allow its association with the Mesolithic occupation. A full summary of all charcoal identifications will be included in the final report.

Radiocarbon dates

Three radiocarbon dates on charcoal are presently available from the Radiocarbon Laboratory of the University of Groningen:

Sample No.	*Date*	*Species*	*Location*	*Site No.*
GrN 6655	6050±75 BP	Oak	H1: Feature 20	H1:II
GrN 6656	8725±60 BP	Pine	H1: Feature 12	H1:II/H1:III
GrN 6657	9145±55 BP	Pine	H2: Feature 5	H2:I

H1: Feature 20 was a charcoal concentration on the occupation floor. This date is clearly too young. The oak wood also indicates that this feature is likely the remains of a later fire and is not associated with the Mesolithic occupation. GrN 6656 is from H1: Feature 12, a definite hearth. The sample used was one of the intact charcoal logs found within this hearth. This date may be acceptable for an early occupation at H1:III. GrN 6657 dates a scatter of charcoal pieces in the occupation level of H2:I to 9145 BP, earlier than the date for H1:III. Typologically, however, H2:I is either late Mesolithic or in an intermediate period of transition between early and late Mesolithic. There is some conflict here to be resolved.

On a more general level, both dates would indicate that at least two of the occupations at Havelte date from the early half of the Boreal period. This again conflicts with the broad picture of the Mesolithic sequence in the area as developed by Newell (1973) which would see only Basal or Early Mesolithic assemblages as characteristic for the area at this time.

SUMMARY

A preliminary discussion of the Havelte project, the sites, and the materials has been presented. More complete descriptions, comparisons, and interpretations will be made in the final report. The existence of six sites, located in the same area and excavated in the same manner is of great advantage in the study of the Mesolithic period. The data from these sites allows more detailed analysis of within- and among-site variability than is usually possible. This not only provides for more meaningful reconstruction of activities at individual sites and comparison among sites, but also opens up some new aspects of Mesolithic research. It is hoped that the preceding discussions have adequately indicated the approach taken, the questions asked and the methods used, in an attempt to begin to understand these archaeological remains as the reflections of patterned behavior of Mesolithic cultural groups. Some progress is being made in this direction, but, as any research should, this project has raised at least as many questions as it has answered. Perhaps one of the values of a report such as this will be in refining the questions asked and the approaches adopted so that future work will provide fuller and more accurate definitions of Mesolithic cultural systems.

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In addition to the individuals mentioned in this report, many others have contributed to the present and continuing success of the Havelte Project. First and foremost among these, of course, have been virtually the entire scientific and technical staff and several advanced students of the Biologisch-Archaeologisch Instituut, particularly Dr. H. T. Waterbolk, who visited the site often and offered much of his knowledge of the archaeology of the northern Netherlands, and also to Dr. R. R. Newell, with whom frequent discussions regarding the Mesolithic in the Netherlands and Northwest Europe were most informative. We greatly enjoyed the visits of the late Dr. A. E. van Giffen. Also, Dr. W. G. Mook of the Radiocarbon Laboratory of the University of Groningen oversaw the dating of the charcoal samples. Mr. M. W. Ter Wee of the State Geological Service of the Netherlands kindly visited the field site numerous times and was greatly helpful in acquainting us with the geology of the region and of the sites themselves. C. S. Peebles of the University of Windsor (Canada) aided in the field for a month during the 1971 season and has since undertaken most of the computing necessary for data banking, retrieval, and analysis of the enormous amount of information involved. Mr. Peebles' participation and the continuing computer services were made possible by a grant to him from the Canada Council (Grant S71 0368) whose assistance is gratefully acknowledged.

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