THE RING AND SECTOR METHOD: INTRASITE SPATIAL ANALYSIS OF STONE AGE SITES, WITH SPECIAL REFERENCE TO PINCEVENT

Dick Stapert
Biologisch-Archaeologisch Instituut, Groningen, Nederland

ABSTRACT: This paper aims at an intrasite spatial analysis of Pincevent (eight habitation units in Niveau IV-2, and three in Habitation 1) and several other Late Palaeolithic sites in Europe, by means of a new method, which is based on the use of rings and sectors around the centre of 'domestic hearths'. One conclusion is that the domestic hearths of Pincevent were located in the open air – not inside tents or in tent entrances. At several other sites, e.g. Gönnersdorf and Étiolles, the method allows the demonstration of tents, mostly with diameters of 5-6 m.

Furthermore, criteria are given for establishing drop and toss zones as defined by Binford (1983). All analysed units of Pincevent show an asymmetry in tool density in the sense that many more tools are present on one side of the hearth than on the opposite side. The drop zones are located in the richest site-halves. Given these results, it seems possible to reconstruct the prevailing wind directions during the various habitations; as nowadays, westerly winds prevailed.

With the ring method the 'centrifugal effect' can be investigated: the tendency for larger objects to end up farther from the hearth than small objects. All the units of Niveau IV-2 show a marked centrifugal effect. This is illustrated by comparing the ring distributions of the tools with those of the cores. The three units of Habitation 1, however, do not show a clear centrifugal effect, and this applies also to several other sites.

Differences between various tool types with respect to their ring distributions are investigated, and it is shown that backed bladelets are systematically located closer to the hearth than scrapers, while borers and burins are intermediate in this respect. Explanations for this phenomenon are offered on the basis of functional analyses. Only one habitation unit of Pincevent, R143, deviates from this general pattern; it probably was a 'special-purpose site'. The same applies to Marsangy N19.

On the basis of four attributes, which are shown to be statistically related, two different types of sites can be established, independent of the sites' dimensions. This dichotomy is shown most clearly by one of these four attributes, the centrifugal effect: sites of Group Y show a clear centrifugal effect, those of Group X do not. The units of Habitation 1 can be placed in Group X (perhaps hunting camps, or 'special-purpose sites'; occupied by men only?), together with sites such as Marsangy N19 and Bro I. Most of the units of Niveau IV-2 are placed in Group Y (presumably family camps), together with sites such as Oldeholtwolde and Niederbieber.

The richest site-halves are tentatively analysed in greater detail, and it is found that at least at some sites of Group Y the two quarters within this half differ in their tool inventories: one quarter shows a higher proportion of backed bladelets, and the other a higher proportion of scrapers. This suggests the presence of at least one man and one woman.

RÉSUMÉ: Cette publication vise à une analyse spatiale intrasite de Pincevent (huit unités d'habitation du Niveau IV-2 et trois dans l'Habitation 1) et de plusieurs autres sites du paléolithique final en Europe à l'aide d'une nouvelle méthode, qui est fondée sur l'emploi des anneaux et des secteurs autour du centre de'foyers domestiques'. Une des conclusions est que les foyers domestiques de Pincevent étaient situés en plein air, pas à l'intérieur ou à l'entrée des tentes. Dans plusieurs autres sites, p.e. Gönnersdorf et Étiolles, la méthode permet de mettre en évidence des tentes, le plus souvent avec un diamètre de 5 à 6 mètres.

En outre, des critères pour établir des *drop zones* et des *toss zones*, comme définis par Binford (1983), ont été fournis. Toutes les unités analysées de Pincevent montrent une asymétrie par rapport à la densité de l'outillage, ce qui veut dire que d'un côté du foyer beaucoup plus d'outils se rencontrent que de l'autre. Les 'drop zones' sont situées dans les moitiés de site les plus riches. En vue de ces résultats, il semble possible de réconstituer des directions prédominantes de vent pendant les diverses occupations; comme à présent, des vents d'ouest prédominaient.

Avec la méthode d'anneau nous pouvons examiner 'l'effet centrifuge': la tendance des objets relativement larges de finir par se trouver plus loin du foyer que les objets menus. Toutes les unités du Niveau IV-2 montrent un effet centrifuge relativement fort. Cela peut être illustré en comparant les distributions d'anneau de l'outillage avec celles des nucléus. Cependant, les trois unités de l'Habitation 1 ne montrent pas un effet centrifuge clair, et il en est de même pour plusieurs autres sites.

Les différences entre les divers types d'outils, par rapport à leur distributions d'anneau, ont été recherchées et il s'est établi que les lamelles à dos se trouvent invariablement plus près du foyer que les grattoirs, lorsque, à cet égard, les perçoirs et les burins sont intermédiaires. A base des analyses fonctionnelles des explications à propos de ce phénomène ont eté données. Il n'y a qu'une seule unité de Pincevent, R143, qui se montre atypique; probablement il s'agit ici d'un 'special-purpose site' (un site avec un but special). Il en est de même pour Marsangy N19.

Au moyen de quatre caractéristiques qui ont des rapports statistiques on peut distinguer, indépendamment de leur dimension, deux types de sites. Cette dichotomie s'est montrée au plus clair par une de ces quatre caractéristiques: l'effet centrifuge. Les sites du groupe Y montrent un net effet centrifuge, contrairement à ceux du groupe X. Au groupe X (peut-être des campements de chasse ou des 'special-purpose sites'; occupés par des hommes seulement?) appartiennent les unités de l'Habitation 1 et des sites comme Marsangy N19 et Bro I. La plupart des unités de Niveau IV-2 et des sites comme Oldeholtwolde et Niederbieber appartiennent au groupe Y (des campements de famille?).

Les moitiés de site les plus riches ont été analysées provisoirement de façon plus détaillée. Il s'est montré que dans au moins plusieurs sites du groupe Y les deux quarts de cette moitié diffèrent par rapport aux outils qui s'y rencontrent: un quart comprend une proportion plus élevée de lamelles à dos, tandis que l'autre comprend relativement beaucoup de grattoirs. Cela suggère la présence au moins d'un homme et d'une femme.

KEYWORDS: Intrasite spatial analysis, ring and sector method, hearths, drop zones, toss zones, dwelling structures, Upper/Late Palaeolithic, Magdalenian, Pincevent, Gönnersdorf

1. INTRODUCTION

During the past decades intrasite spatial analysis has received a good deal of attention in archaeology (see e.g. Carr, 1984; Hietala, 1984). One of the reasons for this interest has been the sophisticated and exhaustive way in which many important Upper Palaeolithic sites have been excavated in this period. One of the best examples is the Late Magdalenian site of Pincevent in the Paris Basin, where several dozen extremely well-preserved habitation units around central hearths have been meticulously excavated (Leroi-Gourhan & Brézillon, 1966; 1972). In such cases much energy has been invested in recording the exact location of as many artefacts as possible, and the wealth of information thus created has encouraged the use of statistical methods in spatial analysis (on Pincevent e.g. Djindjian, 1988; Johnson, 1984; Kintigh & Ammerman, 1982; Simek, 1984).

A second reason for the increased interest in spatial analysis has been the birth and growth of ethnoarchaeology, resulting in many publications that have stimulated archaeologists to speculate about their sites in a less stereotypical way than was usual some 20 years ago (e.g. Binford, 1976; 1978; 1983; O'Connell, 1987; Yellen, 1977).

Another field stimulating the interest in spatial analysis is the study of microwear traces, based on the techniques developed by Keeley (1980; see for an overview: Juel Jensen, 1988). Keeley (in: Cahen et al., 1980), Moss (1983a; 1986; 1987; Moss & Newcomer, 1982) and Plisson (1985) have analysed material from Pincevent. Results of such investigations are of great interest to anyone undertaking intrasite spatial analysis (for another interesting example in the Paris Basin, see the work on Verberie: Audouze et al., 1981; Symens, 1986).

Yet another research technique is beginning to have a tremendous impact on intrasite spatial analysis of Palaeolithic sites: the refitting of stone artefacts (see e.g. Cahen et al., 1980; Cziesla, 1986; van Noten, 1978; Olive, 1988; Pigeot, 1987). In 1987 the first international symposium on refitting was held at Neuwied; the papers presented at this 'Big Puzzle' conference (edited by Cziesla, Eickhoff, Arts & Winter, 1990) include a fascinating contribution on the results achieved at Pincevent (Bodu et al., 1990).

Finally, the work of experimental archaeologists also has contributed to a better understanding of intrasite spatial patterns (e.g. Boëda & Pelegrin, 1985; Karlin & Newcomer, 1982; Newcomer & Sieveking, 1980).

It is quite clear that integration of these various techniques, when applied to well-preserved and carefully excavated sites, will profoundly improve archaeological interpretations (see e.g. Cahen et al., 1980; van Noten, 1978). Unfortunately, intrasite spatial analyses in many cases were not integrated in the above sense. Moreover, they have often involved statistical techniques of great complexity, which has discouraged many archaeologists from applying them, or even from trying to understand them. It has also become clear that several of the statistical techniques used so far are of limited value because of inherent shortcomings, for example because the assumptions underlying the mathematical models are not met by the archaeological data (e.g. Whallon, 1978; 1984; Carr, 1984; see also section 5).

It is not my intention here to criticize various techniques used by other investigators. My point is that there clearly is a need for simple methods of spatial analysis, alongside those involving complex computerized procedures. The goal of this paper is to introduce one such method, which is based on the use of rings and sectors around 'domestic hearths'.

2. THE NEED FOR A GLOBAL APPROACH

It is unrealistic to believe that a statistical procedure can be developed to bring out all spatial patterns that may exist in a given site. These are of many kinds, because many site-formation processes have played a part (Schiffer, 1976). An important problem about many approaches to intrasite spatial analysis is the fact that statistical procedures treat all artefact locations in the same way. If results of ethnoarchaeological studies are taken into account, however, we are forced to admit that artefact locations are of different types, of which only some will bear any relationship to prehistoric 'activity areas'. Many artefact locations will have little if any relation to activity areas, e.g. because they occur in toss zones or dumps (see also section 16). Therefore, any meaningful spatial analysis must attempt to establish the parts of the sites where at least some relation exists between artefact locations and former activity areas. I think it is fair to say that in the case of Pincevent non-mathematical approaches to the interpretation of spatial patterns, based on visual inspection of distribution maps, so far have achieved more interesting insights than the often hardly interpretable outcomes of statistical analyses (see e.g. Julien et al., 1988).

It is useful to distinguish between global and local spatial patterns, the former referring to the general structure of the site, the latter to more localized patterns, such as spatially discrete clusters of artefacts or tendencies to spatial association of various artefact types. In view of the above discussion it seems appropriate to start any spatial analysis in a global way. Important goals in the initial stages of the investigation should be:

1. To establish whether or not a tent (or any other type of dwelling structure) was present.

2. To subdivide the sites into areas with varying relationships between artefact locations and former 'activity areas'.

Only after these goals have been achieved can it be profitable to look for more local spatial patterns.

Even with such a limited aim there are many problems to be faced. One problem that is often underestimated is the possibility of multiple occupations on one and the same site, perhaps spread over hundreds of years. It is to be expected that distributions of a palimpsest nature were created in such cases.

Fortunately, in Pincevent this possibility is restricted to limited stretches of time, because of the ongoing but intermittent sedimentation by the river Seine during the period of occupation. The various archaeological levels are separated by sterile deposits (see e.g. Baffier et al., 1982). We are presented with well-defined living floors, and the individual habitation units generally show a remarkably homogeneous structure: dense artefact concentrations around 'domestic hearths'. In the case of the smaller and medium-sized units we clearly seem to be dealing with 'single events'. Nonetheless, with several of the large habitation units the possibility of repeated occupation cannot be wholly ruled out, and we should keep this in mind when interpreting the results of spatial analysis.

Another problem is posed by the occurrence of 'curation' (maintenance of valuable implements usually made of organic materials; Binford, 1976). It is becoming clear that curation was a widespread phenomenon during the Upper Palaeolithic. This not only means that certain activities, performed with curated tools, left no archaeological trace. Curation can also result in clusters of flint tools discarded at the place where curated implements, often made of organic material, were repaired; this process has been called 'retooling' (Keeley, 1982). One example of this phenomenon is that backed bladelets are often found clustered near hearths. Most probably, used backed bladelets were removed from their shafts here and replaced by newly-made ones, which were secured with resin that had to be heated in the fire (Moss & Newcomer, 1981; Moss, 1983a). The same could be true for concentrations of small scrapers around hearths in several sites of the *Federmesser* tradition (see section 11). In such cases it could well be that the activities documented by the use-wear present on the tools were not performed on the site, but elsewhere, possibly prior to occupation of the site. This implies that spatial co-occurrence of tools does not necessarily correspond to an 'activity area' in which these tools were used together for some specific task. Hafting habits, and 'retooling' as defined by Keeley (1982), must be taken into account if a meaningful intrasite spatial analysis is to be performed.

Functional analyses have indicated that some tool types had several different functions; this is also the case at Pincevent (e.g. Moss, 1983a). Therefore, when spatial analysis is based on the distribution of formal tool types, a certain bias will be introduced. This bias could be avoided by subjecting complete assemblages to use-wear analysis. However, it is unreasonable to ask functional analysts for analyses of complete assemblages (in the case of Pincevent this would also be difficult because many implements are too patinated). Moreover, it should not be expected that functional analysis can give unambiguous results for all the tools at a given site (e.g. Juel Jensen, 1988). For these and other reasons, it is unavoidable to use the distributions of formal tool types for spatial analysis. This underlines the point made above, viz. that it is advisable first of all to take a global approach to spatial analysis, instead of expecting miracles from detailed procedures. Fortunately, existing use-wear analyses of Upper Palaeolithic material indicate that some tool types at least are associated with one dominant function; this is true for backed bladelets (insets of projectiles) and scrapers (hide-working) (see for overviews: Cahen & Caspar, 1984; Juel Jensen, 1988). However, some tool types represent a wide range of functions; this applies especially to burins (e.g. Moss, 1983a; 1988; Plisson, 1985). According to Moss, the burin blow should in many cases be looked upon as a technique to facilitate hafting or handling of implements. Burins seem to have been a kind of 'Swiss army knives' (see also the discussion in Juel Jensen, 1988). If burins were used in a hafted state, concentrations of burins might represent places where the tools were removed from their hafts, and replaced by others, just as with backed bladelets.

I have briefly, and certainly not in an exhaustive way, discussed several phenomena that can complicate spatial analysis (see also Olausson, 1986). We should not expect the outcomes of such analyses to reflect a clear-cut spatial 'organization' of sites, bringing out clearly definable and discrete 'activity areas'. Leaving aside the possibility of repeated occupations, these problems include: the removal of artefacts to toss zones or dumps during habitation, the possibility of multiple functions of formal tool types, and 'retooling' as defined by Keeley (1982). There are many more possibilities to consider, however. For example, children's play could have resulted in more or less random transporting of flints on sites, blurring spatial patterns (see e.g. O'Connell, 1987). Refitting analyses have indicated that in several cases cores had been worked in an incompetent way: possibly the work of children (e.g. Bodu et al., 1990; Ploux, 1989; Stapert & Krist, 1990). Another problem is 'flint scavenging': the collecting by prehistoric man of flint artefacts from abandoned sites. Though not a problem in the case of Pincevent, post-depositional disturbances may also have affected sites in such a way that spatial analysis cannot be performed in a meaningful way.

All these and related problems lead to the same conclusions: we must not expect too much from spatial analysis, and we should start by looking for global patterns before more detailed analyses are attempted.

3. SOME CHOICES

The quest for a simple but meaningful method of spatial analysis is the main concern of this paper. Several choices have to be made before we can proceed.

The first of these relates to the question of whether or not to include artefacts of organic material, such as bones, in the analysis. The method to be introduced in this paper does not take into account spatial distributions of bones, though it can be adapted to do so. The reason for this decision is that I wanted a method that is also applicable to the many sites on the North European Plain, where bones in most cases have not been preserved. Nor shall I use the spatial distributions of stones other than flint (e.g. hearth stones), because at several sites on the North European Plain such stones do not or hardly occur (for example at Niederbieber: e.g. Winter, 1987).

The second choice refers to the question of which classes of flint artefacts should be included in the spatial analysis attempted below. In this paper I shall use the following flint artefacts: tools of selected types (in the case of Pincevent: backed bladelets, borers, burins and scrapers), burin spalls, and cores. There are several reasons for this selection. One general reason to limit the analysis to a restricted number of artefact groups is the wish to economize on the amount of time needed for the analysis. It seems desirable to have a method that yields a maximum of result based on a minimum of tiresome work.

A practical reason for the choices made is the fact that for many sites detailed distribution maps are not available. In many cases the published information consists of plans showing the locations of tools and cores; the various categories of 'flint waste' are often not individually mapped.

Moreover, distribution maps of unretouched blades and flakes will reflect several different site-formation processes that cannot easily be unravelled. Many blades will have been used, but there are also many blades that obviously were considered useless by the occupants, for example because they broke during manufacture or because their shape was irregular (see e.g. Moss, 1983b). At Habitation 1 only 29% of the unretouched blades had been used (Plisson, 1985). Furthermore, it has been demonstrated by functional analysis that blades served a wide range of uses (e.g. Moss, 1983a; 1988). Therefore, if complete functional and refitting analyses of blades have not been performed, it will be difficult to attach meaningful interpretations to the outcomes of spatial analysis of all the blades from any site. Most flakes occurring at Late Palaeolithic sites do not show traces of use (e.g. Moss, 1983a; Plisson, 1985).

The above arguments do not imply that it would be unrewarding to study the spatial patterns exhibited by flint waste. On the contrary, many interesting insights have resulted from investigating these, especially if related to the results from refitting analyses (e.g. Cahen et al., 1980; Olive, 1988; Pigeot, 1987; Ploux, 1989). Nevertheless, if a spatial analysis is to bring out patterns resulting from the daily life of the sites' occupants during the whole period of occupation, tools appear to be more appropriate than flint-knapping waste.

The most important argument for this is the fact that all the flint-knapping episodes that occurred at a given site may account for only a small segment of the total duration of its occupation. At any rate, this seems to be the case at sites such as those at Pincevent, which were predominantly associated with hunting activities (C. Karlin, pers. comm.). At any site the tools, however, would have accumulated gradually during the whole period of occupation. The situation might be different at sites such as Étiolles, where flint-knapping was perhaps the most important activity.

Moreover, as we shall note in several later sections of this paper, flint-working areas show a tendency to be located outside the central parts of the sites, where most of the domestic activities took place. For example, it can often be observed that dense residues of flint-knapping occur just outside the area where tool density is highest. It also seems that knapping waste was often discarded secondarily, away from the central parts.

Finally, we have to anticipate that if several habitation units were occupied simultaneously (as seems to have been the case in Niveau IV-2: P. Bodu, pers. comm.), people will have frequently visited relatives and friends at other units. If visitors joined in with flint-knapping, this will have resulted in residues that may be taken erroneously by archaeologists to have been produced by the regular occupants of that unit. Visitors will also have carried finished tools, but these are unlikely to make up a significant proportion of all the tools that were eventually discarded at any unit.

These arguments lead to the idea that if one wishes to study patterns relating to the 'social space' occupied by the regular occupants of a given unit, tools are more appropriate than waste resulting from flint-knapping.

This statement has the implicit assumption that most of the tools ended up roughly at the spot where they were used during occupation. This correlation is certainly not perfect, but there are reasons to believe that it holds for a significant proportion of the tools (see sections 11 and 12), though probably only within a relatively small part of the total surface area of the sites (see section 16).

To summarize, I have intended to develop a simple method for intrasite spatial analysis that is essentially global in character, and uses only a restricted number of flint artefact groups. Ideally, such a method should make it possible to compare different sites with respect to their spatial patterns; this is one of the goals of this paper. In other words: the method should produce results that can easily be reduced to simple quantitative measures or diagrams.

4. THE DOMESTIC HEARTH AS THE FOCAL POINT

At Pincevent, and at many other Palaeolithic sites where we can be fairly sure that there was only a single occupation, we generally see a large hearth constructed of stones, surrounded by a concentration of artefacts, bones, etc. In the periphery of such habitation units smaller hearths may be encountered, which are called 'satellite hearths'. These were used for certain specialized activities (Julien, 1984). The large central hearth may display a complex structure (Julien et al., 1988; Rieu, 1986), and for a small group of people was the centre of various activities, such as the slaughtering of game, cooking and consuming food, and tool manufacture and repair. Hence the large central hearths are known in France as *foyers domestiques.*

It is clear that the domestic hearth was the focal point in the daily life of the inhabitants, regardless of whether it was inside a tent or outside. Therefore, to analyse global spatial patterns in such sites, one would need methods that are adapted to this characteristic structure.

'Quadrat methods', in which the excavated terrain is partitioned according to a grid pattern, are not adapted to this situation. Such methods do not take into account the dominant feature of the sites under consideration: a central hearth with debris around it in a more or less circular concentration. For example, problems arise with the periphery of the concentration. Some cells will be partially or completely empty, and therefore not comparable with cells in the central parts of the site (see also section 5). Also other techniques, such as nearest neighbour analysis (e.g. Whallon, 1974), are not attuned to the fact that a central hearth defines the global structure of the site. To me it seems clear that we should apply methods of partitioning space that are derived from this structure, not forced upon it.

Though I do not wish to deny that local associations of tools may exist, I think that it is difficult, if not impossible, to define discrete 'activity areas' around the central hearths. For areas located some distance from a domestic hearth, for example near satellite hearths in Pincevent, chances are better in this respect, because in many cases only one or a few types of activity were performed there (Julien, 1984). Since the central hearth attracted many different activities, it can hardly be expected that discrete activity areas, definable on the basis of local associations of tools, should still be recognizable, as these would have become blurred in this small but intensively used area (see e.g. Gould, 1971; Yellen, 1977). Of various types of activity many episodes must have occurred around the hearth. These will have had different results in terms of the number of tools that were discarded, and the size and shape that waste scatters took, and it is to be expected that the residues of many episodes of different activities will overlap. Therefore, even if a site with a domestic hearth was occupied for a relatively short timespan, one would expect the resulting residue around the hearth to have a largely palimpsest nature. Discrete clusters resulting from specific activities will have survived only to a small degree if at all. A citation from Carr (1984: p. 115) nicely illustrates this important point: "The remains from such activities overlay each other and are mixed within a single area. Co-occurrences between different artefact types in this situation reflect *the common social context* in which they were used, rather than use in a common activity." (emphasis mine). This palimpsest nature will be the more pronounced as the occupation had a longer duration (see also O'Connell, 1987). In view of this situation it is hardly surprising that many computerized approaches to intrasite spatial analysis, if applied to sites such as Pincevent, do not produce clear patterns (e.g. Djindjian, 1988: p. 101: 'Intrasite spatial analysis, realised on the whole 36 area of Pincevent, gives finally unsatisfying results"). One could legitimately wonder whether such situations offer any scope at all for meaningful analysis.

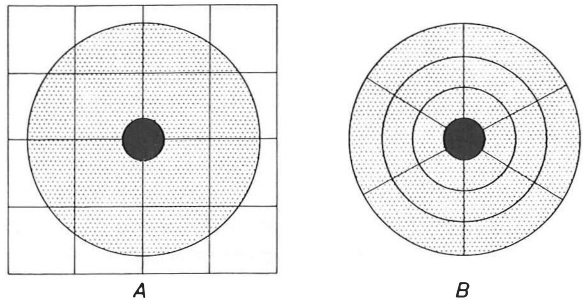

Fig. 1. Schematic representation of two different approaches to spatial analysis, in this case of find concentrations around a central hearth. Many conventional analyses are based on a regular grid, as in A. In this paper B is advocated. The latter system of subdividing space has two phases. In the first, distances are measured between artefact locations and the centre of the hearth. This is done in classes (rings) of 0.5 m width. In the second phase the numbers of artefacts per sector are counted. Depending on the total number of artefacts, a smaller or larger number of sectors can be employed, though in most cases a number of eight is satisfactory. The two procedures can be applied independently, but it may be very useful to combine them.

5. RINGS AND SECTORS

If the domestic hearth is taken as the focal point, two approaches of analyzing spatial patterns present themselves almost 'naturally', as being well-adapted to the global structure of the sites under discussion: measuring the distances between artefact locations and the hearth centre, and recording the distribution of artefacts in the space around the hearth.

Two systems of partitioning space are appropriate if we wish to follow this course: 1. Using concentric rings around the centre of the hearth; 2. Using sectors around the hearth; as depicted schematically in figure 1. These two methods of investigating spatial patterns are independent of each other. They can be applied separately, while using the same artefact locations.

The aim of this paper is to investigate the potential of the ring and sector method, drawing especially from the rich data collected at Pincevent. It should be clear that the method proposed here does not claim to detect all possible spatial patterns in sites. It is directed at describing and interpreting some global spatial patterns that relate to the domestic hearth.

The ring method is extremely simple: frequencies of artefacts are counted in rings around the centre of the hearth. In most cases rings of 0.5 m width are satisfactory, but when the number of artefacts is very large, rings of 0.25 m can be used to gain more detail. Rings of 1 m width are too wide. In this paper I shall only use rings of 0.5 m width. It is advisable to count the ring frequencies per sector, because combining the sector and ring approaches may be fruitful. It is obvious that in applying the ring and sector method one can only use artefacts of which the locations were measured individually – not finds from the sieve.

At Pincevent there are two phenomena that place a constraint on the maximum distance from the hearth centres within which artefact locations can be used. The first is the fact that often the various habitation units are quite close together; overlaps with other units should be avoided. This applies especially to Habitation 1. The second is the existence of dumps: concentrations of waste removed collectively. It is desirable to avoid these in our analysis, because flint artefacts present in them no longer have any spatial relation to former activity zones. Dumps are mostly located more than 3 m from the domestic hearths. Therefore it was decided to use only artefact locations within 3 m from the hearth centres. Even then, however, Habitation 1 poses problems due to the close proximity of the three hearths (see section 8). For the habitation units in Niveau IV-2[1] this limit was found to be adequate. It should be noted that by this decision we limit ourselves to the analysis of the 'domestic space' around the hearths.

The distribution of artefact frequencies in the rings can be illustrated in the form of histograms, in which 0 on the X-axis is the centre of the hearths. It is important to note that we are not discussing densities here, in terms of numbers of artefacts per square metre. Of course the rings progressively grow in surface area, from the centre outwards. In applying the ring method, however, we are interested in the absolute frequencies per ring, and it does not matter in what quarter the artefacts are located in the space around the hearth. The number of tools used in any single episode of prehistoric activity would have been the same, irrespective of whether the work was done close to the hearth, or away from it. Calculating densities per ring would only transform the data, and moreover give the false impression that the artefacts are scattered evenly in the rings (see section 12). For the ring method it is not relevant whether the artefacts are clustered locally or occur scattered. The rings only serve as a graphical illustration of the method, and in fact it would be more precise to speak about distance classes. When ring frequencies are transformed into densities (i.e. average densities per ring), in the case of Pincevent diagrams of the type illustrated in figure 2 (for unit T112) result, which clearly illustrate the association between hearths and high tool densities.

The sector method investigates frequencies in sectors around the centre of the hearth. The choice of the number of sectors employed is arbitrary. In my experience a number of eight in most cases works best. However, if the total number of artefacts within 3 m from the hearth centre is very low, a number of four or six sectors can be used (however, see section 20). Similarly, the placing of the sector boundaries is also arbitrary. It is advisable to use the main axes of the excavation trenches for placing the sector boundaries, because it is neutral and practical. The sectors should be equally large; in cases where this is not possible, problems will arise when the results are interpreted (Stapert & Terberger, this volume).

With the sector method we are dealing with data that are much weaker than the distance data used in the ring method. Distance data can be considered as measurements in the ratio scale (Siegel, 1956), allowing many statistical manipulations (though nonpa-

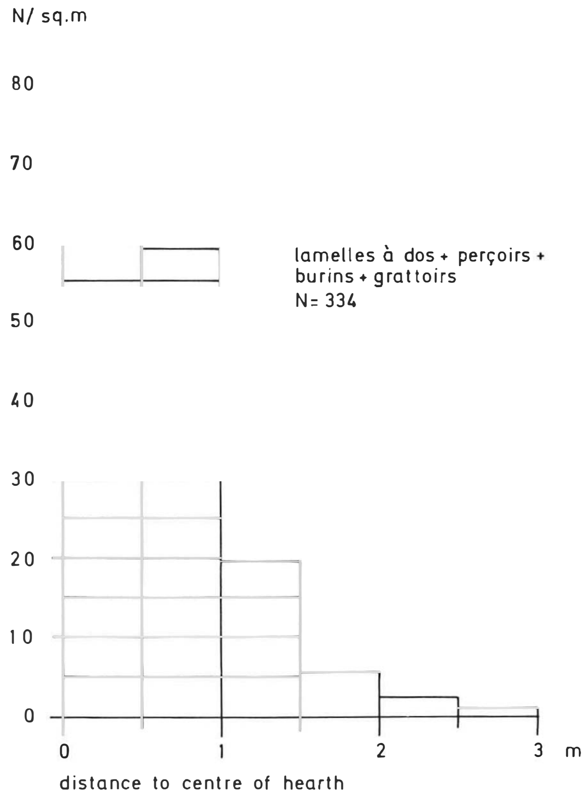

Fig. 2. Pincevent, unit T112 in Niveau IV-2. The numbers of tools (four types) per ring of 0.5 m width are expressed as densities: in numbers per square metre. The centre of the hearth is 0 on the X-axis. This diagram clearly brings out the fact that the hearth is associated with high find density. It should be noted, however, that the densities are averaged per ring, obscuring some spatial patterns. For example, many more tools occur on one side of the hearth than on the opposite side (see section 12). Compare this figure with figure 46 (tools), where the same data are presented in the way usually adopted in this paper: absolute frequencies per ring.

rametric statistics are preferable). Frequencies in sectors around the hearth, on the other hand, constitute measurements in the nominal scale, despite the fact that the frequencies themselves are counted in the ratio scale. The same is true for frequencies in cells of a grid structure of whatever kind.

Apart from this general problem, one circumstance especially hinders statistical evaluation of sector frequencies (or, for that matter, grid cell frequencies). In general terms this problem is the result of 'abundancy effects'. For example, at Pincevent and many other sites we observe that many more tools are located on one side of the hearth than on the opposite side (see section 12). In other words: some parts of the sites have high tool densities, and other parts low tool densities. Abundancy effects will cause spurious positive correlations between pairs of tool types if raw frequencies are used, because in some sectors there will be many tools of both types, and in some other sectors few. With grid cell data the situation is even worse, because there will be many cells in which one or both tool types have zero counts (see e.g. Speth & Johnson, 1976). These spurious correlations cannot be avoided in a satisfactory way. For example, using percentages per sector will result in spurious negative correlations. This is a consequence of the fact that if one type has a high proportion in one sector, all the other types will show low percentages, as they always have to total 100%. As an example Spearman's rank correlation coefficients (rho; see Siegel, 1956) were calculated between backed bladelets and borers in the case of unit T112 (fig. 3; the eight sectors constitute the cases). When using absolute frequencies per sector, rho is definitely positive, though not significantly (+0.60), but when percentages per sector are used, rho is significantly negative (-0.74). Both tendencies are likely to be largely artefacts created by the character of the data; therefore, they cannot be interpreted in any meaningful way. For this reason, correlation analysis for pairs of tool types is avoided in this paper. It was considered possible, however, to apply it to frequencies of all the tools per sector compared to those of the cores (see section 15).

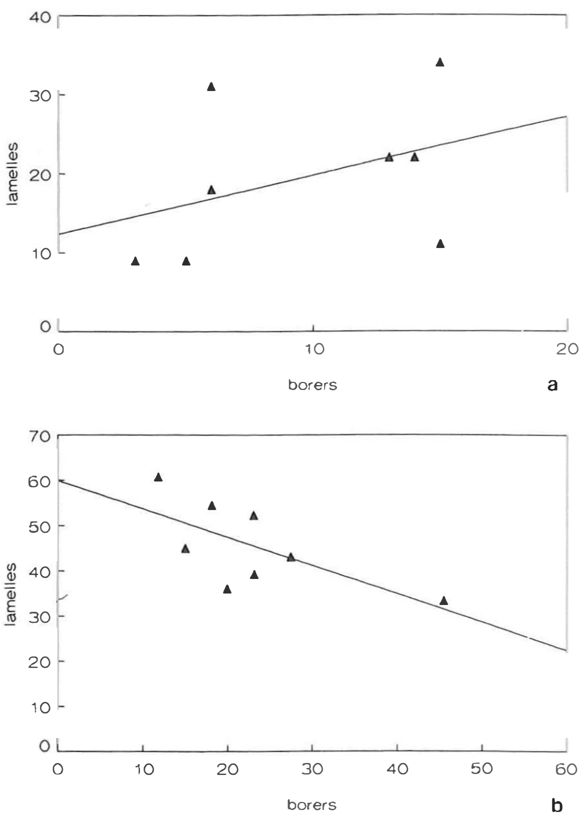

Fig. 3. Pincevent, T112. Scatter diagrams of borers against backed bladelets (*lamelles*) over eight sectors. A. Frequencies per sector; B. Percentages per sector. Regression is based on least squares. For both sets of data Spearman's rank correlation coefficients (rho; see Siegel, 1956) were calculated for these two tool types (the eight sectors constitute the cases). Based on absolute frequencies rho is clearly positive (+0.60), though not significant; based on percentages per sector rho is significantly negative (-0.74). It is suggested that both types of correlation will mostly produce spurious results. If based on absolute frequencies positive correlations will result because of 'abundancy effects': strong density differences between the sectors (or between the cells of a grid structure). If based on percentages unrealistic negative correlations will result.

6. THE TENT PROBLEM

There has been a great deal of speculation about whether domestic hearths lay within or outside tents (on Pincevent see e.g. Audouze, 1987; Binford, 1983; Julien et al., 1987; 1988; Leroi-Gourhan & Brézillon, 1966; 1972; Plisson, 1985). At most Palaeolithic sites there are no archaeological traces of huts of tents, so that any reconstructions of dwelling structures must remain hypothetical. Sites with unmistakable remains of huts or tents are in fact quite rare. Famous instances are of course the mammoth-bone huts in eastern Europe and the USSR, such as those at Mezirich and Mezin (e.g. Pidoplichko, 1976). Drawings and photos of these huts can be found in many books and papers, but detailed distribution maps of flint artefacts appear to have remained unpublished.

At Gönnersdorf I a circle of postholes was observed around a hearth. This finding inspired a *yaranga*-like reconstruction (Bosinski, 1979; 1981; on *yarangas* see e.g. Faegre, 1979).

Somewhat more frequently circles of large stones occur around a domestic hearth. Examples of these have been excavated at Malta (house no. 5: Gerasimov, 1958), Étiolles (Julien et al., 1988; Olive et al., 1988; Pigeot, 1987), Rekem (Lauwers, 1988), and Vigne-Brun (Combier, 1985; Combier et al., 1982). At Gönnersdorf (Concentration IV) too such a circle of stones around a hearth was excavated, to which I shall return below (see also Bosinski, 1981; Stapert, 1990; Terberger, in press). Such stone circles are interpreted as tent-rings; they are well-known ethnographically, especially from the Eskimos.

Mostly, however, there is not the slightest archaeological evidence of tents or huts. At the Hamburgian site of Oldeholtwolde in the Netherlands, where a Magdalenian-like domestic hearth with central pit was excavated (Stapert, 1982; Stapert et al., 1986), many hundreds of stones were found, but there was no indication of a clear-cut circle around the hearth. Neither were any traces of dwellings found among the dozens of habitation units at Pincevent.

At some Late Palaeolithic and Mesolithic sites, faint stains in the soil have been interpreted as possible remains of huts (for example at Westerkappeln: Günther, 1973; Bergumermeer: Newell, 1980), but in most cases these are likely to be traces of pits created by ancient treefalls (Kooi, 1974).

Of course this situation has not deterred archaeologists from postulating tents or huts around or beside the hearths. A well-known example is the model presented by André Leroi-Gourhan, the excavator of Pincevent (e.g. Leroi-Gourhan & Brézillon, 1972). He visualized the domestic hearths in the very entrances of tents. Such situations are well-known in ethnography, for example among the Bushmen of southern Africa (Yellen, 1977), while in some cases Eskimos too are known to locate their hearths in this way (see examples in Faegre, 1979; see also Binford, 1983). However, in these cases the hearth is in fact mostly located somewhat outside the entrance, or at one of its sides.

For Habitation 1, Leroi-Gourhan & Brézillon (1966) proposed a dwelling structure composed of three tents joined together (fig. 4). Important arguments for this model were that the three hearths were thought to have been in use simultaneously (this is indicated by refittings: e.g. fig. 44; see also Karlin: in Cahen et al., 1980; and section 13), and that they are quite close to one another. Binford criticized Leroi-Gourhan's model in his book *In pursuit of the past* (1983). In this book he presents his important 'seating model' for outdoor hearths, to be discussed in the section below. Binford believes that hearths II and III of Habitation 1 were outdoor hearths, used consecutively by a single group of people. In response to a change in wind direction, the people turned around, and built a new campfire. (Binford calls this process 'rotation'. I find this use of the term some-

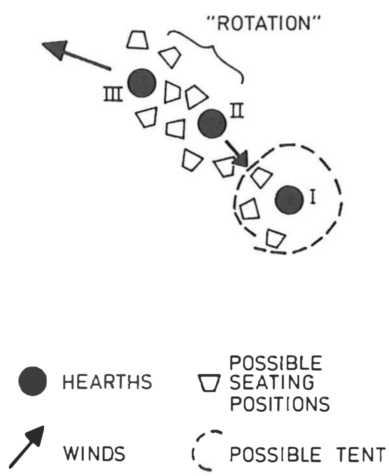

Fig. 5. Pincevent, Habitation 1. Binford's model (after Binford, 1983: p. 157).

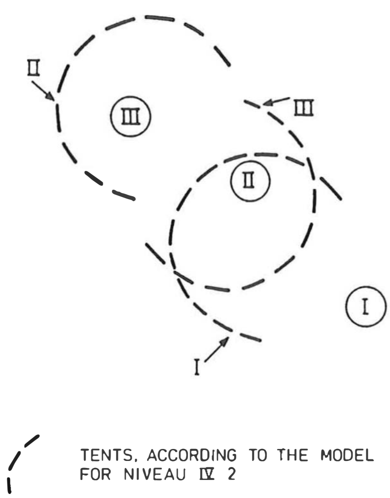

Fig. 6. Pincevent, Habitation 1. The model proposed by Julien et al. (1987) for the units in Niveau IV-2, superimposed on Habitation 1. In this model it is assumed that the hearths were situated 1 or 2 m outside the tent entrances. It can be seen that this model does not work for Habitation 1, irrespective of whether contemporaneity of the three hearths is assumed (see also fig. 43).

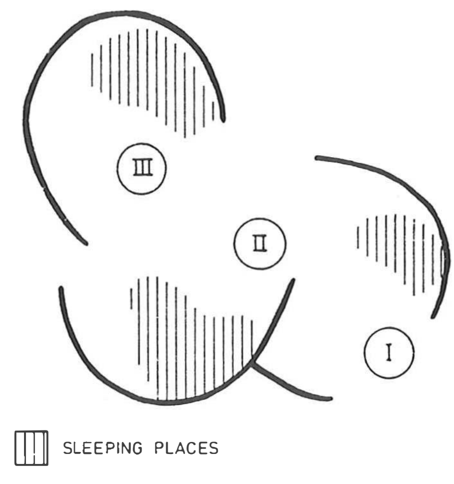

Fig. 4. Pincevent, Habitation 1. The model as proposed by Leroi-Gourhan (after Leroi-Gourhan & Brézillon, 1966): a dwelling structure consisting of three combined tents.

what confusing. I would like to reserve it for actual rotation around a single hearth, prompted by changes in wind direction.) As for Hearth I of Habitation 1, on the other hand, Binford suggests (in his fig. 93) that it may have been inside a tent (fig. 5).

Both Julien et al. (1987) and Audouze (1987) have argued that Leroi-Gourhan's model for Section 36 (Niveau IV-2), featuring tents with hearths in the entrances, should be corrected in the sense that it is more probable that the hearths were clearly outside the entrance, at a distance of 1 to 2 m. This would imply that the hearths, and also the working spaces around them, were completely in the open air, leaving the tent entrances free. However, this corrected model would not work for Habitation 1, because of the three hearths' being so close together (fig. 6).

Other archaeologists visualized the hearth at the centre of a tent (e.g. Burdukiewicz, 1986). For this arrangement too, many ethnographic parallels exist, as in the tents of the Lapps and the North American Indians.

The possibility that hearths were out in the open, without a tent nearby, is not frequently considered. A tent at some distance from the hearth could easily remain archaeologically invisible if most of the activities were performed outside. Figure 7 shows the models discussed above.

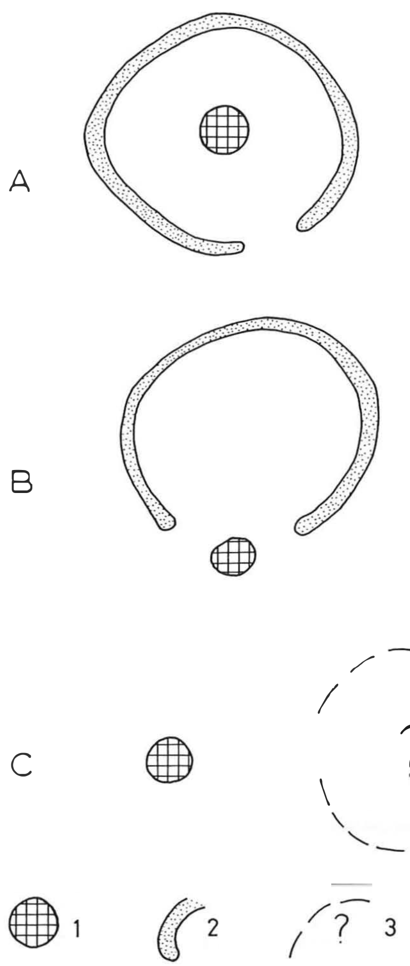

Fig. 7. Some possible models of dwelling structures with a hearth. A. Hearth at the centre of a tent or hut; B. Hearth at or near the entrance of a tent or hut; C. Hearth in the open air, with or without a tent or hut within a few few metres' distance. 1. Hearth; 2. Tent or hut wall; 3. Possible tent.

The great danger with many proposed models is that a kind of 'ethnography with a shovel' is embarked upon (Gamble, 1986; Wobst, 1978), while hard evidence to underpin any hypothetical dwelling is lacking. There is no sense in simply forcing plans of Nunamiut dwellings onto archaeological distribution plans as an 'interpretation'. Hence it is necessary to develop an empirical archaeological method which will allow us actually to observe whether a tent was present or not. I believe this should be the first step in any meaningful intrasite spatial analysis.

7. BINFORD'S MODEL AND THE CENTRIFUGAL EFFECT

Ethnoarchaeological knowledge about people's spatial behaviour in relation to hearths is of crucial importance. Binford (1983) presented useful descriptions, which can be summarized in his 'hearth model' (fig. 8). He distinguishes drop zones and toss zones. Drop zones are found close to the hearth in the form of a semicircle, where small debris fall to the ground during all sorts of activities, and generally are left lying. Larger pieces of refuse, such as larger bones, end up in the toss zones. Two toss zones are distinguished: a backward toss zone which lies in the form of an arc around the drop zone, and a forward toss zone on the opposite, unoccupied side of the hearth. An important point to note is that pieces of refuse arrive in the toss zones individually, one by one. This is in contrast to dumps. Dumps are spots, usually at more than 3 m distance from the hearth, where refuse is collectively discarded. Archaeologically, dumps are quite easily recognized, and they have been found at many Magdalenian sites (Julien et al., 1988). In dumps we may find ashes and stone fragments that were cleared out of the hearths, bones, and flint waste (including used tools). The removal of coarser material towards the toss zones was a more continuous process throughout the time of occupation, taking place through tossing or kicking away.

There are two important differences between the drop zone and the toss zones. The first is that toss zones are clearly more peripheral with respect to the hearth, at any rate in an overall sense. However, there is a certain overlap, in terms of distance to the hearth, between the drop zone and the forward toss zone (indicated in figure 8 by means of broken lines). The second is the size of the items that end up in them: small objects in the drop zone, larger ones in the toss zones. Hence we are dealing with a size-sorting process: a tendency towards spatial segrega-

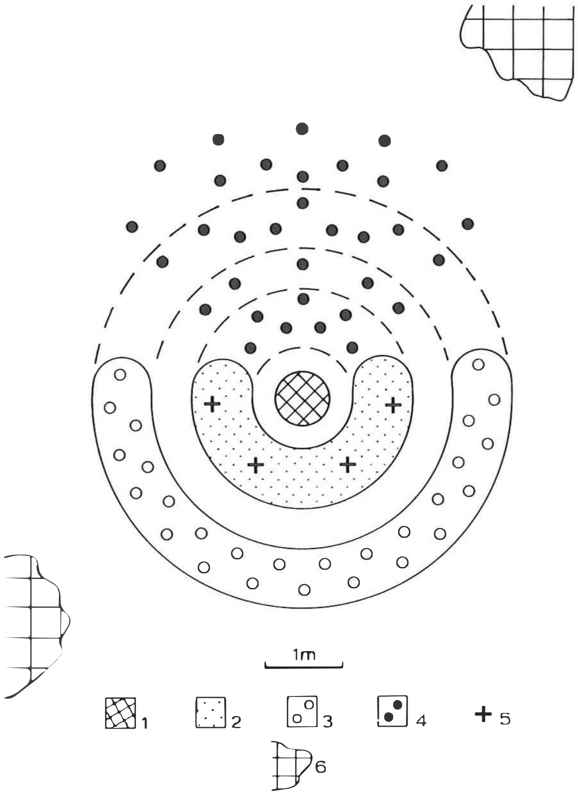

Fig. 8. Sketch of Binford's hearth model (after Binford, 1983: p. 153, with minor alterations). 1. Hearth; 2. Drop zone; 3. Backward toss zone; 4. Forward toss zone; 5. Seating positions of four people; 6. Dumps.

tion of finer and coarser refuse. On the whole the coarser items have a greater chance than the small ones of ending up in the periphery of the site. This general pattern has been known to archaeologists for a long time: many distribution plans show that cores (the largest flint artefacts) mainly occur in the periphery of sites (see for a fine example the distribution maps of Deimern 45 (Taute, 1968)). The archaeologist Löhr (1979) called this phenomenon the centrifugal effect, and this useful term was also employed by Leroi-Gourhan & Brézillon (e.g. 1966) and other French archaeologists, though not always under exactly the same definition. In this paper the term is exclusively used to indicate the size-sorting process described above: the tendency for larger objects to end up farther away from the hearth. The centrifugal effect has also been observed by several other ethnoarchaeologists. One of the most interesting examples is the excellent paper by O'Connell (1987) on the Australian Alyawara.

Of course there are various complications. For example, at the Hamburgian site of Oldeholtwolde we found that used-up cores were generally lying in the periphery, while a few still exploitable ones remained near the hearth (Stapert & Krist, 1990). This once again stresses the importance of taking a global approach to the study of spatial patterns. Moreover, it is of interest that not all sites show a centrifugal effect, a point to which I shall return later (in section 14).

Although ethnoarchaeological observations, such as Binford's, are extremely useful, they also present several difficulties if one attempts to use them for archaeological interpretations. One of these problems can be elucidated by the concept of 'time depth'. The model as depicted in figure 8 in fact illustrates the situation at a given moment. With archaeological sites, however, we are dealing with a residue of an occupation of perhaps several months. Even if at any given moment during occupation the spatial 'organization' of a site resembled the model of figure 8, its lay-out did not necessarily remain unchanged. For example, if during occupation wind directions changed several times, the whole system would have rotated around the hearth repeatedly. If the wind mostly came from the same direction, the resulting residue would still roughly resemble the model.

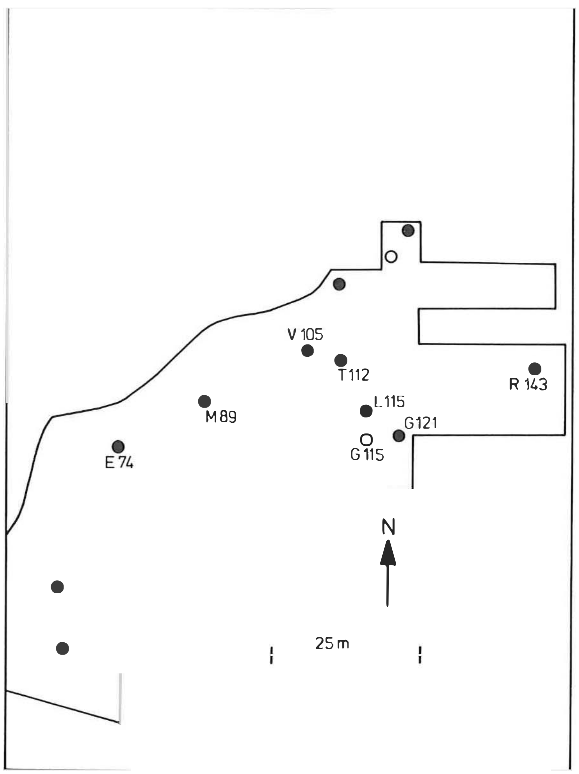

Fig. 9. Pincevent, Niveau IV-2. After Julien et al. (1987: p. 338). The units that are included in the spatial analysis are indicated with the number of the square in which the hearth is located. Infilled circles indicate *foyers domestiques*. The hearth of G115, without a central pit, is considered to be a 'satellite hearth' (e.g. Julien, 1984).

However, if there was no prevailing wind direction during the period of occupation, the end product would definitely be a palimpsest residue, even if at any given moment the site's structure was similar to Binford's model (see also section 13).

Within a tent with a central hearth, the centrifugal movements are of course restricted by the tent wall. Therefore one may expect much of the refuse to be carried outside and dumped *en masse*. One type of dump is characteristic of tents (or other dwellings): the door dump (Binford, 1983). People simply throw their larger pieces of rubbish out through the tent entrance, to the left or to the right. However, even within a tent the centrifugal effect will be operative, though generally not in all directions. The tent wall then functions as a barrier: the refuse accumulates against it, again with a relatively high proportion of coarse material. This I should like to call the barrier effect.

8. UNIMODAL RING DISTRIBUTIONS: OPEN-AIR HEARTHS

In this and the following section I shall concentrate especially on ring distributions for all the tools taken together. These distributions are found to be of two different kinds: unimodal and bimodal. In this section the unimodal distributions are presented, while the bimodal ones are discussed in section 9.

So far, I have analysed eight units of Niveau IV-2: E74, M89, V105, T112, L115, G115, G121, R143 (see fig. 9, after Julien et al., 1987). Most of these hearths are *foyers domestiques*, but G115 is considered to be a 'satellite hearth' (without a central pit: Julien, 1984; Leroi-Gourhan & Brézillon, 1972). Nor does R143 seem to fit the 'normal' model for habitation units; it appears to be a 'special-purpose site' (Julien et al., 1987; see also sections 11 and 19).

For Niveau IV-2 it was usually possible to analyse all tool locations within 3 m from the hearth centres, without overlaps with other units, while

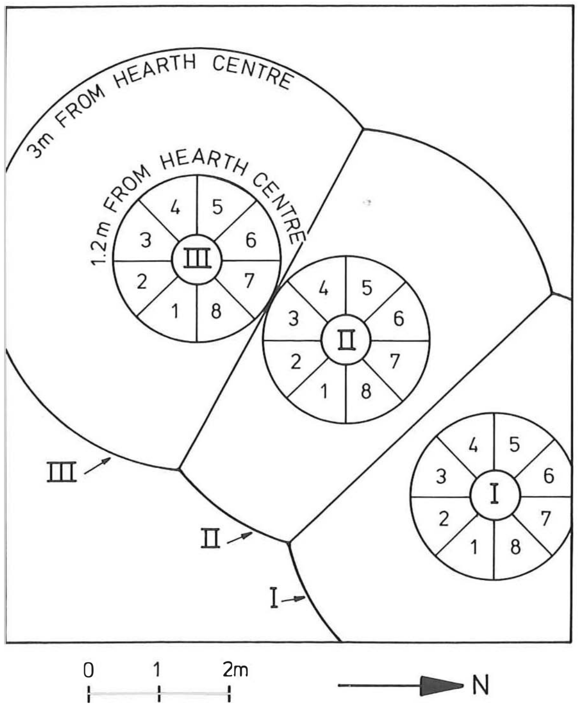

Fig. 10. Pincevent, Habitation 1. Because the three hearths are located very close together, a normal application of the ring and sector method is impossible. The rings farther than 1 m from the hearth centres are incomplete, and sector frequencies can be investigated only within 1.2 m from the hearth centres.

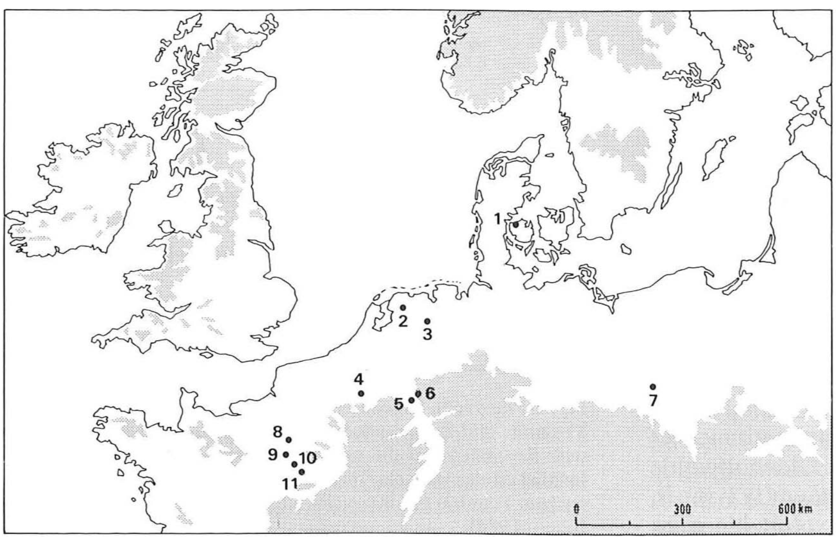

Fig. 11. Map showing the sites in Europe that have been investigated with the ring and sector method. Areas more than 200 m above sea level are shaded. 1. Bro; 2. Oldeholtwolde; 3. Emmerhout; 4. Orp; 5. Gönnersdorf; 6. Niederbieber; 7. Olbrachcice; 8. Verberie; 9. Étiolles; 10. Pincevent; 11. Marsangy.

avoiding dumps. Habitation 1, however, presented severe problems in the application of the ring and sector method. The three hearths were too close together; analysis had to proceed in the way depicted in figure 10. As can be seen, rings farther than about 1 m from the hearth centres are not complete, while the sector method can be applied only to artefact locations within 1.2 m from the hearth centres, if we want the sectors all to be equally large. These constraints mean that we have to be very careful when interpreting the results of our analysis.

For comparison, in this and following sections reference is also made to the results from a number of other sites in northern/Central Europe (see fig. 11):

Late Magdalenian: Étiolles P15 (Olive, 1988), Verberie 2-D1 (= E1) (Audouze et al., 1981; Audouze & Cahen, 1984; Symens, 1986), Marsangy N19 (Schmider, 1979; 1984; 1988), Orp East (Vermeersch et al., 1984), Gönnersdorf I, III and IV (Bosinski, 1979; 1981; Stapert, 1990; Stapert & Terberger, this volume; Terberger, in press).

Hamburgian: Oldeholtwolde (Stapert, 1982; Stapert et al., 1986), Olbrachcice 8 East (Burdukiewicz, 1986).

Federmesser tradition: Niederbieber I and IV (Bolus, n.d.; Winter, 1986; 1987).

Brommian: Bro I (Andersen, 1973).

Mesolithic: Duvensee 8 (Bokelmann et al., 1981) and 13 (Bokelmann et al., 1985; see also Bokelmann, 1986).

These sites of course have individual characteristics, and present various problems as to the application of the ring and sector method, which I cannot now discuss in detail. However, I should mention here the problem of Orp East. At this site two stone constructions are present, of which either one or both could be a hearth. Vermeersch thinks the northern one (B) to be a hearth, which he believes was located just inside the entrance of a tent (fig. 12). However, backed bladelets are tightly clustered around the southern one (A) (fig. 13), suggesting that if only one of the stone constructions was a hearth it must have been the southern one. On the basis of this assumption I measured the ring distribution of the tools of Orp East with respect to the centre of stone construction A (fig. 15). It is also possible that both stone constructions were hearths, of which one is associated especially with backed bladelets and the other with scrapers (fig. 14; see also section 20).

Most of the analysed sites show unimodal ring distributions (single-peak histograms) for the tools (see fig. 15): Oldeholtwolde, Niederbieber I and IV (only IV is illustrated in fig. 15), Bro I, Orp East A, Olbrachcice 8 East, and Marsangy N19. These sites, except Orp, will serve as reference material in following sections. Unimodal distributions were also obtained for sites 8 and 13 of Duvensee.

All eight concentrations of Niveau IV-2, and the three hearths of Habitation 1, show unimodal distance distributions (figs 16 and 17).

Traces of huts or tents were observed at none of these sites. Several authors did however postulate the presence of tents. Most reconstructions show a hearth at or near the entrance: at Pincevent, Orp and Bro. In the case of Olbrachcice the hearth was visualized in the middle of a tent. As will be explained in the next sections, there are good reasons to believe that unimodal ring distributions are characteristic of hearths in the open air.

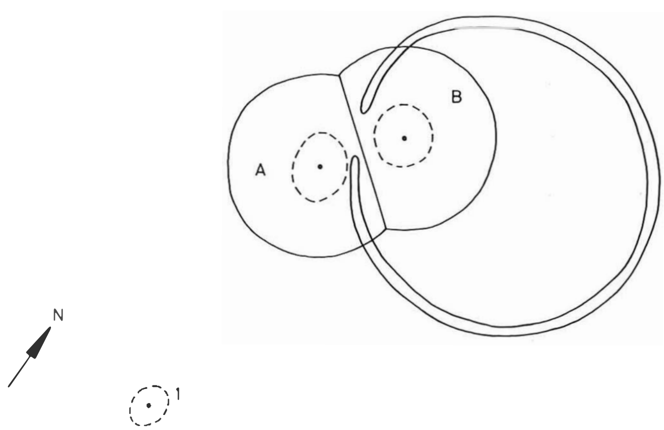

Fig. 12. Schematic site plan of Orp East (after Vermeersch et al., 1984). 1. Stone constructions, either or both of which could be hearths (according to Vermeersch et al., only stone construction B was a hearth); 2. Areas within 1 m from the centres of the stone constructions (see fig. 74:D); 3. Tent wall as reconstructed by Vermeersch et al.

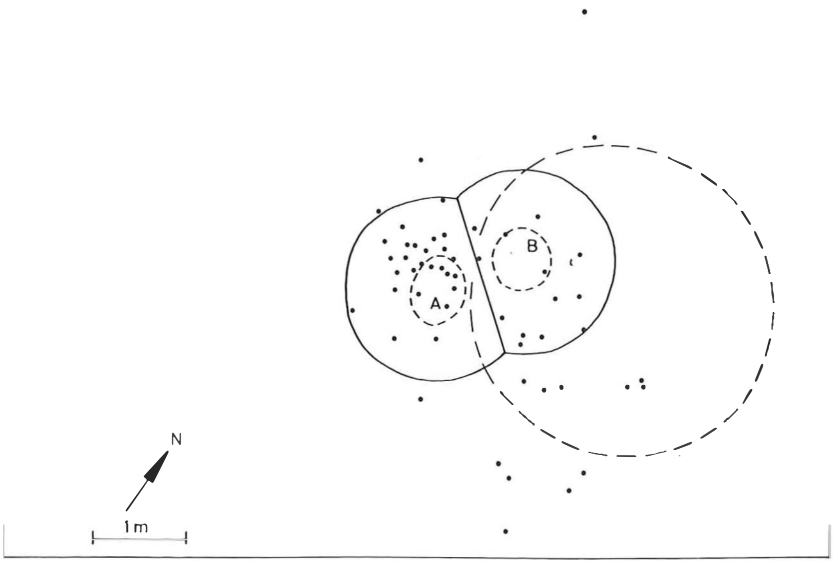

Fig. 13. Orp East. Distribution of backed bladelets (after Vermeersch et al., 1984). It can be seen that backed bladelets are clustered especially around stone construction A, suggesting that this one at any rate functioned as a hearth.

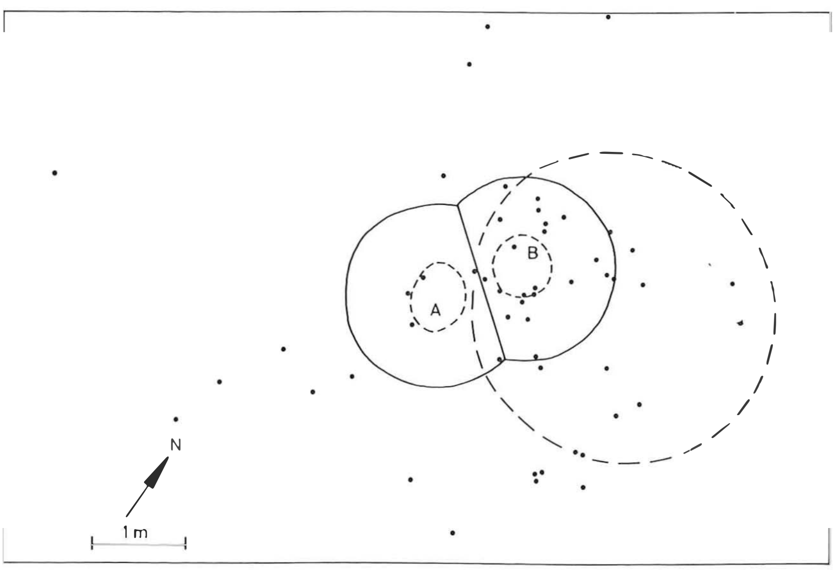

Fig. 14. Orp East. Distribution of end scrapers (after Vermeersch et al., 1984). Scrapers seem to be associated with stone construction B. See section 20.

It is interesting to note that the diagrams for the units of Pincevent are all very similar: they invariably have the mode in the 0.5-1 m class, and do not show much variation. For the other sites with unimodal ring distributions, however, a great deal of variation is apparent. The peak may be present in the 0.5-1 m class, but also much further away; for example, in Marsangy N19 it is in the 2-2.5 m class. Also Oldeholtwolde and Bro I show relatively distant peaks, in the 1.5-2 m class.

There may be various reasons for this variability. One of these could be differences in the number of people occupying a unit. Since only a semicircle is availabe for sitting near to an open-air hearth (see section 12), the distance between the drop zone and the hearth will become larger when a greater number of people are present (see fig. 18). However, other explanations are also possible, so that we cannot really rely on this variable for estimating the number of occupants. Nevertheless, it is remarkable that in the case of Pincevent the mode is always very close to the hearth, and invariably in the same ring: 0.5-1 m. This suggests that the groups of people occupying the various units at Pincevent were relatively small, and did not vary much in size.

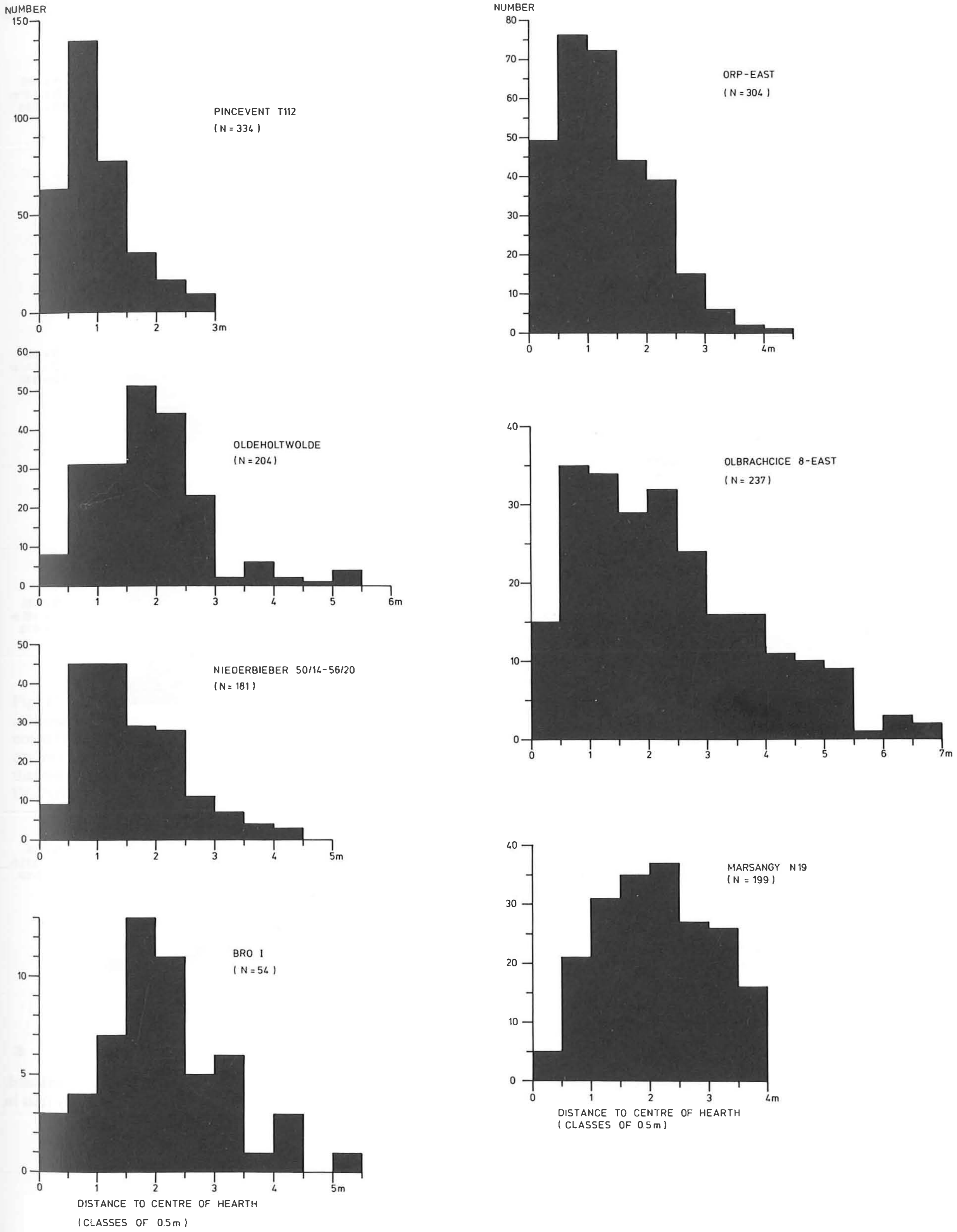

Fig. 15. Seven sites in Europe showing unimodal ring distributions for all the tools taken together. Pincevent is represented by T112 only (for the other units of Pincevent, see figs 16 and 17). Only one of the analysed sites of Niederbieber is shown (IV: 50/14-56/20); Niederbieber I was also analysed and shows a similar ring distribution. In the case of Orp East, distances from the centre of stone construction A are used (see figs 12-14), on the assumption that if only one of the stone constructions was a hearth it must have been this one. Unimodal ring distributions such as these presumably relate to open-air hearths.

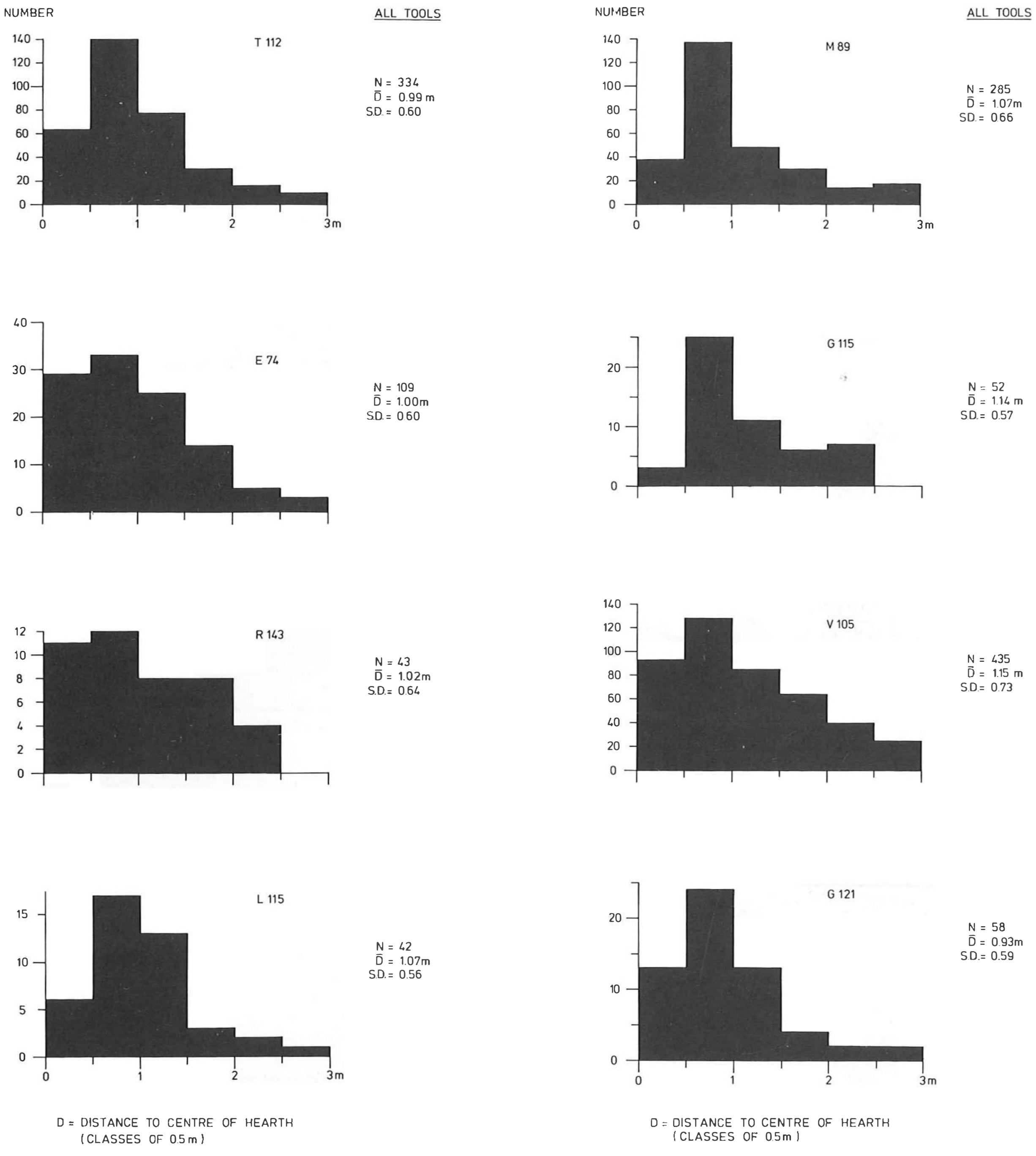

Fig. 16. Pincevent, Niveau IV-2. Ring distributions of all tools (of four types: backed bladelets, borers, burins and scrapers) combined, for the eight analysed units. All units show unimodal distributions, and these are remarkably homogeneous: the mode invariably falls in the 0.5-1 m class (compare with fig. 15).

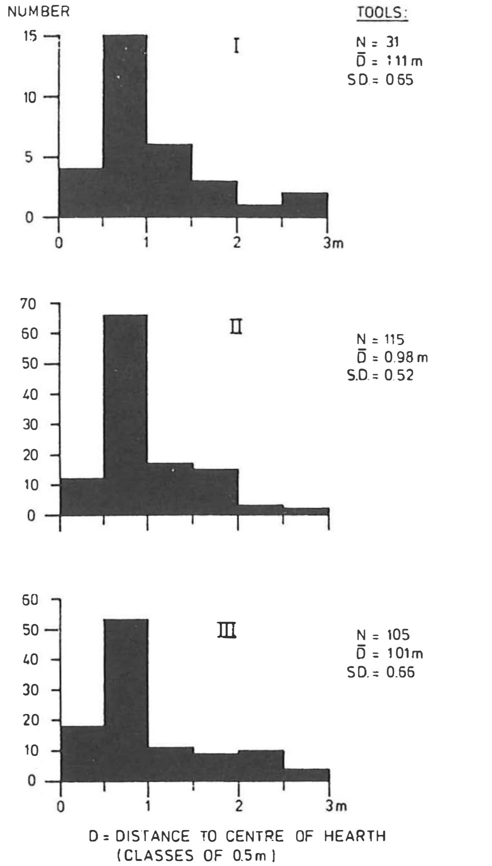

Fig. 17. Pincevent, Habitation 1. Ring distributions of all tools (of four types) taken together, for the three units. It should be noted that in this case the rings farther than 1 m from the hearth centres are incomplete (see fig. 10). It can nevertheless be seen that the distributions are similar to those of the units in Niveau IV-2 (fig. 16): unimodal, and with the mode in the 0.5-1 m class.

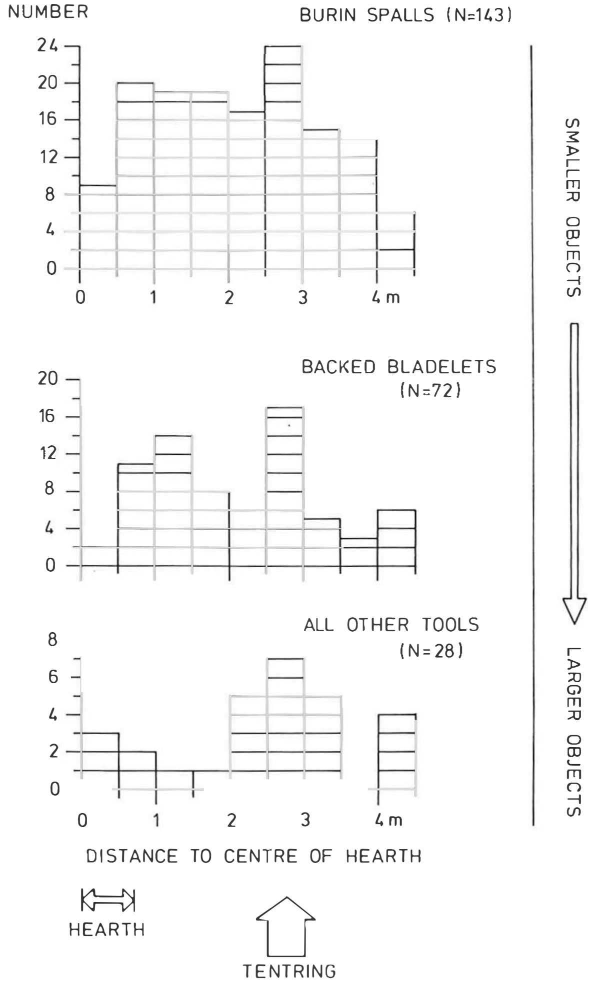

Fig. 19. Gönnersdorf IV. Distances to the centre of the hearth for three size-classes of artefacts: burin spalls, backed bladelets, other tools. The objects in the last-named group are larger than those in the first two, and it can be seen that they generally lie considerably farther from the hearth than the smaller artefacts. Compare with figure 20.

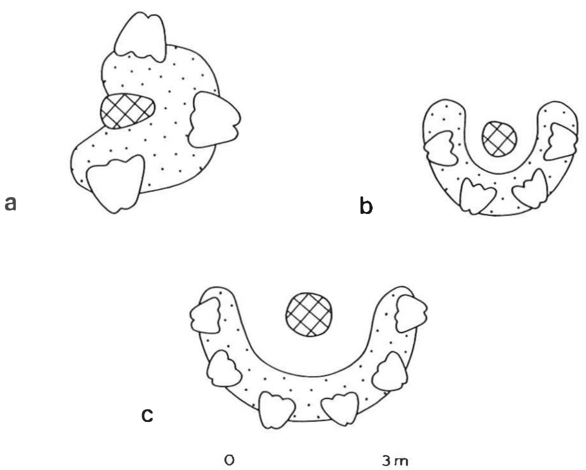

Fig. 18. Illustration of the fact that the drop zone tends to be located farther from the hearth as the number of people sitting around the hearth grows. A. The drop zone near hearth B at the Anaktiqtauk site in Alaska, with three persons sitting around the hearth (after Binford, 1983: p. 154). The scale given by Binford must be wrong, but important to note is the fact that the drop zone is very close to the hearth; B. The drop zone observed at the Mask site, with four persons sitting around the hearth (after Binford, 1983: p. 153). In this case the drop zone is somewhat farther from the hearth than in A; C. The presence of six people, with the same amount of elbowroom as in case B, will lead to a location of the drop zone even further away from the hearth. 1. Hearth; 2. Drop zone; 3. Person.

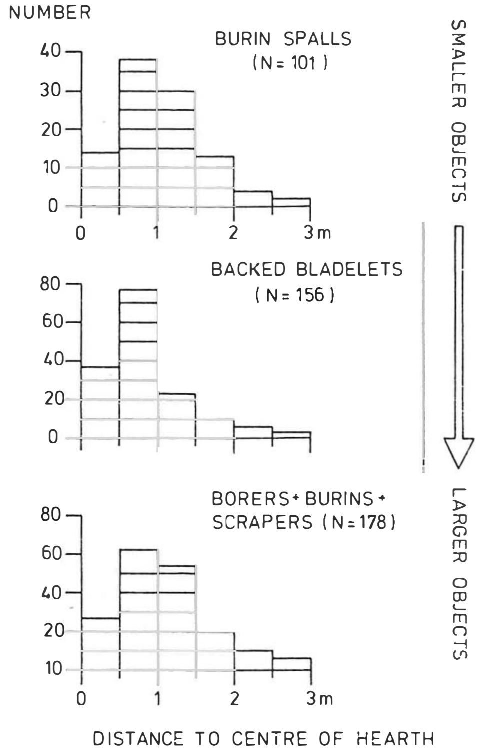

Fig. 20. Pincevent T112. Distances to the centre of the hearth for the same three categories of artefacts as in figure 19. In this case the difference between smaller and larger objects is far less marked than at Gönnersdorf IV (fig. 19). Figures 19 and 20 demonstrate that the centrifugal effect is much more pronounced within a tent (Gönnersdorf) than in the open air (Pincevent).

9. BIMODAL RING DISTRIBUTIONS: HEARTHS IN TENTS

Unfortunately, hardly any detailed plans are available of sites with convincing tent-rings, such as units U5 and W11 at Étiolles. Through the kind cooperation of Thomas Terberger (Mainz), I was given the opportunity to study the tent-ring of Gönnersdorf IV. A publication by Terberger is in press; for an illustration of the tent-ring see Bosinski (1981: *Abb.* 40). In this paper I intend to discuss Gönnersdorf IV in a general way, because of its importance for the development of my arguments; a more detailed presentation will be given elsewhere.

The tent-ring of Gönnersdorf IV is about 5 m in diameter. Apart from a hearth at the centre of the ring, there was a second hearth outside it, at a distance of about 3 m. Through stone-refitting, this hearth was shown to be associated with the tent; around it hardly any flints were recorded. The site is a small and 'specialized' one: backed bladelets especially occur in quantity. Other tools, apart from burins (and burin spalls), are present in very small numbers only. Within the tent-ring of Gönnersdorf IV no cores were found.

When the artefacts are divided into three size-classes (burin spalls, backed bladelets and other tools), then the centrifugal effect is found to be quite pronounced (fig. 19). The larger tools, such as burins, on average lie considerably farther from the hearth than the small burin spalls. At Pincevent and other 'unimodal' sites this pattern is far less evident (fig. 20).

When we look at the ring distribution of all tools together in Gönnersdorf IV, then its bimodal pattern is immediately apparent (fig. 21). The first peak lies at c. 1.0 m from the centre of the hearth; a second, higher one at c. 2.5 m. This second peak, as we have seen, is generated mainly by the larger tools (such as burins and scrapers), though backed bladelets also show this peak. It more or less coincides with the tent-ring of large stones.

The first peak can be interpreted as the drop zone near the hearth. It is made up especially of backed bladelets, with hardly any large tools. The first peak is also evident in the ring distribution of the burin spalls. In other words: only very small objects are

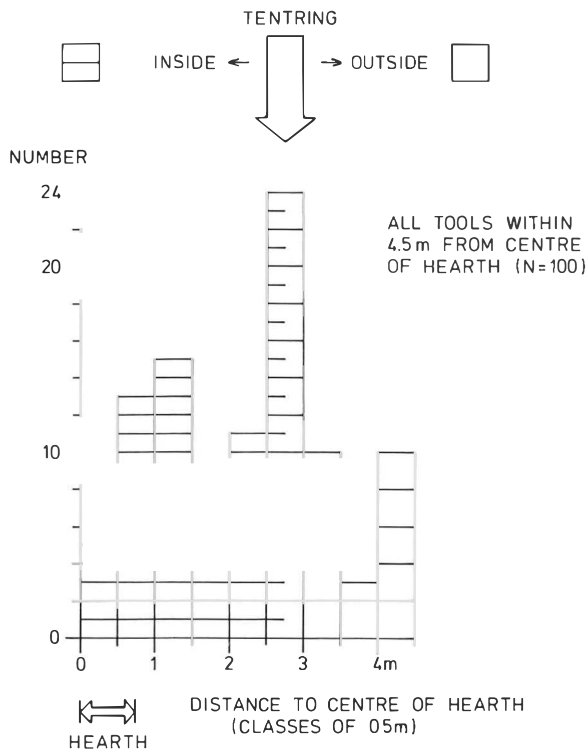

Fig. 21. Gönnersdorf IV. Distances of the tools (all types) to the centre of the hearth. The distribution clearly is bimodal, with the second peak higher than the first. The second peak approximately coincides with the tent-ring of large stones, which can be explained by the barrier effect (see text under 9). Compare this figure with the unimodal distributions of figures 15-17.

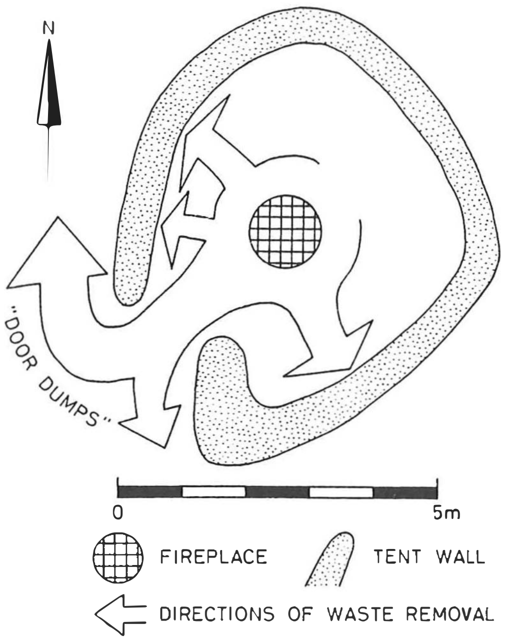

Fig. 22. Sketch of the tent of Gönnersdorf IV with a central hearth. Clearing the floor of larger objects meant that they accumulated against the tent wall as a result of the centrifugal and barrier effects, or were discarded through the entrance (in 'door dumps'). At the back of the tent (opposite the entrance) is an area poor in finds; this probably was the sleeping area.

left near the hearth, and the larger ones, including tools, are removed from the central parts of the tent.

In my opinion, the second peak results from the combined centrifugal and barrier effects. The results of the analysis can be summarized into a model as shown in figure 22.

Two important points emerge from investigating the tent-ring of Gönnersdorf IV:

1. *In a tent the centrifugal effect is stronger than it is around a hearth in the open air*. With 'unimodal' sites the centrifugal effect is evident especially in the position of the cores, which are found on average 0.5-1 m farther from the hearth than the tools (see section 14).

In a tent, clearing-out affected the smaller objects also. Though in Gönnersdorf IV a 'door dump' can be observed (several larger tools are found outside the presumed tent entrance), the second peak nevertheless must have been created largely by pieces that ended up near the tent wall during the period of occupation, as a result of the centrifugal effect. This is partly in contrast to the description by Binford of Nunamiut behaviour: "These distinctive dumps and toss zones would not occur inside a house, because people rarely throw waste materials against the walls of their home." (Binford, 1983: p. 157); "... the doughnut-shaped distribution of waste material is

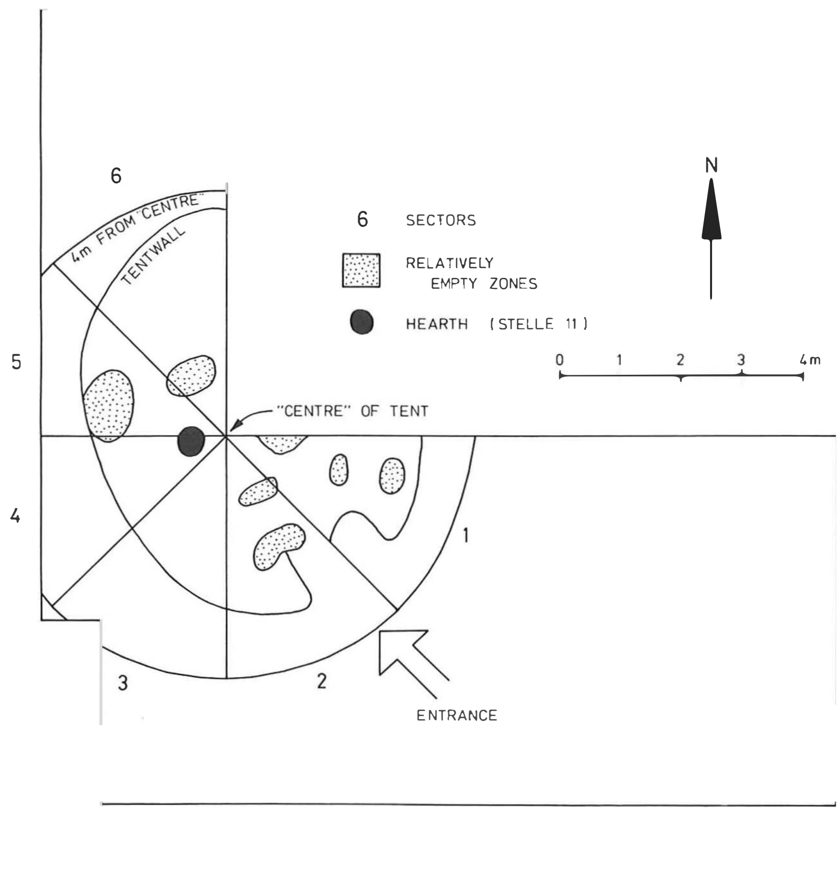

Fig. 23. Gönnersdorf I, schematic site plan (after Bosinski, 1979). The tent wall indicated in the drawing is the reconstruction by Bosinski, on the basis of postholes. For the application of the ring method an artificial point is taken as the 'centre'. Distances up to 4 m between artefact locations and this assumed centre are measured in six sectors separately. The ring distributions are bimodal in all sectors; that of sector 3 is presented in figure 26.

typical of activities which take place out-of-doors." (Binford, 1983: p. 158). We can note, however, that the second peak does not generally occur around the whole circumference of the tent, but is especially evident in the half where the entrance is located.

2. *The tent wall is made visible through the barrier effect*. In other words, my interpretation of the second peak is that the centrifugal movements occurring in a tent with a central hearth are 'stopped' by the tent wall, in due time resulting in a second peak in the ring distribution that roughly coincides with the tent wall.

Because within a tent the centrifugal effect was strong and also affected the smaller tools, the drop zone near the hearth can only be a remnant. Hence, relatively few tools will have remained at the spot where they were used, and this is the case especially with larger tools. In such cases there will not be much point in trying to distinguish local 'activity areas' through statistical analyses that assume all locations to have the same relevance.

The analysis of the tent-ring of Gönnersdorf IV seems to provide us with a method of demonstrating the presence of a tent with the help of the ring method. This would be very useful. It was decided to test the results for Gönnersdorf IV by analysing another site with an unambiguous dwelling structure. For this, Gönnersdorf I was selected: here the presence of a tent is evident from a circular arrangement of postholes (Bosinski, 1979). The outline of this structure is oval, not circular, and the hearth is not at the geometrical centre. Furthermore, about one quarter of the structure was destroyed prior to excavation. Therefore, an artificial point was selected as the 'centre' for the ring method, and the distances to this point were measured per sector so as to minimize the variation in distance between the assumed centre and the tent wall (see fig. 23). All artefact locations within 4 m from the assumed centre were used; these include tools and 'larger artefacts' as presented by Bosinski (1969).

Applying the method to Gönnersdorf I would give an impression of its reliability. For example, it is probable that several occupations took place, just as with the other large concentrations of Gönnersdorf (Stapert & Terberger, in press). Therefore, if the pattern should nevertheless prove to be the same as that observed at Gönnersdorf IV, we could be confident that the method is effective. The results of

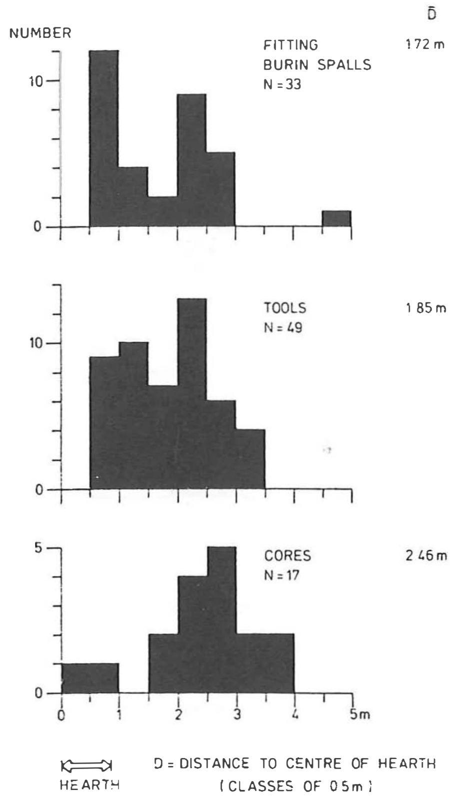

Fig. 25. Étiolles P15. Ring distributions of burin spalls (only those fitting to burins), tools and cores (data taken from Olive, 1988). Both the burin spalls and the tools show a bimodal pattern, with the second peak in the 2-2.5 m class, suggesting the presence of a tent wall at about 2.5 m from the hearth centre. The cores hardly occur in the central part of the tent, and show a single peak in the 2.5-3 m class. Compare with figure 19.

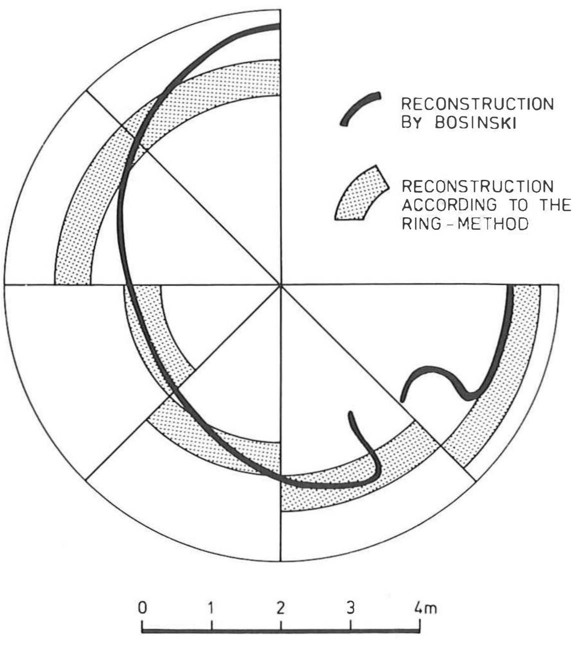

Fig. 24. Gönnersdorf I. A comparison of the reconstruction by Bosinski with that derived independently by means of the ring method. It can be seen that the two reconstructions of the tent wall are very similar.

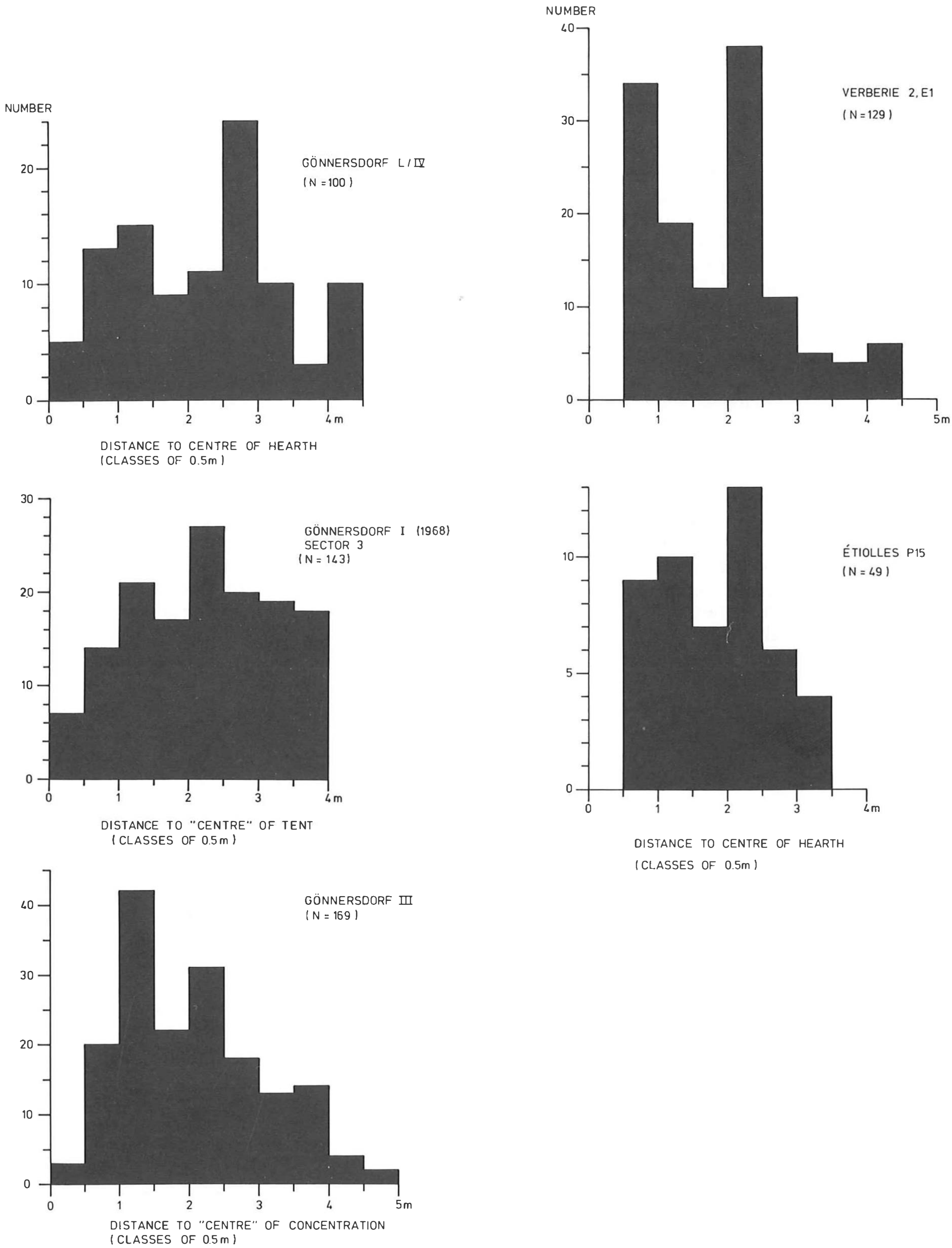

Fig. 26. Sites showing bimodal ring distributions for the tools. For Gönnersdorf I only the diagram of sector 3 is given (see fig. 23). In the case of Verberie D1 (= E1), the locations of the used implements mapped by Symens (1986) were used (backed bladelets are not included). Bimodal ring distributions such as these are thought to be characteristic of hearths inside dwelling structures.

this exercise will be published in detail elsewhere. Here only one of the produced ring diagrams is given, that of sector 3 (fig. 26). In all six sectors the tent wall as postulated by Bosinski was evident in the form of a second peak. The results are summarized in figure 24, in which Bosinski's reconstruction is contrasted with the tent wall as found independently by applying the ring method. It can be noted that the two reconstructions are quite similar. The ring method was also applied to Gönnersdorf III, and once again a clear bimodal distribution was found for at least one of the occupation phases (Stapert & Terberger, in press; see fig. 26).

With the knowledge gained from Gönnersdorf, it must now be possible to detect a tent even when it has left no direct archaeological trace, as, for example, in cases where the hides forming the tent wall were secured to the ground with loose earth instead of large stones. So far, two archaeologically 'invisible' tents have been identified in this manner: at Étiolles P15 (Olive, 1988) and Verberie 2-E1 (=D1) (Audouze et al., 1981; Symens, 1986), both Late Magdalenian sites in the Paris Basin. The ring distributions for tools from these sites (in the case of Verberie selected used implements, as mapped by Symens) are presented in figure 26. In these two cases we see exactly the same pattern as at Gönnersdorf. The second peak always lies at a distance of 2.0-2.5 m from the centre of the hearth. Although very few tools were present in Étiolles P15 (a total of 49), the bimodal pattern is very clear nonetheless, and this applies even to burin spalls (fig. 25). In Étiolles P15 a tent had been envisaged by Olive, though there were no direct archaeological traces.

In the case of Verberie, finding a bimodal distribution surprised me, because the site is in many respects similar to the habitation units of Pincevent (see also Audouze, 1987), where only unimodal distributions could be established. It should be noted, however, that the analysis of Verberie is not complete, since no distribution map of the backed bladelets was available. Therefore, the results for Verberie should be considered as provisional.

10. MODELS FOR HEARTHS IN THE OPEN AIR AND IN TENTS

We can now classify the investigated sites into two types: those with unimodal and those with bimodal frequency distributions of distances between tool locations and the hearth centres.

In the case of bimodal distributions we are dealing with hearths inside tents. We have to be careful, however, with simply assuming that the second mode coincides with the tent wall. This peak may continue a little beyond the position of the tent wall, because the door dumps lying just outside the entrance will have slightly extended the peak in an outward direction. Moreover, the second peak will not always be evident around the whole circumference of the former tent. Often in the tent-half opposite the entrance hardly any flints are encountered; here the sleeping area may have been. Therefore, if the number of tools is sufficiently high (which is often not the case), it may be rewarding to prepare ring distributions per sector.

Unimodal ring distributions will in general be characteristic of hearths in the open air. However, we should not be satisfied too soon in this case, because we have not yet discussed the possibility of hearths located in or near tent entrances. It is improbable that people should have placed their hearth in the tent entrance, because this would be rather unpractical. Moreover, if the hearth did occupy a position just within or at the entrance, we might expect a strong centrifugal effect in this much-trodden area, as with a hearth in the middle of a tent. The unimodal sites mentioned under 8, however, do not show such a strong centrifugal effect. It therefore seems reasonable to assume that in these cases the hearth was out in the open. Of course we then still do not know whether there was a tent on the site. There could have been one standing a few meters away from the hearth, as proposed by Julien et al. (1987). Unfortunately, there seems to be no way to prove or disprove this possibility.

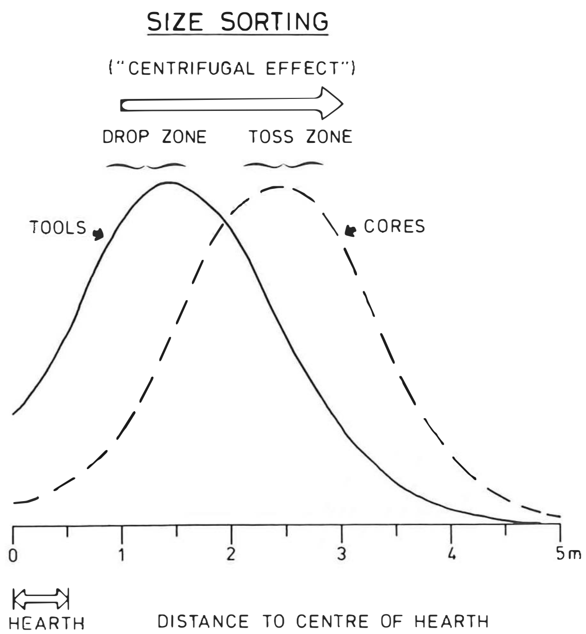

Fig. 27. Schematic representation of the centrifugal effect in sites with unimodal distributions of distances between tools and the hearth centre. Cores on average lie 0.5-1 m farther away from the hearth than the tools. Note: not all 'unimodal' sites show a clear centrifugal effect (see section 14). Compare with figure 28.

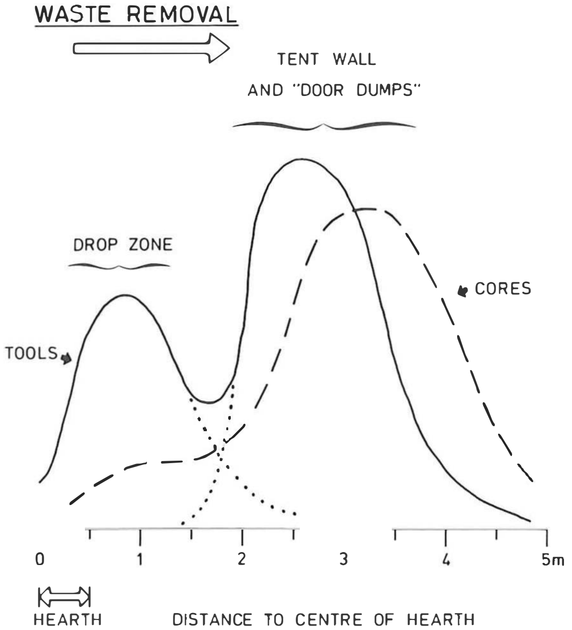

Fig. 28. Schematic representation of the centrifugal and barrier effects in sites with bimodal distributions of distances between tools and the hearth centre. The first peak is produced by objects in the drop zone around the hearth; the second, by objects that have accumulated against the tent wall as a result of both the centrifugal and barrier effects, as well as artefacts thrown out through the entrance. In 'bimodal' sites the centrifugal effect is always clearly recognizable.

The results of the ring method investigations can be conveniently represented in the form of models (figs 27 and 28).

These are of course 'idealized', and many departures from the models should be anticipated with individual sites. For example, not all sites with unimodal ring distributions show a clear centrifugal effect (see section 14). But on the whole these models seem to work adequately for most of the investigated sites. This suggests that the ring method is a useful analytical tool. The effectiveness of the method seems to be due to two factors especially:

1. It links up with ethnoarchaeological models, such as Binford's hearth model. Drop and toss zones can now be made visible, which is a prerequisite for meaningful spatial analysis. I shall return to this point in later sections.

2. The method is derived from the global structure of many Upper/Late Palaeolithic sites: a central hearth, which clearly was the focus of all sorts of activities, with refuse scattered around it.

Moreover, the method is simple, and above all, transparent: it contains no inherent assumptions of a statistical nature, which encumber many other approaches to spatial analysis. Nor are there any implicit archaeological assumptions, for example the naive idea that tools lie where they were used. Instead, the method makes it possible to detect various distortions of the original spatial 'organization' of the sites, such as the centrifugal effect.

So far, the ring method seems to make it possible to demonstrate whether hearths lie in the open or inside a tent. As we have seen, all habitation units of Pincevent produced unimodal ring distributions, which leads to the conclusion that the hearths of Pincevent were in the open air. Since in this paper I intend to summarize especially the results for Pincevent, I shall discuss only sites with unimodal ring distributions in the following sections. The spatial patterns associated with hearths inside tents are quite different from those at sites with open-air hearths, and will form the subject matter of another paper.

The conclusion that the hearths at Pincevent were in the open air does not exclude the possibility that windbreaks were present (see section 12).

11. TOOL TYPES AND RING DISTRIBUTIONS

In the above I mainly discussed ring distributions of all tools taken together. In this section I shall look at individual tool types. In the case of Pincevent the following tool classes were included in the analysis: backed bladelets, borers (*becs* and *perçoirs*), burins and scrapers.

In almost all cases backed bladelets are on average located closest to the hearths, and scrapers farthest away, while borers and burins are intermediate in this respect. This pattern is the normal one both in Niveau IV-2 and in Habitation 1. As examples from Niveau IV-2 the diagrams of V105, T112 and G121 are presented (figs 29-31). On average the scrapers in Pincevent are located more than 0.5 m farther from the hearths than backed bladelets. It is possible to express this difference as an index for each habitation unit: the ratio of mean D of the scrapers to mean D of the backed bladelets (D is distance to the centre of the hearth). For Niveau IV-2 this index is on average 1.45 (Standard Deviation 0.34): the scrapers are on average almost 1.5 times as far from the hearth as the backed bladelets.

There is only one unit in Niveau IV-2 that significantly deviates from this general pattern: R143 (fig. 32). Here backed bladelets are on average situated farthest away from the hearth, while burins, borers and scrapers are located relatively close to the hearth. In this case the above-mentioned index is clearly below 1: 0.76. R143 is also different from the other units in Niveau IV-2 in several other respects. For example, the proportion of backed bladelets is significantly lower than it is in all other units of Niveau IV-2, and that of scrapers significantly hig-

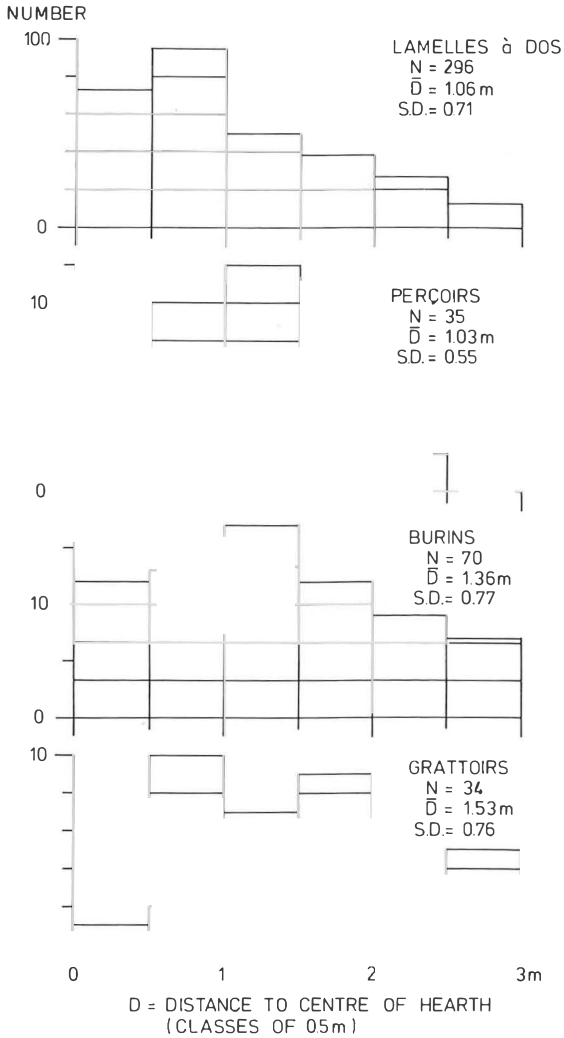

Fig. 29. Pincevent V105. Ring distributions of four tool types. Note that the distribution of the scrapers is slightly bimodal. Compare with figures 30-32.

her (see section 18). Therefore, R143 is thought to be a 'special-purpose site'; indications for hunting activities and food preparation are scarce here (see Julien et al., 1987), while hide-working seems to have taken place relatively often. Perhaps such special-purpose units were associated with 'ordinary' units in the vicinity (see Bodu & Julien, in press). Another possible example of such a unit is G64. (A recently excavated unit in Niveau IV-40, around hearth J116, also appeared to be characterized by hide-working as the dominant activity (Moss, 1987). However, analysis by means of the ring and sector method showed this unit to be comparable to the 'normal' units in Niveau IV-2 in many respects.)[2]

In Habitation 1 we see the same pattern as in Niveau IV-2, but in an 'exaggerated' form: here the index for the difference between backed bladelets and scrapers is on average 2.44. This difference is caused not so much by the scrapers being farther from the hearth in Habitation 1 than in the units of Niveau IV-2, but by the backed bladelets being closer to the hearth. Yet the trend is the same in Habitation 1 and Niveau IV-2, and the three hearths of Habitation 1 are remarkably similar. The indexes for Niveau IV-2 and Habitation 1 are presented in figure 33 in classes of 0.5.

The differences between the tool types with regard to their ring distributions are presented in a simple graphical way in figure 34. In this diagram the tool classes are ranked, for the individual habitation units, according to their relative distances to the hearths. Rank 1 is given to the tool class that is closest to the hearth, and rank 4 to the tool class that is farthest from the hearth. The first criterium for the ranking is the mode in the ring distributions. If modes are the same, ranking is achieved on the basis of differences in the mean distances to the hearth. The resulting diagram for all 11 analysed units of Pincevent (fig. 34) clearly shows the pattern descri-

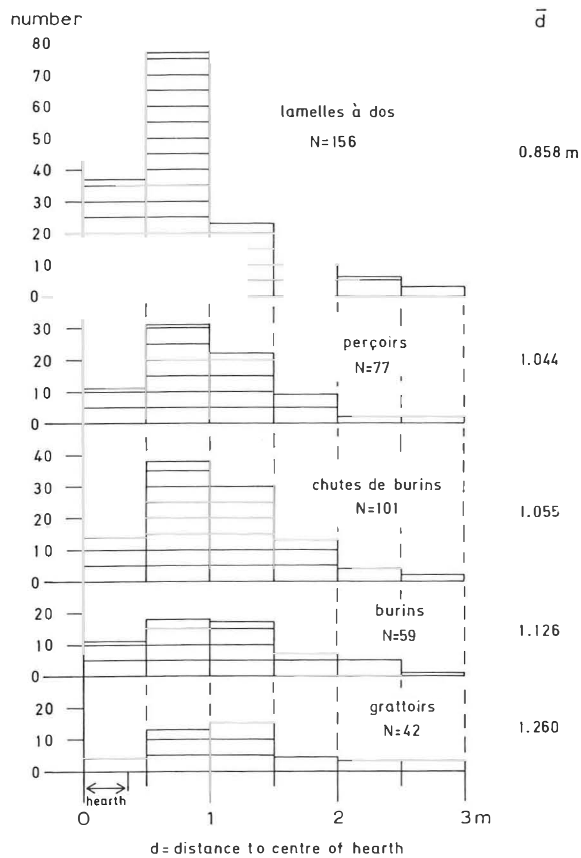

Fig. 30. Pincevent T112. Ring distributions of four tool types and of burin spalls.

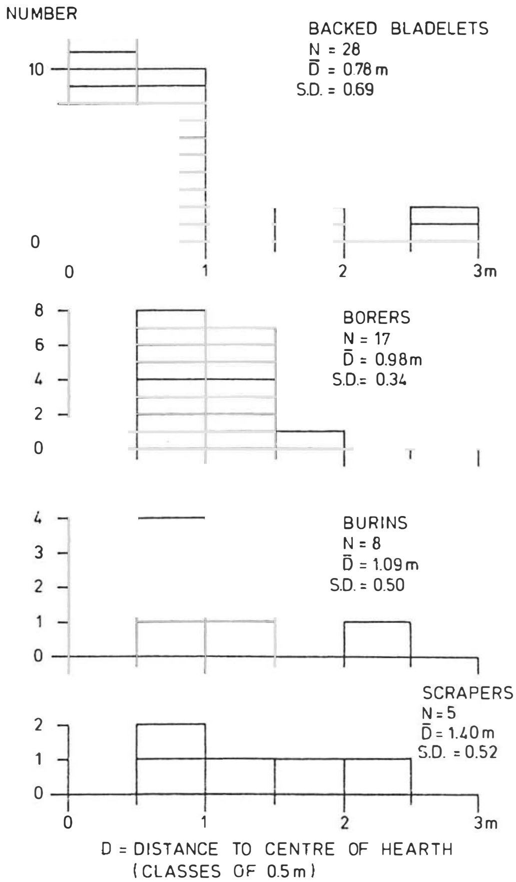

Fig. 31. Pincevent G121. Ring distributions of four tool types.

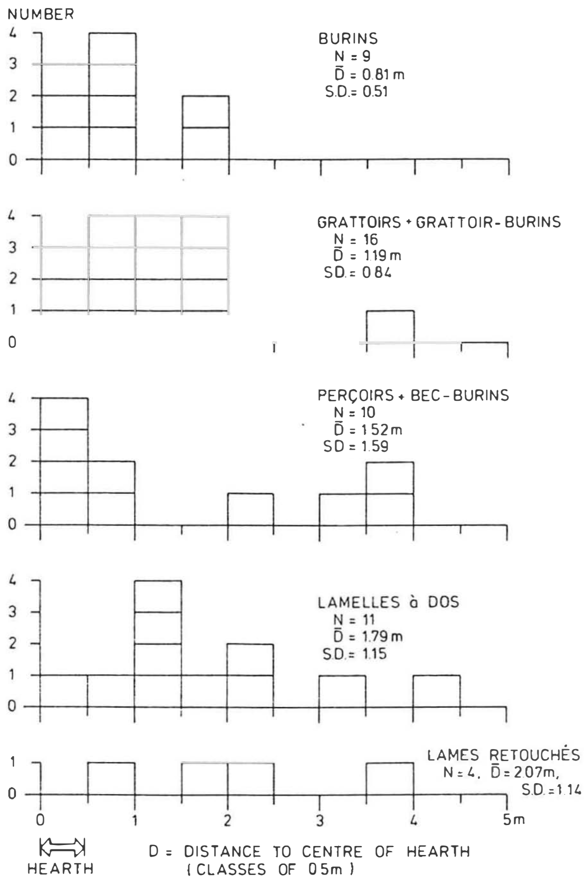

Fig. 32. Pincevent R143. Ring distributions of four types, and of retouched blades. This is the only unit of Pincevent in which backed bladelets are located farther away from the hearth than the other types (compare with figs 29-31).

bed above: with the exception of R143, backed bladelets are closest to the hearth and scrapers farthest away. (This is also the case with unit J116 in Niveau IV-40[2].)

In order to establish whether the differences between the various tool types are significant, tests can be performed for each separate unit. For example, in the case of T112 backed bladelets can be shown to be significantly different, in terms of their ring distribution, from burins and scrapers, by use of the Kolmogorov-Smirnow two-sample test (two-tailed p's smaller than 0.025). However, for several units this method does not work well, because the numbers of tools are too small. A simpler method is to perform a Fisher test on the data of the ranking diagram of figure 34. In doing this we are not looking at individual units, but at the general picture in Pincevent. The units having ranks 1 and 2 for each type class are combined, and also the units having ranks 3 and 4; then each pair of tool classes is compared. The results can be summarized as follows. Backed bladelets are significantly different from burins and scrapers, and both borers and burins are also significant-

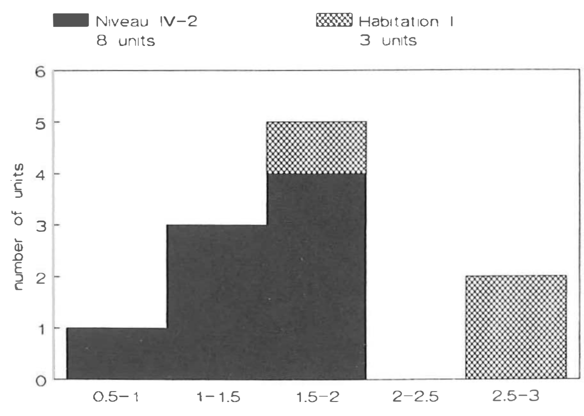

Fig. 33. Pincevent. Bar chart presenting the ratio of mean D of the scrapers / mean D of the backed bladelets (D is distance to the centre of the hearth), in classes of 0.5. R143 is the only unit with an index below 1. It can also be noted that in Habitation I the difference between backed bladelets and scrapers is more pronounced than in Niveau IV-2.

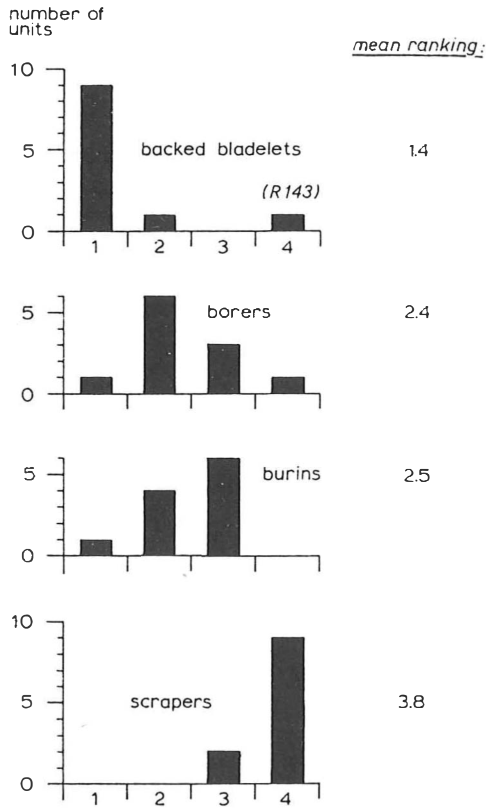

Fig. 34. Pincevent. Diagram in which four tool types are ranked according to their distance to the hearth centres. Rank 1 is given to the tool type that is closest to the hearth, and rank 4 to the tool type farthest away. The first criterium for the ranking are the modes in the ring distributions. If the mode is the same for several types, ranking is based on differences in the mean distances. The figure shows that backed bladelets almost always have rank 1, and scrapers rank 4, while borers and burins are intermediate. There is only one exception to this general pattern: in unit R143 backed bladelets are farthest away from the hearth.

ly different from scrapers. All in all, we can conclude that the observed pattern is a real one, and therefore is in need of an explanation. We should note, however, that exceptions exist, such as R143.

It can be concluded that for almost all units of Pincevent, the tool classes can be divided into three groups, regarding their ring distributions:

1. Close to the hearth: backed bladelets.
2. Intermediate: borers and burins.
3. Far from the hearth: scrapers.

The search for an explanation of this pattern seems to boil down to two questions:

a. Why are backed bladelets situated close to the hearth?

b. Why are scrapers situated far from the hearth?

Thanks to the existing analyses of use-wear traces on the tools of Pincevent (Moss & Newcomer, 1981; Moss, 1983a; 1986a; 1987; Plisson, 1985), it is possible to offer plausible explanations. Backed bladelets were almost exclusively used as insets (mostly as barbs) of projectiles, which in most cases would have been spears (Leroi-Gourhan, 1983). It is clear that many backed bladelets found near hearths are used specimens. It seems reasonable to suppose that the used bladelets were removed from their shafts and discarded near the hearth. New barbs, manufactured on the site, were placed in the same shafts. In this process of 'retooling' (Keeley, 1982), most probably some mastic was used that had to be heated in the fire, for example birch tar (Moss & Newcomer, 1981; Moss, 1983a). It is probably be-

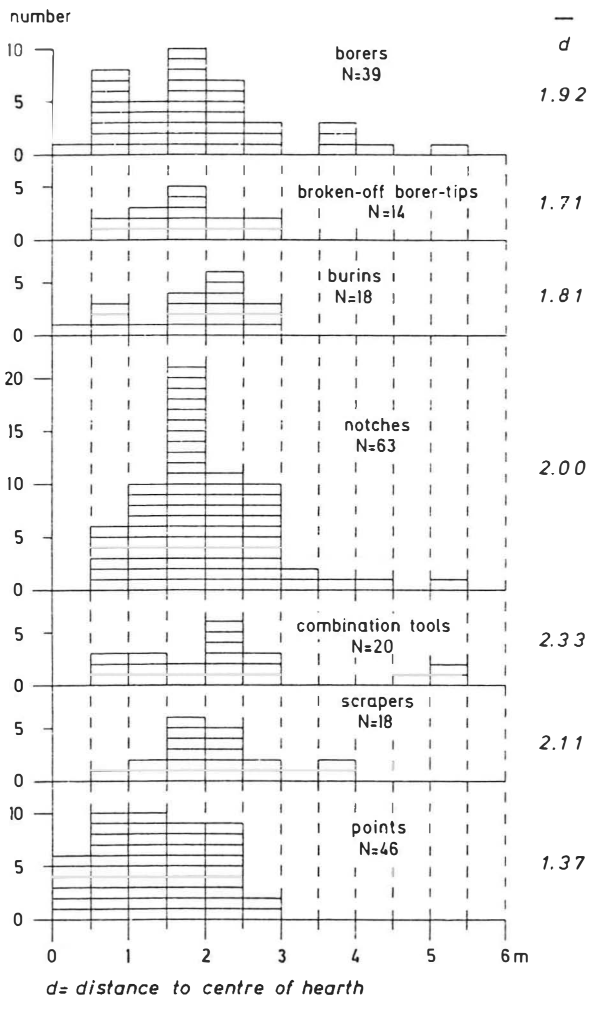

Fig. 35. Oldeholtwolde (Hamburgian, the Netherlands). Ring distributions for several tool types, and for broken-off borer-tips. Note that points (shouldered points, tanged points and a few Tjonger points) are closest to the hearth, and scrapers relatively far away. The combination tools are also located far away from the hearth; these are mostly combinations of a scraper with either a borer or a burin. Borers and burins are intermediate. This is the same pattern as found in most of the units at Pincevent.

cause of this process that used backed bladelets are generally found close to hearths. An ethnoarchaeological example of hafting work requiring the use of heat is given by Binford (1986; see also O'Connell, 1987).

In most cases the use-wear analyses of scrapers from Upper Palaeolithic sites indicate that they were used on hides (Keeley, 1978; Moss, 1983a; 1987; see also Cahen & Caspar, 1984; Juel Jensen, 1988), though other functions have also been demonstrated. Working hides often requires quite some space, implying that this task could not easily be carried out very close to the hearth, and this could be the main reason why scrapers are mostly found relatively far from the hearth.

Most tasks carried out by means of borers and burins evidently required neither fire nor a large amount of space, so that these tools tended to be used and discarded at intermediate distances from the hearth.

At several sites of the *Federmesser* tradition scrapers are found roughly equally close to the hearths as 'projectiles' (in this case points, not backed bladelets), for example at Niederbieber. Most scrapers at *Federmesser* sites are short flake scrapers, in contrast to Magdalenian or Hamburgian sites where scrapers are mostly made on relatively long blades. It is possible that the short *Federmesser* scrapers were used in a hafted state. In such cases the scrapers may have ended up close to the hearths for the same apparent reason that used points or backed bladelets did: they were removed from their shafts and replaced by newly-made ones. Therefore, in *Federmesser* sites it may well be that scraping hides was done at a distance, and that the scrapers were not discarded at the place where they were used. In other words: hafting habits are very important in this connection. I have assumed that when scrapers were made on long blades it was not necessary to shaft them. Therefore, in the case of Pincevent and other Magdalenian sites it seems reasonable to presume that most of the scrapers were discarded more or less at the place where they were used. Moss (1983a: pp. 132-133) found no unambiguous evidence for hafting on the blade scrapers of Pincevent. However, several scrapers of Oldeholtwolde may have been used in a hafted state (Moss, 1988: p. 402). It should be noted in this connection that hafting is notoriously difficult to establish (Juel Jensen, 1988).

In the diagram of unit V105 (fig. 29) it can be seen that the ring distribution of the scrapers shows several modes, in contrast to those of the other tool classes, which are unimodal. This phenomenon can be observed in several other sites too. This suggests that several types of hide-working may have existed. Probably some hide-working was small-scale and did not require very much space. Plisson (1985: p. 228) proposes that at hearth II of Habitation 1 such small-scale hide-working took place: perhaps the manufacture of clothes?

In the case of Pincevent we have seen that backed bladelets are mostly located close to hearths, and scrapers far away. I have explained this pattern by assuming that heat was needed in the retooling of 'projectiles', and relatively much space for hide-working. Because backed bladelets are much smaller than scrapers, an alternative explanation could be that this difference is due simply to the centrifugal effect. However, there are good reasons for believing that this latter explanation is not correct. Backed bladelets in Magdalenian sites were in most cases insets of spears. In Hamburgian sites backed bladelets hardly occur. Instead we encounter relatively many 'points', e.g. shouldered points, tanged points and Azilian points. From functional analyses we know that these points were also insets of projectiles (e.g. Fischer et al., 1984; Moss, 1988). Points and scrapers in Hamburgian sites are about equally large. Yet here we see the same pattern as in Pincevent. For example, in the Hamburgian site of Oldeholtwolde the points are on average located 0.74 m closer to the hearth than scrapers (fig. 35), and the same difference is found in many other non-Magdalenian sites, such as the small Creswellian site of Emmerhout (Stapert, 1985). Therefore, the difference between 'projectiles' and scrapers, regarding their ring distributions, cannot be attributed merely to the centrifugal effect.

Not all backed bladelets were used as insets of projectiles. For example, some show use-wear resulting from hide-working (Moss, 1983a; 1987). Returning to the anomalous picture in R143, it seems improbable that the (scarce) backed bladelets present in that unit were insets of projectiles, because in that case it is difficult to understand why they ended up so far from the hearth. Because scrapers at R143 are situated relatively close to the hearth (closer than at any other unit of Pincevent), it is possible that especially small-scale hide-working was done here. It would be interesting to have use-wear data on the implements from R143 (for a further discussion of R143, see sections 19 and 20).

As noted above, the pattern with scrapers located farther from the hearth than 'projectiles' is also observed at many other sites than Pincevent. If we look at four 'unimodal' sites where scrapers were mostly made on blades (Oldeholtwolde, Olbrachcice 8 East, Bro I, Marsangy N19), it is found to be present in three of these. The exception is Marsangy N19, where on average backed bladelets (and points) are located somewhat farther from the hearth than scrapers (fig. 36). Borers are located closest to the hearth. Schmider (1988) has drawn attention to the fact that *becs* played an important role in Marsangy N19. (They also occur in quite high proportions in Habitation 1, but are relatively scarce in Section 36

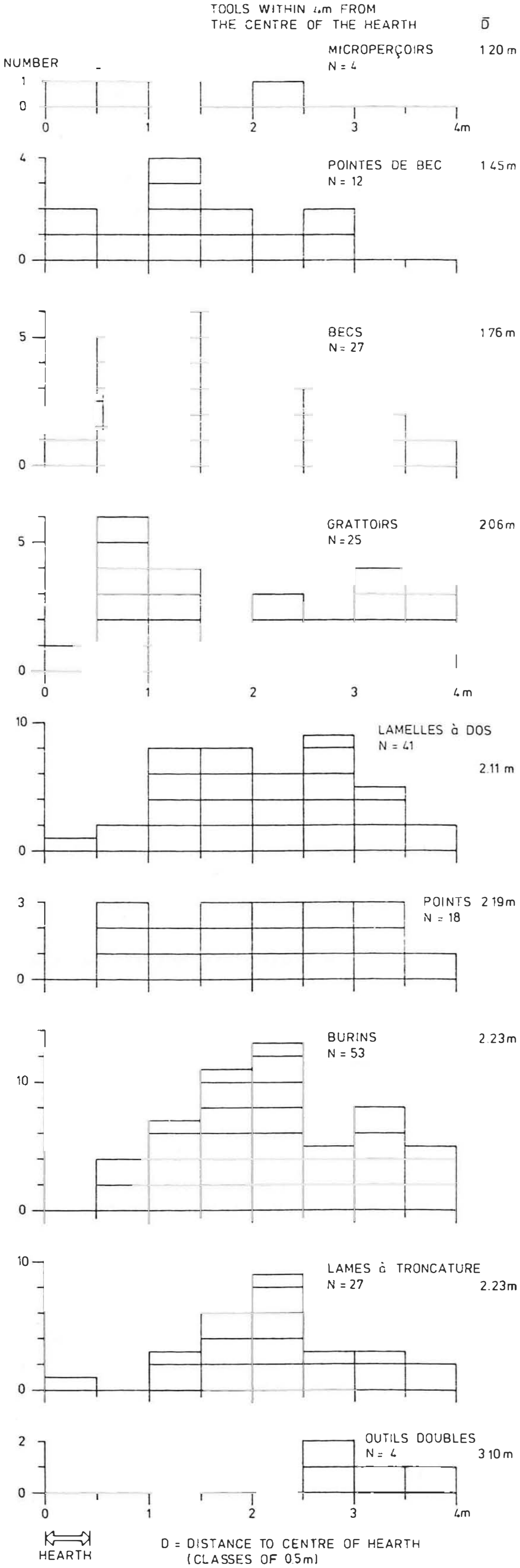

Fig. 36. Marsangy N19. Ring distributions for individual tool types. Borers (*becs* and *microperçoirs*) are situated closest to the hearth, while 'projectiles' (backed bladelets and points) are relatively far from the hearth. As at several other sites, the ring distribution of the scrapers has a bimodal character: some scrapers are located very close to the hearth, others far away.

of Niveau IV-2.) Perhaps Marsangy N19 was a 'special-purpose site' where specialized technical work was done. Julien et al. (1988) suggest that it may have been associated with 'normal' family camps nearby (D14 and H17, which were not analysed with the ring and sector method).

12. DROP ZONES: THE RICHEST SITE-HALVES

In many publications of Late Palaeolithic sites density maps are presented, summarizing, for example, the numbers of flints per square metre, or per $^1/_4$ square metre (e.g. Cziesla, 1989; Kind, 1983; 1985). Although such maps may be useful, they can also be misleading. It is certainly incorrect to assume that high densities are necessarily correlated with prehistoric activity areas. We have already noted the existence of dumps. A more serious problem is the fact that many sites show a tendency towards spatial segregation of tools and flint waste (see also section 15). This means that if all flints are mapped together, it could well be that the zones with relatively low densities are in fact former activity areas, and not the parts with the highest densities. Therefore, it is advisable to prepare density maps for tools and flint waste separately.

If we look at distribution maps of tools only, almost all the sites of the kind discussed in this paper (artefact concentrations around central hearths) show a marked asymmetry, in the sense that many more tools are found on one side of the hearth than on the opposite side.

This asymmetry in tool density may have several causes. For example, at sites where a central hearth is inside a tent, there often is a relatively empty zone opposite the entrance; here the sleeping area may have been located.

If artefact concentrations around hearths were created in the open air, as is the case at Pincevent, the existence of a prevailing wind direction during occupation is a possible explanation. This hypothesis will be discussed further in section 13.

In this section I shall attempt to quantify this asymmetry, and to establish that this density pattern is significant and could not have been produced by chance. In order to investigate this, the concentrations are divided into two halves so as to maximize the difference between the numbers of tools in the two halves. In other words, we seek three or four adjacent sectors (depending on whether a total number of six or eight sectors are employed) that have a higher total of tools than all other combinations of three or four adjacent sectors. Of course, since the sector boundaries are fixed, this way of quantifying the asymmetry in tool density results in minimum estimates. Throughout the remainder of this paper, the site-half with the highest total number of tools is called the 'richest site-half' or 'R', and the other half the 'poorest site-half' or 'P'. The asymmetry can be quantified easily by calculating what percentage of the total number of tools is present in R.

For the 11 analysed units of Pincevent (Niveau IV-2 and Habitation 1) the mean percentage of tools in R is 73.7% (Standard Deviation 8.6). This means that on average about three quarters of the tools belong in one site-half.

In Niveau IV-2 the mean percentage in R is 72.6%, the range being 61.1% (V105) - 90.5% (L115). In Habitation 1 the mean percentage in R is somewhat higher: 76.9%, the range being 70.8% (II) - 82.7% (III).

Before attempting to explain this density asym-

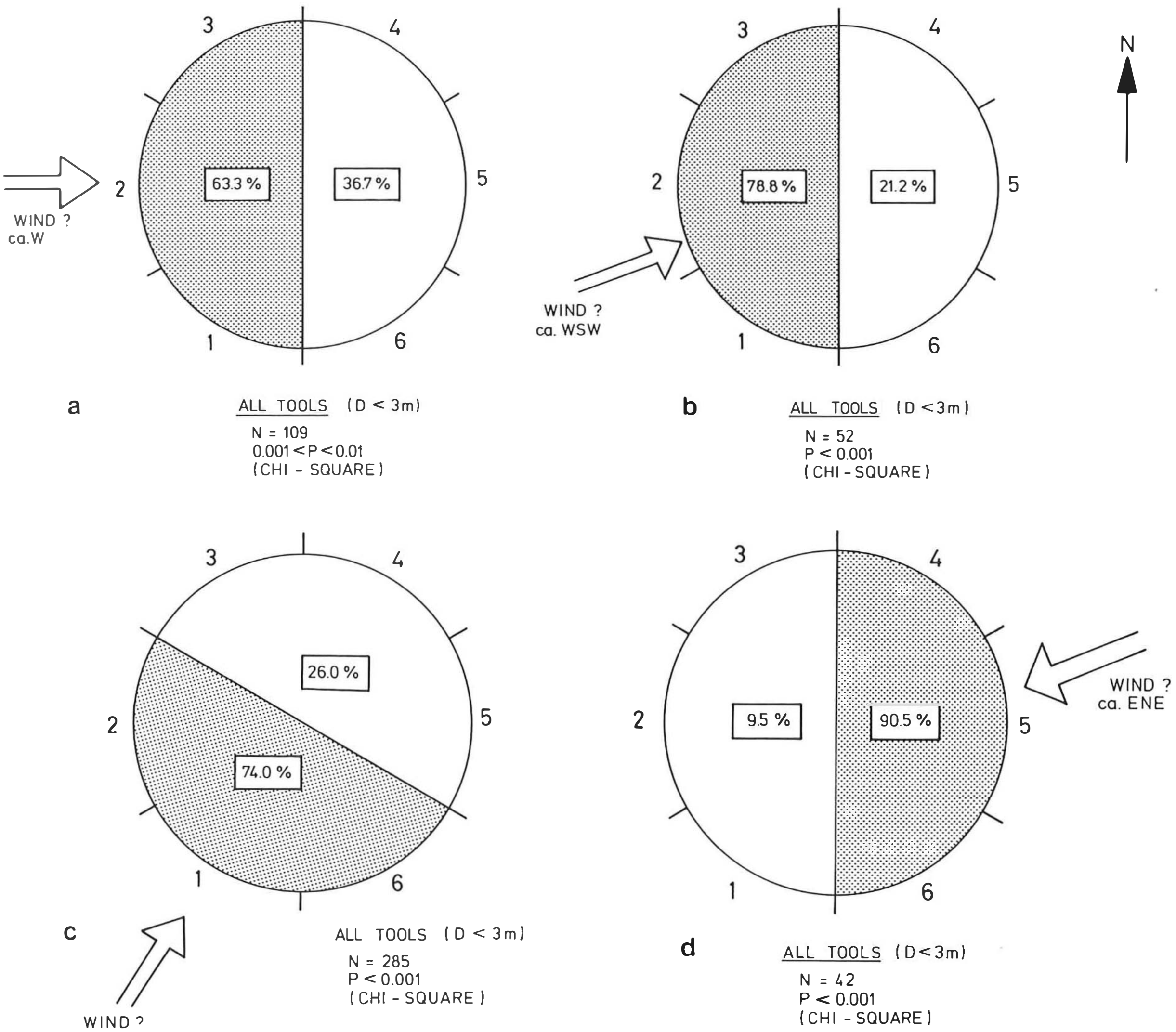

Fig. 37. Pincevent. Reconstructions of the prevailing wind direction during habitation, for four units in Niveau IV-2: a. E74; b. G115; c. M89; d. L115. The units are divided into halves so as to maximize the difference between the numbers of tools in the two halves. The percentages of N tools in the two halves are indicated in the figure. In most cases the wind arrow is placed in the middle of the richest site-half, but if the tools are markedly concentrated in one part of it, the arrow is shifted in that direction. The difference between the frequencies in the two site-halves is tested by the chi-square one-sample test (Siegel, 1956), and the probability that this difference could have arisen by chance is given for each unit (two-tailed p's).

metry, it is necessary to investigate whether the difference between the tool frequencies in the two site-halves could have arisen by chance. It is usual to use the chi-square one-sample test in such cases (Siegel, 1956: pp. 42-47). This test was applied to all eleven units of Pincevent separately, and in all cases the difference proved to be significant (two-tailed p's vary between <0.001 and 0.02; for examples see fig. 37). Therefore, we may conclude that the asymmetry is real, and hence in need of an explanation. The same goes for five other analysed 'unimodal' sites in Europe: Oldeholtwolde (percentage of N tools in R: 61.8%), Niederbieber I (60.6%) and IV (59.2%), Bro I (66.7%), and Marsangy N19 (67.3%); in the case of Olbrachcice 8 East (55.3%) the difference is not significant (0.1 <p (two-tailed) <0.2).

As explained earlier, it is probable that the habitation units of Pincevent were all encampments in the open air. This means that people would have sat mainly on one side of the hearth – to windward, in order to avoid the smoke. The next question to investigate is therefore: was the occupied side of the hearth located in the richest site-half, or in the poorest? In other words: is the drop zone in the site-half with the highest tool density, or in the opposite half? This is not a trivial question, because we cannot know *a priori* where most of the tools were eventually discarded: in the forward toss zone, or in the drop zone and the backward toss zone.

The observations by Leroi-Gourhan concerning the spatial patterns in Section 36 (Niveau IV-2) at Pincevent (Leroi-Gourhan & Brézillon, 1972: 247-250) provide an unambiguous answer to this question: the drop zone was located in the richest site-half. His model defines the following zones:

A. The central hearth;

B. The central activity area around the hearth, which is divided into two parts:

B1. The 'inner' activity area located at the side of the hearth where tools and ochre are abundant – but flint waste, hearth stones, bones etc. rare –, and

B2. The 'outer' activity area on the opposite side of the hearth, where tools and ochre are less abundant, and which, on the same side of the hearth but with increasing distance, merges into

D-G. The 'clearing up area', where fragmented hearth stones, bones and flint waste were discarded;

C. A relatively empty zone behind B1 – on the same side of the hearth but further away – where the sleeping area could have been located (within a tent, according to Leroi-Gourhan).

Note that this model describes a pattern of spatial segregation of tools and flint waste: on one side of the hearth many tools are present and not much waste, on the opposite side the reverse is true.

Apart from the postulation of a tent, the model of Leroi-Gourhan can be fitted almost completely to Binford's hearth model (1983). The following correlation between the two models can be proposed:

Leroi-Gourhan	Binford
B1 and C	drop zone and backward toss zone
B2 and D-G	forward toss zone

This correlation leads to the conclusion that the drop zone, i.e. the side of the hearth where people were sitting and working, is located in the 'richest site-half' as defined above, and the forward toss zone in the 'poorest site-half'. In the next sections I shall present more evidence to support this hypothesis.

One difference between the two models is the assumption by Leroi-Gourhan of an activity area close to the hearth in the poorest site-half (B2), while in Binford's model this is part of the forward toss zone. As explained in section 7, this difference may be nothing more than a reflection of a difference in time depth. If one looks at the flint distribution maps of e.g. Habitation 1 (Leroi-Gourhan & Brézillon, 1966), the occurrence of a neat circle of flint artefacts all around the hearths, at a distance of 0.5-1 m from the hearth centres, is striking. This phenomenon seems to indicate that the drop zone was located in different parts around the hearth at different times during occupation (see also section 15, and fig. 64). As we shall see in the next section, this probably implies that wind directions changed repeatedly during occupation, prompting the people to rotate around the hearth. This does not alter the fact that there is a clear asymmetry in tool density. Hence, though wind directions changed several times, there was nevertheless a prevailing wind direction, leading in due time to the observed density asymmetry.

13. WIND DIRECTIONS

If the conclusions reached above are correct, viz. that the hearths of Pincevent were in the open air, and that the drop zone was mostly contained in the richest site-half, it should be possible to reconstruct the prevailing wind directions during the various occupations.

First, however, I want to test these hypotheses, by investigating one of their implications. If sites had a prolonged habitation, the chance that wind directions changed several times is greater than if the period of occupation was very short. People will have rotated around the hearth as a response to changes in wind direction. This means that the strength of the density asymmetry discussed above can be expected to vary according to the length of the occupation: the longer the period of occupation, the weaker the asymmetry. Unfortunately, it is difficult to estimate the duration of occupation. One very rough relative measure is the total number of tools

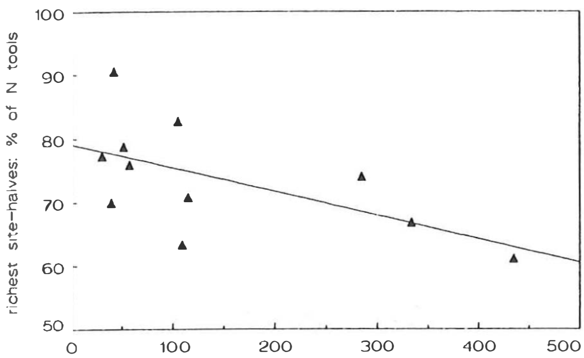

Fig. 38. Pincevent. Scatter diagram, in which for all eleven units (Niveau IV-2 and Habitation 1) the total number of tools (within 3 m from the hearth centres) is plotted against the density asymmetry (expressed as the percentage of N tools that is found in the richest site-half). The regression is based on least squares, and it can be seen that a significant negative correlation exists between these two variables (rho = -0.61, two-tailed p = 0.045). See section 13.

per habitation unit. However, this number is not only dependent on the length of the occupation, but also on the number of people. Because in the ring distributions for the tools at Pincevent the mode is invariably found in the 0.5-1 m ring, and also because these diagrams are remarkably homogeneous (see figs 16 and 17), I have the impression that the variation in the number of adults was small. Therefore, it seems legitimate to use the total number of tools as a rough indicator of the relative duration of the occupation.

We would therefore expect a negative correlation to exist between the total number of tools and the strength of the density asymmetry. This is indeed the case. In figure 38 I have plotted the asymmetry (in terms of the percentage of tools present in R) against total tool numbers, for all eleven units at Pincevent. Rho = -0.61 (rho = Spearman's rank correlation coefficient: see Siegel, 1956), and the correlation is significant (two-tailed p = 0.045). Thus my hypotheses passed a test aimed at falsifying them, by way of investigating a deduction (Popper, 1963; yet this does not necessarily imply that the hypotheses are true).

It also seems worthwile to 'test' the results for Pincevent in another way. In this and following sections I shall compare the patterns found at Pincevent with those revealed by the six other analysed 'unimodal' sites in Europe (see section 8). Though the sample is very small, again a negative correlation is found between density asymmetry and total tool numbers (rho = -0.43), but in this case it is not significant. However, the trend is the same; if a positive correlation would have shown up, we might legitimately question the correctness of the hypotheses.

On the basis of the above considerations, I have reconstructed the prevailing wind directions during the occupations at Pincevent. (For some examples see figure 37. In most cases the wind arrow can be placed at the middle of the richest site-halves. If, however, in one quarter within R many more tools occur than in the other quarter, the arrow is shifted in that direction.)

The results for Niveau IV-2 are summarized in two different ways:

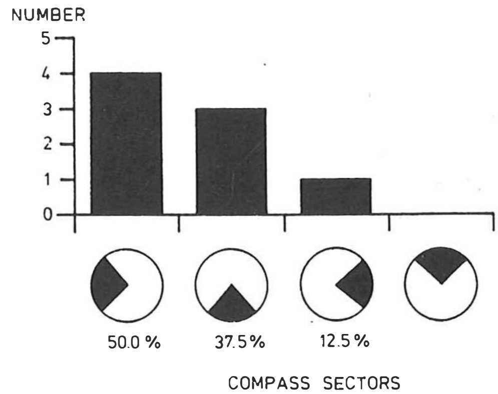

Fig. 39. Pincevent, Niveau IV-2. Bar chart indicating the reconstructed prevailing wind directions during habitation for eight units, divided into 4 compass quarters. It can be seen that westerly winds prevailed.

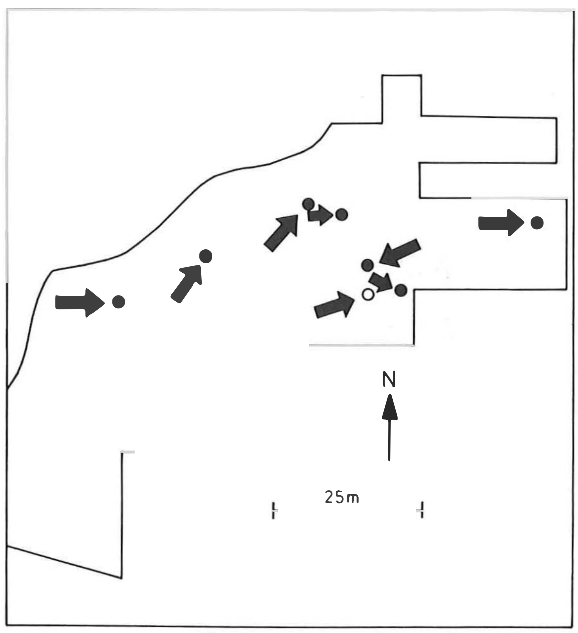

Fig. 40. Pincevent, Niveau IV-2. Map, showing the reconstructed prevailing wind directions for the eight analysed units. The only unit showing an easterly wind is L115.

1. The numbers of units per compass quarter are presented in a bar chart: figure 39. It can be seen that westerly winds predominated. One unit, however, probably was occupied during an easterly wind: L115. Two units show southerly or southwesterly winds: V105 and M89.

2. The reconstructed prevailing winds are indicated in a plan: figure 40.

One aspect of these results relates to the question of contemporaneity of the various units. If two units show very different reconstructed wind directions, it is improbable that they were occupied simultaneously (however, this does not exclude contemporaneity in a broader sense: see below). For example, L115 probably was not occupied at exactly the same time as the nearby units G115 or G121.

The reconstructed prevailing wind directions for eight other 'unimodal' sites in Europe are presented in figure 41. These include six Upper/Late Palaeolithic sites, and two units (8 and 13) of the Mesolithic site of Duvensee (Bokelmann, 1981; 1985). (For Niederbieber, only the reconstructed wind direction for unit IV (= 50/14-56/20) is included (SSW). Meanwhile, the wind direction for unit I has also been established: ENE. This outcome makes it improbable that these two units were occupied simultaneously.)

The results for these eight sites are very similar to those obtained for Niveau IV-2 in Pincevent: predominantly westerly winds, quite a lot of southerly winds, some easterlies, no northerlies.

This picture is more or less the same as that of the present. As an example, the winds occurring at Groningen (northern part of the Netherlands) are presented in figure 42 (based on *Atlas van Nederland*, 1963-1977). This diagram shows the same trend as found for the analysed Palaeolithic and Mesolithic

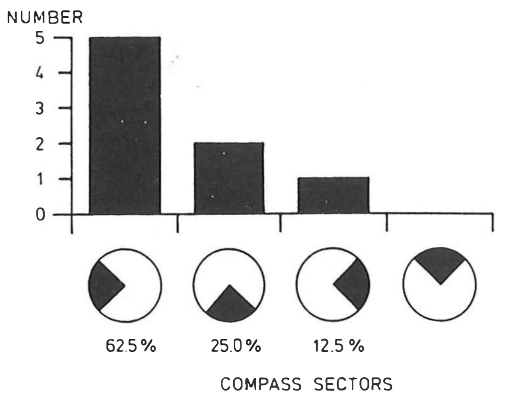

Fig. 41. Bar chart, showing the reconstructed prevailing wind directions for eight other 'unimodal' sites in northern Europe, dating from the Upper/Late Palaeolithic and the Early Mesolithic. The same picture as for Niveau IV-2 in Pincevent is obtained.

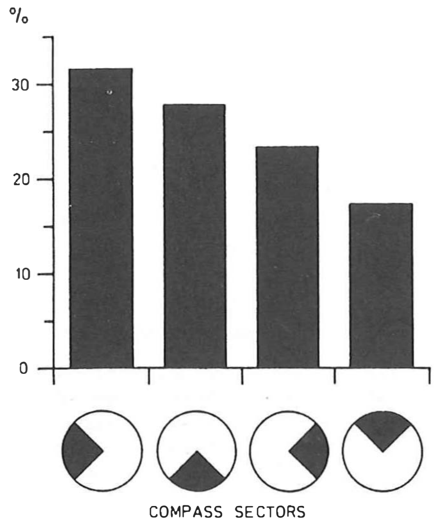

Fig. 42. Wind directions near Groningen (northern Netherlands), averaged over a 30-year period in the 20th century. The same trend as found both in Niveau IV-2 and for eight other unimodal sites in Europe is repeated: westerly winds predominate, and northerly winds are the least frequent.

sites. At Paris too, westerly winds predominate nowadays, except during the spring when northerly and easterly winds prevail (Arléry, 1970). Again: this does not prove that my hypotheses are correct, but it does suggest that they could be true. Another point to note is that geological observations also indicate that westerly winds predominated during the Late Glacial (e.g. Maarleveld, 1960).

The sample for Habitation 1 is very small: three units. Moreover, as we have remarked, the sector analysis is hampered here by the fact that the three hearths are very close together. Nevertheless, in all three cases the asymmetry in tool density is significant in a statistical sense. The reconstructed prevailing wind directions are indicated in a map (fig. 43). Units I and II show winds from the SSW, while unit III probably was occupied during a wind from the NNE. (My reconstructed prevailing wind directions for units II and III are roughly the same as those suggested by Binford, 1983: see fig. 5.) This makes it improbable that unit III was occupied simultaneously with either one or both of the two other units. Moreover, it also seems unprobable that units I and II were in use at the same time, though their reconstructed wind directions are the same: the people sitting at hearth I would have been bothered by the smoke from hearth II. Thus, these results seem to suggest that none of the hearths of Habitation 1 were in use simultaneously with any of the others.

This is in sharp contrast with the ideas of Leroi-Gourhan & Brézillon (1966). Contemporaneity is suggested especially by the occurrence of refitted

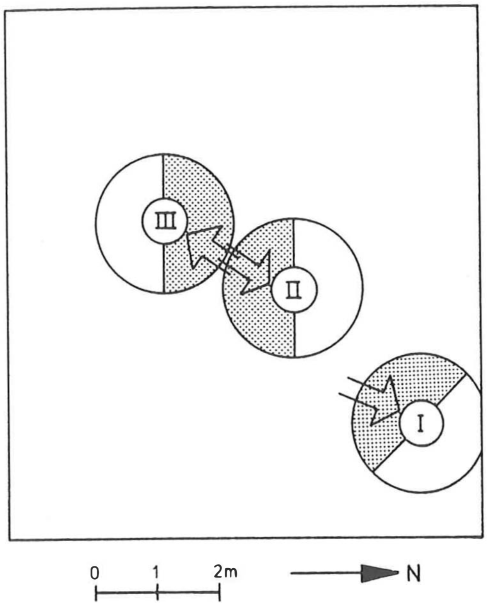

Fig. 43. Pincevent, Habitation 1. Reconstructed prevailing wind directions.

flints connecting the three units, see e.g. figure 44: burin spalls fitting to burins. There are many more instances of refitting indicating contemporaneity, and especially the occurrence of bidirectional refitting linkages between units is a strong argument in such cases. For example, Karlin (in: Cahen et al., 1980) described some results of refitting with the material of Habitation 1. One core was prepared near hearth III; most of the resulting flint waste was later dumped at a spot 3-4 m to the SE of this hearth. Then the prepared core was transported to hearth II, where a series of blades were produced. Both stages in the work were probably done by the same knapper. Another core was also worked at both of these hearths, in several stages. But in this case a renewed preparation and exploitation of the core was probably undertaken by a second flint knapper (Karlin, pers. comm., 1990). These results suggest that the three hearths of Habitation 1 were simultaneously used by a single group of people. Bidirectional refitting linkages also exist between many units in Niveau IV-2 (Bodu et al., 1990; C. Karlin & P. Bodu, pers. comm., 1990), and these cannot be explained away by flint scavenging only.

Thus, the results of the refitting analysis quite convincingly point to contemporaneity of the three hearths of Habitation 1 (and also to contemporaneity of many of the units in Niveau IV-2). Moreover, the three units of Habitation 1 are very similar to one another in many ways (though some functional differences may exist: Plisson, 1985), suggesting that they could easily have been produced by the same group of people. The residues of the three units are in the same stratigraphical level, so in any case there cannot have been much time separating the three hearths.

Thus, we are confronted with two seemingly opposed outcomes. If we accept the evidence that there was no dwelling structure covering the three hearths, my analysis points to different prevailing wind directions at hearths II and III, indicating that at any rate these two hearths were not in use at exactly the same time, while the results of the refitting analysis indicate contemporaneity of all three hearths. If one does not want to dismiss one of these outcomes, they should be combined. This seems possible if two different kinds of contemporaneity are distinguished:

a. *Alternating contemporaneity*. A single group of people using several hearths, alternately, during one period of occupation.

b. *Collateral contemporaneity*. Different groups of people using different hearths during one occupation period. In this case the occupation periods for different hearths need at least partly to overlap in time.

The issue is further complicated by the circumstance that the demonstration of a prevailing wind direction does not exclude the possibility that during times with other wind directions the same hearth was also used, as noted in section 7.

In my opinion, the hypothesis of alternating contemporaneity, as defined above, would be the most

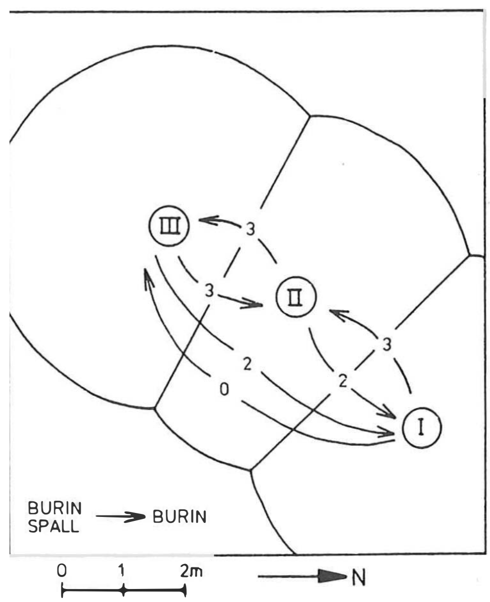

Fig. 44. Pincevent, Habitation 1. Refittings of burin spalls and burins in the cases where the linkages cross inter-unit boundaries. Figures refer to number of cases (data taken from Leroi-Gourhan & Brézillon, 1966).

likely one in the case of Habitation 1. There are many examples in the ethnographical literature of a group of people using several hearths in the course of a single period of occupation. One ethnoarchaeologically documented case is the Mask site described by Binford (1978).

For the many units in Niveau IV-2, where not only *foyers domestiques* but also 'satellite hearths' occur, it seems that both types of contemporaneity would have occurred. It is probable that at any rate the larger find concentrations, around *foyers domestiques*, were occupied by different groups of people, partly or completely during the same period, but at any rate overlapping in time. Several smaller concentrations, especially near satellite hearths, may be examples of alternating contemporaneity. For example, there is one satellite hearth in Niveau IV-2 where, apart from some bones, eight flakes were found, deriving from several different cores which were worked near three *foyers domestiques* (T112, G115, G121). (This example is quoted by S. Ploux (1989), based on work by C. Karlin and P. Bodu.) This clearly means that the three *foyers domestiques* were at some moment in use simultaneously, and people coming from all three had a meeting at the satellite hearth. In other words: the three *foyers domestiques* show a collateral contemporaneity, and the satellite hearth shows an alternating contemporaneity with all three *foyers domestiques*.

At the end of this section I would like to consider the possible existence of windbreaks. Leroi-Gourhan's suggestion that the sleeping area was located in the relatively empty zone (C) behind the drop zone seems plausible, but it is unprobable that it was inside a tent. A much-cited phenomenon, pointing to the existence of a wall of some kind, is the fact that the flint discard scatter of unit V105 seems to avoid zone C of unit T112 (Leroi-Gourhan & Brézillon, 1972: e.g. figure 60; however, this is less clear in the distribution of the bones: fig. 76). Thus, a windbreak could have been located at the back of zone C, at a distance of about 3.5 m from the hearth centre. Since there are hardly any flints in zone C, this wall cannot be demonstrated by the ring method.

14. BACKWARD TOSS ZONES: THE CENTRIFUGAL EFFECT

Most cores occurring in Late Palaeolithic sites are used-up cores, and only a few seem to be still exploitable. I have already noted (in section 7) that the few still usable cores tend to be present in the central parts of sites. This reflects the situation most commonly found: viz. that flintworking was done close to the hearth. There are exceptions to this rule, however, the most notable one being Marsangy N19 (Julien et al., 1988; Schmider, 1984).

As a large proportion of the cores are residual ones, we may expect that these will dominate the picture when we look at the spatial patterns of all cores taken together. Because even residual cores are quite large, and globular in form (not thin and flat, as blades are), we could hypothesize that cores were more apt to be cleared away than tools. The presence of large and irregularly formed flints in the central activity area, where many daily activities took place, must have been regarded as a nuisance. Getting rid of unwanted objects could have been achieved in two different ways: removing them to the periphery of the site, or throwing them to the unoccupied side of the hearth. In terms of Binford's hearth model these two possibilities can be rephrased as:

a. Removing them to the backward toss zone.
b. Removing them to the forward toss zone.

The first tactic would manifest itself in what we have called the centrifugal effect: the tendency for larger objects to end up farther from the hearth than small pieces. This phenomenon can be investigated by means of the ring method, and will be discussed in this section.

The second tactic would result in another type of spatial segregation of larger and smaller objects, which can be investigated by means of the sector method. This will be discussed in the next section.

The centrifugal effect should show up in ring frequency distributions if we divide the artefacts into size-classes. For this purpose I have divided the artefacts into three groups: burin spalls, tools (all types taken together) and cores. Because backed bladelets are the best represented tool class at Pincevent, and are very small (on average even smaller than burin spalls), we may anticipate that burin spalls and tools will not show much difference in this respect. Therefore, if the centrifugal effect should have been operative, we would expect it to be evident especially from the difference between cores on the one hand, and tools or burin spalls on the other. To demonstrate the centrifugal effect, I have prepared bar charts for the three groups, showing artefact frequencies in rings 0.5 m wide, and have mounted them one above the other for comparison.

All eight analysed units of Niveau IV-2 show a clear centrifugal effect. As examples, the diagrams for T112, V105 and G121 are presented in figures 45-47. It can clearly be seen that cores are on average much farther away from the hearths than tools. The difference between the mean distances of tools and cores for the units of Niveau IV-2 ranges from 0.49 m (T112) to 1.38 m (R143). The average difference is 0.91 m (Standard Deviation 0.26).

The centrifugal effect can be summarized as a simple index: the ratio of the mean distance to the hearth centre of the cores to that of the tools. If the

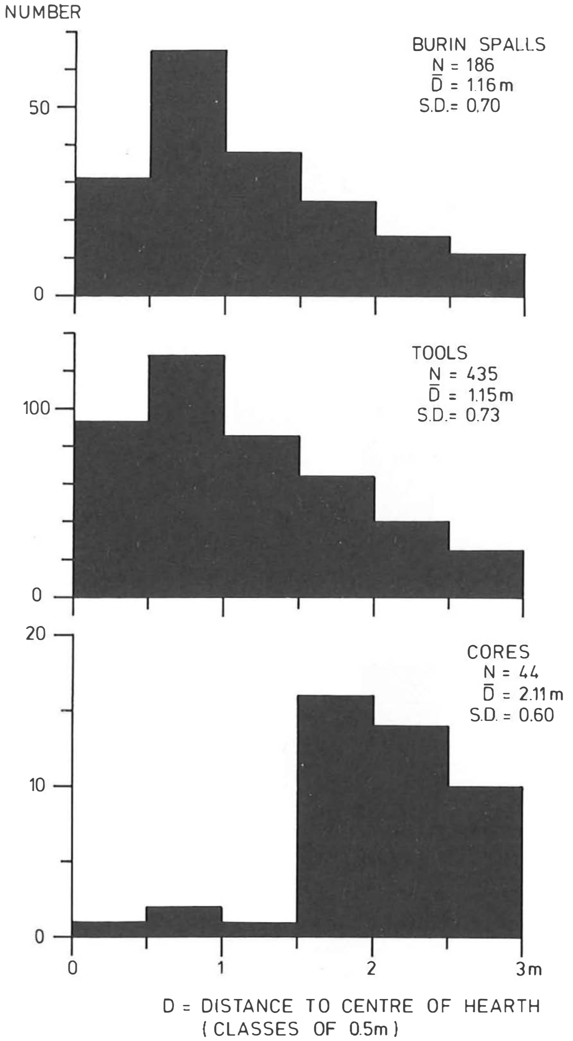

Fig. 45. Pincevent V105. Ring distributions for burin spalls, tools (four types taken together: backed bladelets, borers, burins and scrapers) and cores. Note that the cores are clearly located further from the hearth than tools or burin spalls.

index falls around 1, no centrifugal effect is apparent; if it is higher than 1.15, the centrifugal effect can be said to be present.

For the eight units of Niveau IV-2 the 'centrifugal index' ranges from 1.49 to 2.35; the mean index is 1.87 (Standard Deviation 0.27). To summarize: the average distance of cores to the hearth centres tends to be 1.5 to more than 2 times that of tools.

The picture for Habitation 1 is radically different. As we have seen above, the analysis according to the ring and sector method here is hampered, because the three hearths are so close together. Nevertheless, if a centrifugal effect were present it should show up in the diagrams, even if not all the rings up to 3 m from the hearth centre are complete, as this problem affects all artefact classes. Yet all three units of Habitation 1 show a complete absence of the centrifugal effect (fig. 48). In fact, in two cases the cores even are, on average, located somewhat closer to the hearth than the tools. The indexes are: 0.61, 0.96 and 1.05 (the average index for Habitation 1 is 0.87).

This interesting result suggests that we might be dealing with two different types of sites in Pincevent: sites showing a clear centrifugal effect (Niveau IV-2) and sites showing no centrifugal effect (Habitation 1). The centrifugal indexes for all eleven units of Pincevent are presented in a bar chart (fig. 49), which brings out this dichotomy between Niveau IV-2 and Habitation 1 very well.

In the remaining sections of this paper I shall investigate this matter more fully, using several other attributes. It is of interest, however, to note here that also the other analysed sites with open-air hearths ('unimodal sites'), can be divided into the same two groups. Sites showing a clear centrifugal effect include Oldeholtwolde, Olbrachcice 8 East and Niederbieber I and IV (the indexes for these sites are 1.52, 1.29, 1.48, 1.32, respectively).

Two other analysed sites that had hearths in the open air, Marsangy N19 and Bro I, show no clear

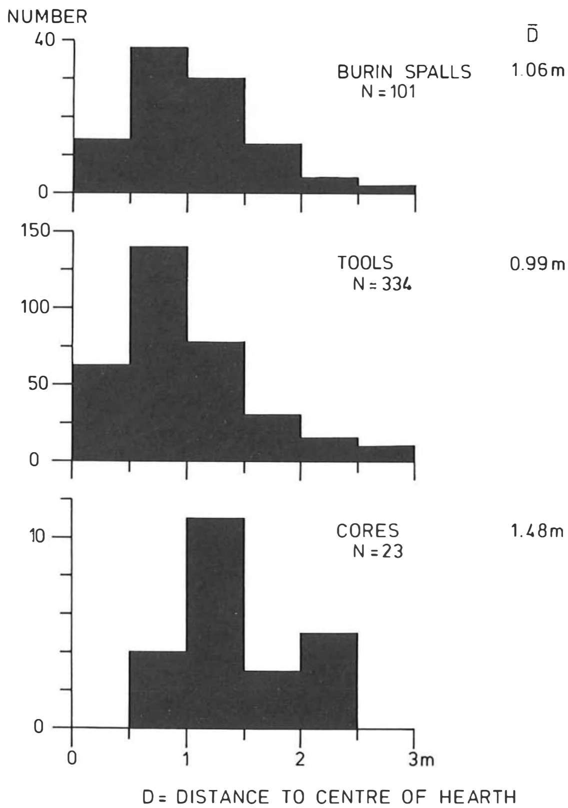

Fig. 46. Pincevent T112. Ring distributions for burin spalls, tools and cores.

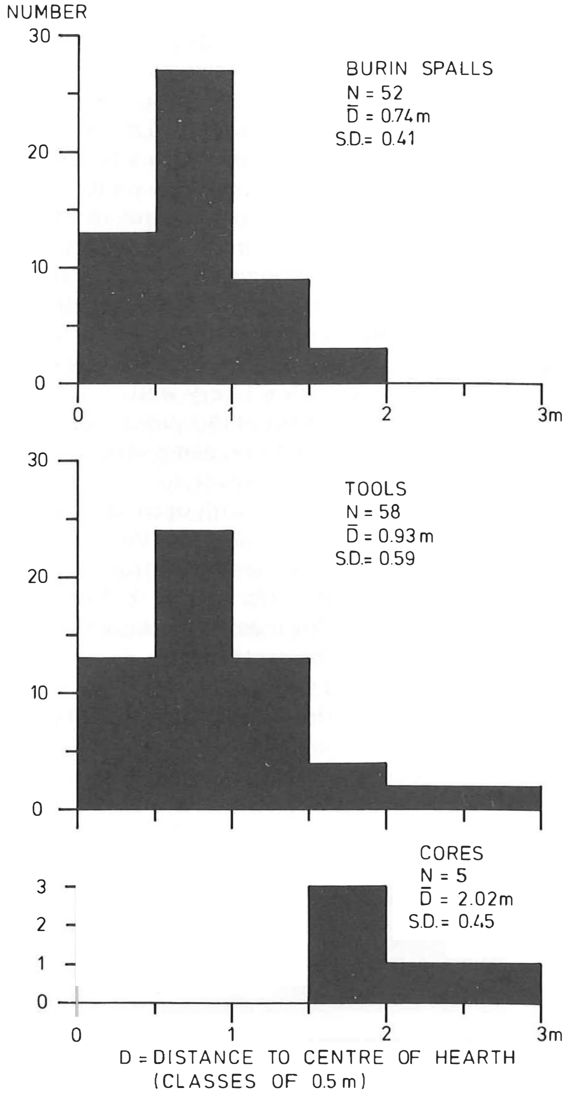

Fig. 47. Pincevent G121. Ring distributions for burin spalls, tools and cores.

centrifugal effect (indexes 1.10 and 0.99, respectively), like the units of Habitation 1. (As noted above (section 9), all 'bimodal sites', which had hearths inside tents, show a clear centrifugal effect.)

We have seen that in Niveau IV-2 all units show a clear centrifugal effect. I concluded that the drop zone is to be found in the richest site-half. It has also been noted that the centrifugal effect should be apparent especially from the existence of a backward toss zone, behind the drop zone. This is because the forward toss zone starts relatively close to the hearth, and therefore overlaps with the drop zone in terms of the distance to the hearth centre (fig. 8). If the hypothesis that the drop zone lies in the richest site-half should be true, we would expect the centri-

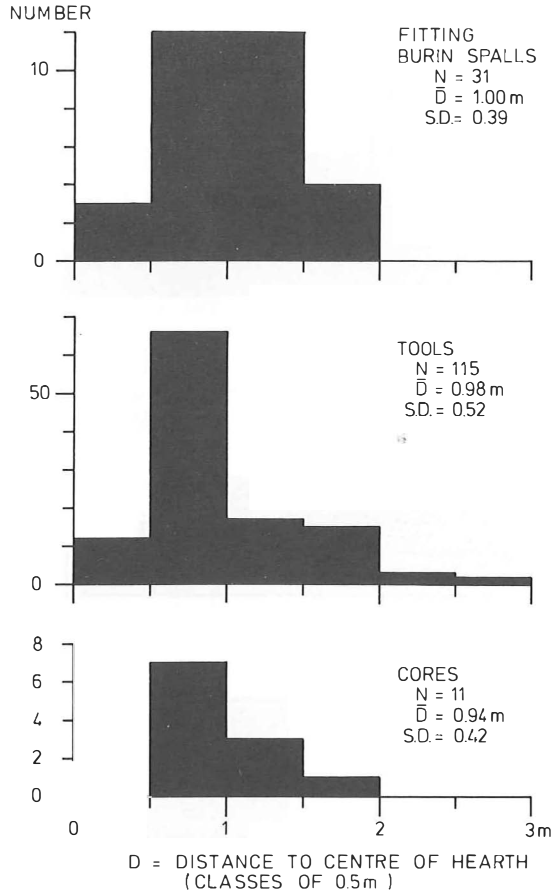

Fig. 48. Pincevent, Habitation 1, hearth II. Ring distributions for burin spalls (only those fitting to burins), tools and cores. Note that in this case a centrifugal effect is not apparent: compare with figures 45-47.

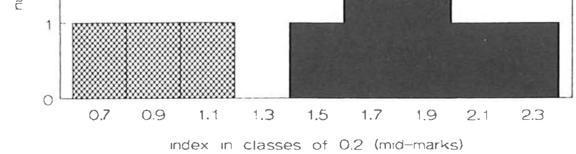

Fig. 49. Pincevent. The centrifugal effect is expressed as an index: mean D of cores / mean D of tools (D is distance to the centre of the hearth), and the indexes for all analysed units are presented in a bar chart in classes of 0.2 (mid-marks are given in the figure; class boundaries are as follows: 0.61-0.80, 0.81-1.00, etc.). It can be seen that there is no overlap between the values of Niveau IV-2 and those of Habitation 1. In Habitation 1 the centrifugal effect is not apparent, in Niveau IV-2 it is always present.

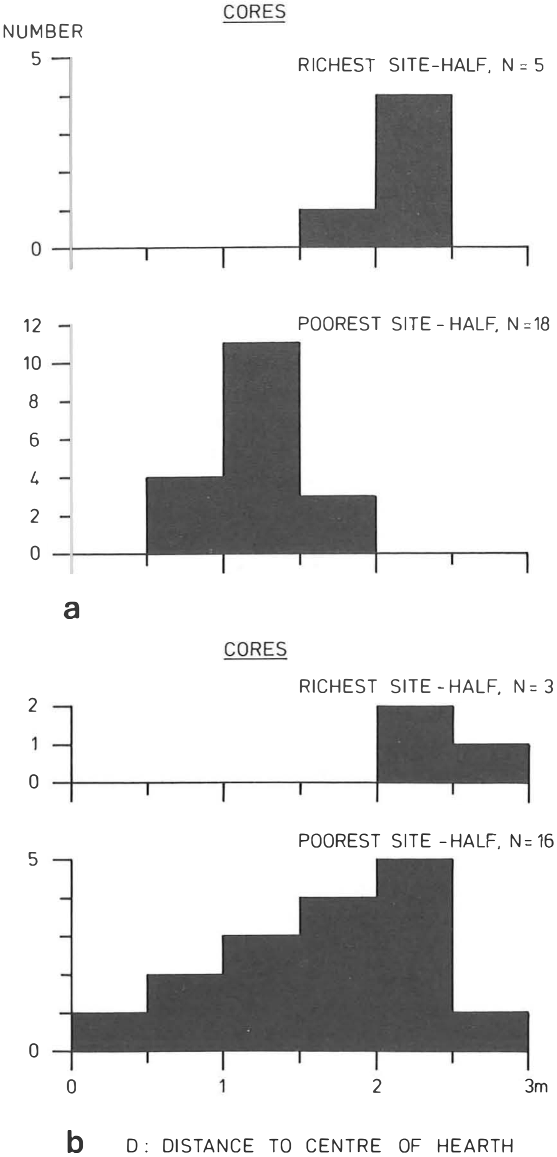

Fig. 50. Pincevent. Units T112 and E74. The ring distributions of cores are presented separately for the richest and poorest site-halves. The cores tend to be farther away from the hearth in the richest site-halves, suggesting that those halves contained the drop zone.

fugal effect to be stronger in that site-half than in the poorest site-half. This is indeed the case at most units of Niveau IV-2; as examples I present the ring distributions for cores in both site-halves for units T112 and E74 (fig. 50; see also fig. 64). Because in many units the number of cores in the richest site-halves is quite low (see section 15), I decided to prepare a similar diagram for all eight units of Niveau IV-2 taken together (fig. 51; this seems legitimate, because the ring distributions of tools for all units in Pincevent are very homogeneous). There is a marked difference between the two frequency distributions. The fact that the centrifugal effect is strongest in the richest site-halves supports the conclusion that the drop zones were in the richest site-halves. Especially noteworthy is the sharp increase of the frequencies of cores in the richest site-halves for distances over 1.5 m from the hearth centres. This suggests that we can fix the boundary between the drop zone and the backward toss zone for Pincevent: it lies at about 1.5 m from the hearth centres. This applies to all units in Niveau IV-2. In Habitation 1 (and in Marsangy N19 and Bro I), however, backward toss zones seem to be non-existent; at any rate they cannot be demonstrated by the spatial distributions of flint artefacts.

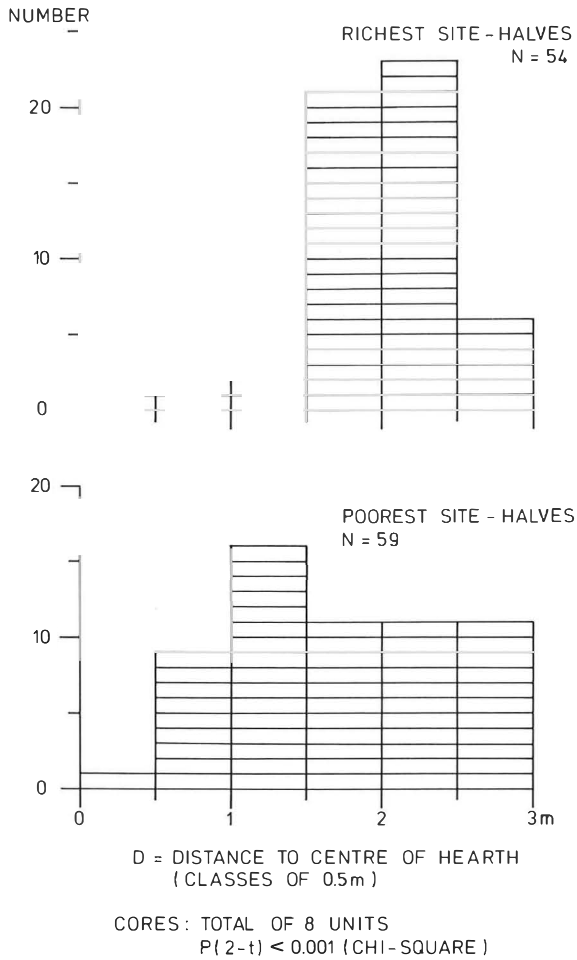

Fig. 51. Pincevent, Niveau IV-2. Ring distributions for the cores in the richest and poorest site-halves for all eight analysed units together. Note the sharp increase in the number of cores in rings farther than 1.5 m from the hearth centres in the richest site-halves. This suggests that the boundary between the drop zone and the backward toss zone was about 1.5 m from the hearth centres.

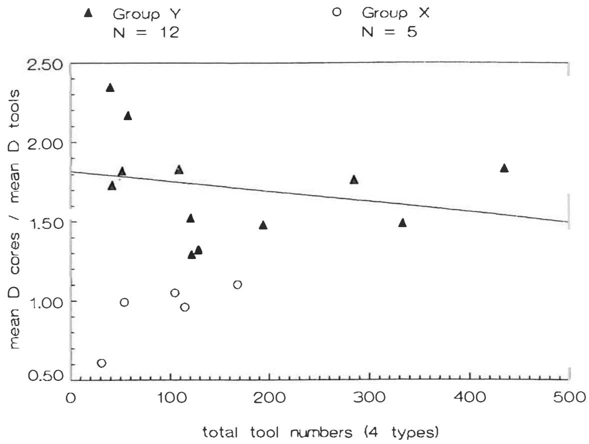

Fig. 52. Pincevent (eight units in Niveau IV-2, three units in Habitation I), and six other 'unimodal' sites in Europe. Scatter diagram of the centrifugal index against total tool numbers per site or unit. The sites are divided into two groups: Group X and Group Y (see section 19). Sites of Group Y show a clear centrifugal effect, those of Group X do not. A regression curve (based on least squares) is shown for the sites of Group Y. It can be noted that there is no convincing correlation between these two variables. In other words: the strength of the centrifugal effect is not a function of the duration of occupation.

In the above I suggested that two site types may exist: sites showing a clear centrifugal effect, and sites that do not. However, one might wonder if the strength of the centrifugal effect is not simply a function of the duration of the occupation: the longer the duration, the more pronounced the centrifugal effect. To investigate this possibility, I made a scatter diagram in which the centrifugal effect is compared with the total tool numbers per unit (fig. 52). The relative length of the occupation periods is thought to be best estimated by total tool numbers per unit (see discussion in section 13). In figure 52 all sites showing a clear centrifugal effect are indicated by triangles (these include the eight analysed units in Niveau IV-2, and Oldeholtwolde, Olbrachcice 8 East, and Niederbieber I and IV). A regression curve (based on least squares) is shown for these twelve sites. It can be seen that there is no correlation between total tool number and the centrifugal effect (in fact, there is a weak negative correlation: r = -0.26). Hence, contrary to what one might expect intuitively, the strength of the centrifugal effect does not seem to reflect the duration of occupation. However, a relation between these two variables can be said to exist in a more general sense. Sites showing no clear centrifugal effect are, on average, smaller than sites that do (see section 19). Larger sites show the centrifugal effect more frequently than smaller sites. But if we only look at the sites with a clear centrifugal effect (as in fig. 52), there is no correlation between its strength and total tool numbers: among the sites showing a pronounced centrifugal effect there are several very small ones. On the basis of these considerations it seems that we are indeed dealing here with two different site types.

15. FORWARD TOSS ZONES: SECTOR DISTRIBUTIONS OF TOOLS AND CORES

In this section I shall investigate whether a forward toss zone can be established, using the sector frequencies of tools and cores. If such a discard pattern existed it is to be expected that cores and tools will show a tendency towards spatial segregation: the proportion of cores to tools will be higher in the forward toss zone than in the drop zone. I expect this to be the case even if there was not only a forward toss zone but also a backward toss zone, because we have seen that used-up cores were cleared from the drop zone more often than used-up tools.

This type of spatial segregation of cores and tools can be investigated in several ways. For example, it may be demonstrated by applying correlation analysis to sector frequencies of tools and cores. If a forward toss zone existed we should expect a clear negative correlation between tools and cores, and if it did not, a positive one. As nonparametric methods of correlation are to be preferred for this kind of data, I have used Spearman's rank correlation coefficient (rho; see Siegel, 1956).

Before we proceed, however, I shall briefly discuss a difference between the ring and the sector approaches. If sites with a hearth in the open air saw a prolonged occupation, chances are that the wind direction during habitation changed from time to time (see also section 13). This could easily have resulted in disturbance of the patterns we want to study by the sector method, because people would have rotated around the hearth in response to the changes in wind direction. Patterns associated with the ring distributions, however, are likely to suffer much less from rotation around the hearth. Therefore, when studying correlations between tools and cores on the basis of their sector frequencies, we should anticipate that a number of sites (large sites especially, such as V105) will not show clear patterns.

Both strongly negative and strongly positive correlations are found. In Niveau IV-2 a significant negative correlation between cores and tools is present in T112 (fig. 53): rho = -0.80. The same pattern is found in several other sites, for example Oldeholtwolde (fig. 54; rho = -0.91) and Niederbieber I (rho = -0.65).

Other sites show significant positive correlations. This is true for at least two units of Habitation 1; the scatter diagram for unit II is given in figure 55 (rho = +0.80). Other 'unimodal' sites showing a strong

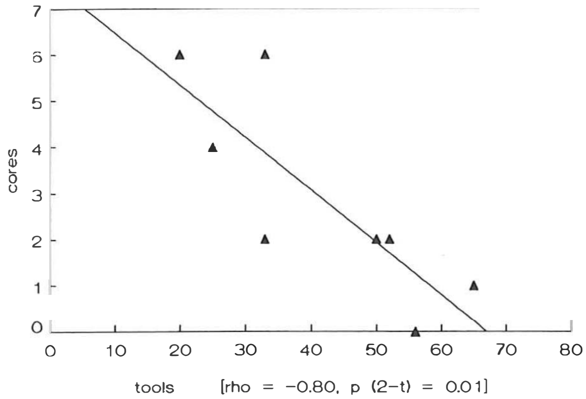

Fig. 53. Pincevent, T1 12. Scatter diagram in which the numbers of cores and tools in eight sectors are plotted against each other. There is a significant negative correlation between the two artefact groups, indicating a tendency to spatial segregation of tools and cores.

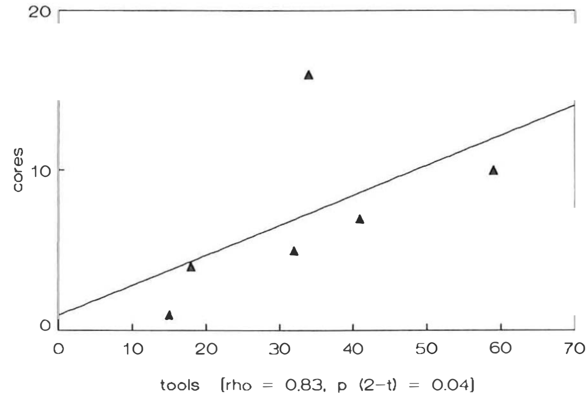

Fig. 56. Marsangy N19. Scatter diagram of tools against cores in six sectors. A positive correlation is apparent.

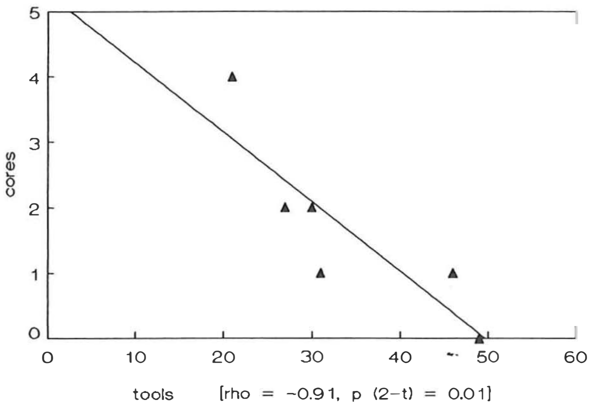

Fig. 54. Oldeholtwolde. Scatter diagram of tools against cores in six sectors. A negative correlation is apparent.

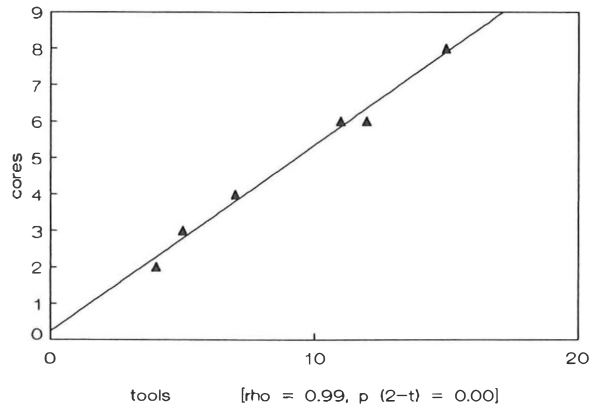

Fig. 57. Bro I. Scatter diagram of tools against cores in six sectors. A strong positive correlation can be noted.

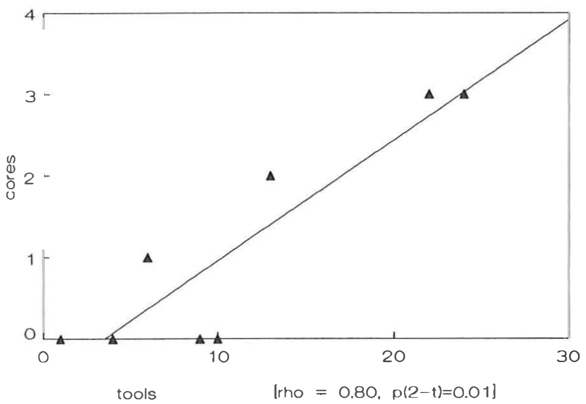

Fig. 55. Pincevent, Habitation 1, hearth II. Scatter diagram of tools against cores in eight sectors. In this case there is a significant positive correlation.

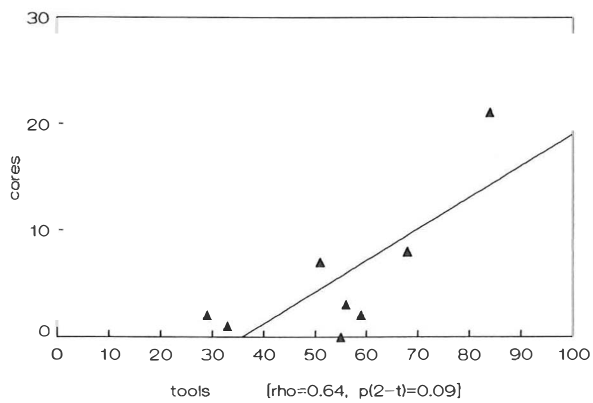

Fig. 58. Pincevent, V105. Scatter diagram of tools against cores in eight sectors. A weak positive correlation is apparent, mainly accounted for by one outlier.

positive correlation are Marsangy N19 (fig. 56; rho = +0.83) and Bro I (fig. 57; rho = +0.99).

Unfortunately, many units of Niveau IV-2 have too few cores for a meaningful correlation analysis, and this applies also to many other sites. For example, T112 is the only unit in Niveau IV-2 with a significant rho. All the other units show weak trends, except perhaps V105, which has a moderately strong positive correlation (rho = +0.64). The correlation is not significant, however (two-tailed p = 0.09), and the scatter diagram (fig. 58) is also not very typical, because the positive trend is mainly caused by one 'outlier'. It is possible that the picture for V105 is due to prolonged habitation, during which wind directions changed several times (it has the weakest asymmetry in terms of tool density: see section 12). The same may be true for Olbrachcice 8 East.

It would be useful to have other ways of investigating the spatial segregation of cores and tools in terms of their sector distributions. One way could be to compare the proportions of tools in R and P with those of cores (figs 59 and 60), by means of a significance test such as the Fisher test. However, even then the low numbers of cores in several units would prevent a meaningful application. For only three units in Niveau IV-2 could a significant difference between P and R be established on the basis of the frequencies of tools and cores in them: T112 (p = 0.00), E74 (p = 0.00) and M89 (p = 0.05).

Perhaps the best way of describing the tendency to spatial segregation of cores and tools in their sector distributions would be to calculate the following ratio for each unit: percentage of N tools in R / percentage of N cores in R. In figure 60 these ratios are presented in classes of 0.5. It can be seen that the values for the units in Habitation 1 fall around 1, thus pointing to the absence of a forward toss zone. Several units in Niveau IV-2, however, show a much larger proportion of tools than of cores in R, indicating the presence of a forward toss zone.

I shall now address the question whether there is a significant difference between Niveau IV-2 and Habitation 1 in terms of the proportions of tools and cores in R and P. In other words: I shall consider the general picture of the two levels, not of individual units. To answer this question, I added all up the tools and the cores in R and in P, for the eight units of Niveau IV-2, and for the three units of Habitation 1 (figs 61 and 62). A significant difference between the two site complexes is evident through application of the chi-square test.

In Habitation 1 there is no significant difference between R and P in terms of the proportions of tools to cores. Therefore, the existence of a forward toss zone cannot be demonstrated, at least not for flint artefacts. The same is true for Marsangy N19 and Bro I.

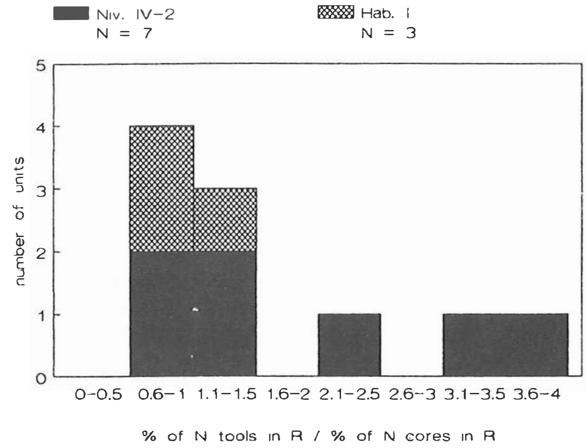

Fig. 60. Pincevent, Niveau IV-2 (except unit G115, because it has only one core) and Habitation 1. The ratio of the percentage of N tools present in the richest site-halves (R) to that of cores, in classes of 0.5. It can be seen that the values for Habitation 1 fall around 1, while in Niveau IV-2 in several units the proportion of tools in the richest site-halves is much higher than that of cores.

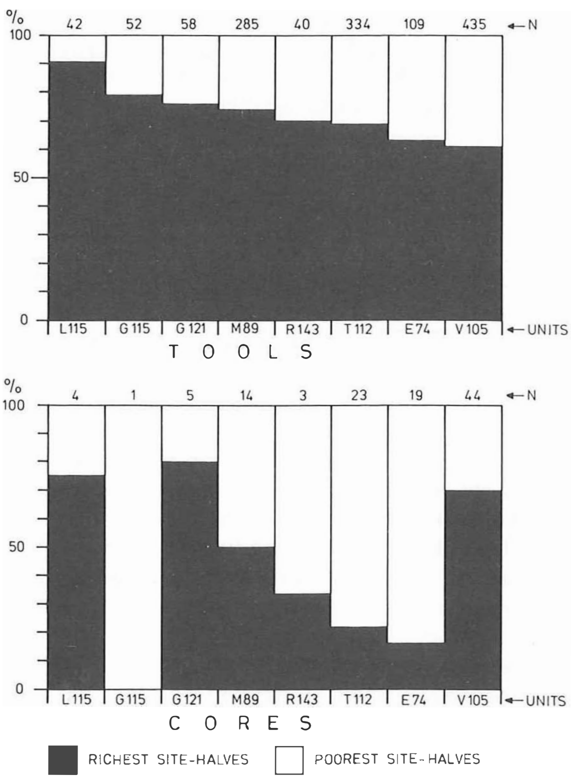

Fig. 59. Pincevent, Niveau IV-2. The percentages of N tools and of N cores in the richest site-halves. There are two richest site-halves with their percentage of N cores higher than their percentage of N tools: the small unit G121, and the very large unit V105.

In Niveau IV-2 the difference between tools and cores as regards their proportions in R and P is significant, suggesting that a forward toss zone did exist. This is also the case with sites such as Oldeholtwolde and Niederbieber. However, we should note that for two units in Niveau IV-2 a forward toss zone cannot be demonstrated, because the proportion of cores in R is higher (instead of lower) than that of tools: V105 and G121 (see fig. 59). The number of cores in G121 is very low (N = 5). If in the case of V105 we are dealing with a residue of prolonged habitation it may well be that repeated rotation around the hearth blurred the sector distributions.

Again we have found a radically different picture for the units of Habitation 1 and those of Niveau IV-2. Moreover, the two other sites that were previously found to be similar to Habitation 1 through the absence of the centrifugal effect, Marsangy N19 and Bro I, again can be placed in the same group as Habitation 1, this time because of the absence of a forward toss zone. Indeed some patterning appears to emerge in the data. It seems as if two types of sites are represented in my sample: sites where continual clearing behaviour in the space around the central hearth can be documented in at least two ways (backward and forward toss zones), and sites where such patterns seem largely absent. We shall come back to this in later sections.

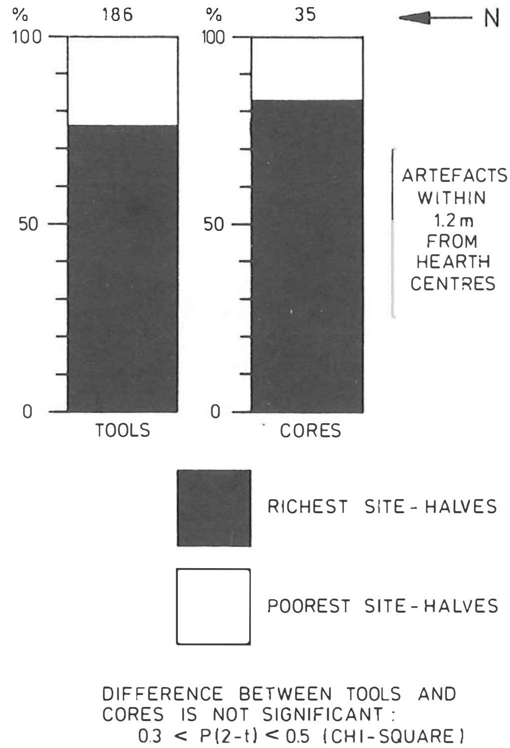

Fig. 62. Pincevent, Habitation 1. For all three units, the numbers of tools and cores in the richest and poorest site-halves have been added up, and there is no significant difference between the proportions of cores and those of tools. In fact, the average proportion of cores in the richest site-halves even is somewhat higher than that of tools.

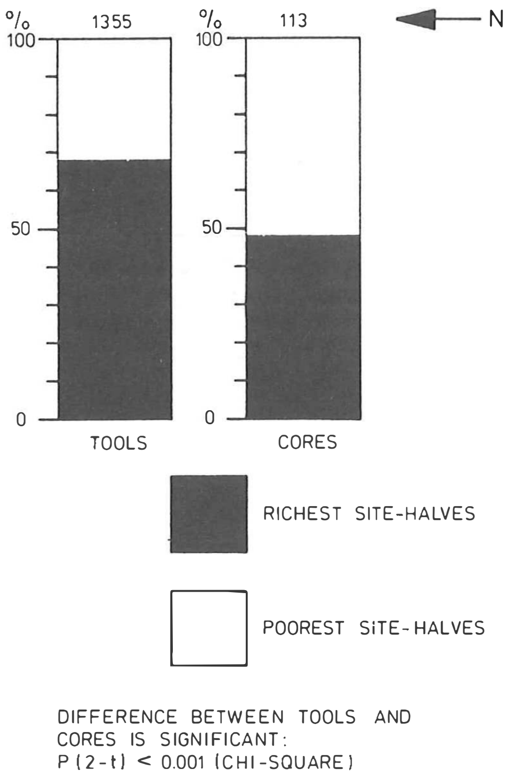

Fig. 61. Pincevent, Niveau IV-2. For all eight units, the numbers of tools and cores in the richest and poorest site-halves have been added up, and it can be seen that the proportion of cores in the richest site-halves is significantly lower than that of tools.

16. SPATIAL ORGANIZATION OF THE UNIT IN NIVEAU IV-2

One conclusion of the preceding two sections is that the units in Niveau IV-2 generally show a remarkable similarity to Binford's hearth model, in the sense that forward and backward toss zones can be clearly established. Ironically, this is not the case in Habitation 1, to which site Binford initially applied his model: here these clearing patterns seem to be largely absent.

This section offers a generalized model for the habitation units in Niveau IV-2 (fig. 63), based on the results of the ring and sector method. It is almost identical to Binford's model. Several general observations can be made:

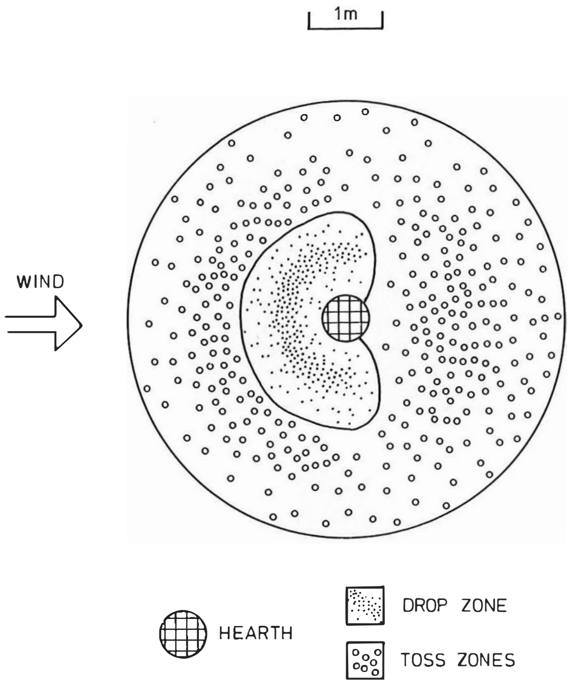

Fig. 63. Pincevent, Niveau IV-2. Schematic sketch of some results of the analysis with the ring and sector method, showing the general 'spatial organization' of the habitation units. Note that this reconstruction is very similar to Binford's hearth model for open-air hearths (compare with fig. 8).

1. The drop zones are located relatively close to the hearths. This suggests that the groups occupying the various units in all cases were fairly small, comprising at most three or four adults.

2. The drop zones are located on the windward side of the hearths. As we have seen, this is the 'richest site-half' in terms of tool numbers.

3. The boundary between the drop zone and the backward toss zone is situated at about 1.5 m from the hearth centre.

In the drop zone we may anticipate some correlation between tool locations and prehistoric activity areas. Though we have to reckon with smearing processes and overlapping, for example due to rotation, there will be at least a global relationship. This is not the case in the toss zones. In the forward toss zones especially, we can hardly expect any relationship between tool locations and former activity areas. Even if the drop zone was located for some time in the poorest site-half (see section 12), this area will be dominated by tossed artefacts, because it was a toss zone for a much longer period. In the backward toss zone there might be some relation, because discarded used-up tools are not likely to have landed very far from the place in the drop zone where they played a functional role. Nevertheless, this relationship will be quite weak.

This means that if one is looking for local spatial patterns, for example in terms of spatial co-occurrence of various tool types, meaningful results are unlikely to be achieved when all tool locations are included in the analysis. Of the total surface area within 3 m from the hearth centres, only about 12.5% is occupied by the drop zone. Thus, an analysis of the whole site based on grid-cell frequencies would include more or less worthless data in about 87.5% of the cells. The surface area of the drop zone is quite small: about 3.5 square metre. Therefore, if one were to restrict oneself to grid cell frequencies within the drop zone, it would be hardly possible to attain an adequate level of statistical strength. Moreover, as I remarked above, discrete activity zones cannot be expected to have survived in this small but densely used area. Instead we must anticipate that the tool locations in the drop zone reflect consecutive episodes of various types of activity, overlapping each other in space.

To what extent do our conclusions regarding the global spatial structure of the units in Niveau IV-2 undermine the interpretations given in section 11, based on the ring distributions of individual tool types? There we used all locations within 3 m from the hearths. It now appears appropriate to use only tool locations in the richest site-halves. As an example, diagrams for the two site-halves of unit M89, presenting ring distributions for several categories of artefacts, are given in figure 64. It can be seen that the diagrams for the richest site-half indeed are very different from those for the poorest site-half. This means that a certain bias is introduced when all tool locations are used in studying differences between tool types. Therefore, it is advisable to prepare separate ring diagrams for the two site-halves, as I intend to do in future analyses. On the other hand, we have seen that about three quarters of all the tools are in the richest site-halves. Hence, the patterns in that site-half will dominate the ring distributions even when all locations are used. Therefore, I feel that the phenomena described in section 11 are real, and would show up even more distinctly if only the locations within the richest site-halves should be considered.

This assumption was tested in 1990, using the as yet unpublished unit J116 in Niveau IV-40[2]. It was found that the method is hardly susceptible to this type of bias. The diagram obtained on the basis of all locations is similar to the one based only on locations in the richest site-half, and even to the one based only on the small sample investigated by Moss (1987). These results will be published elsewhere (Stapert, in prep.).

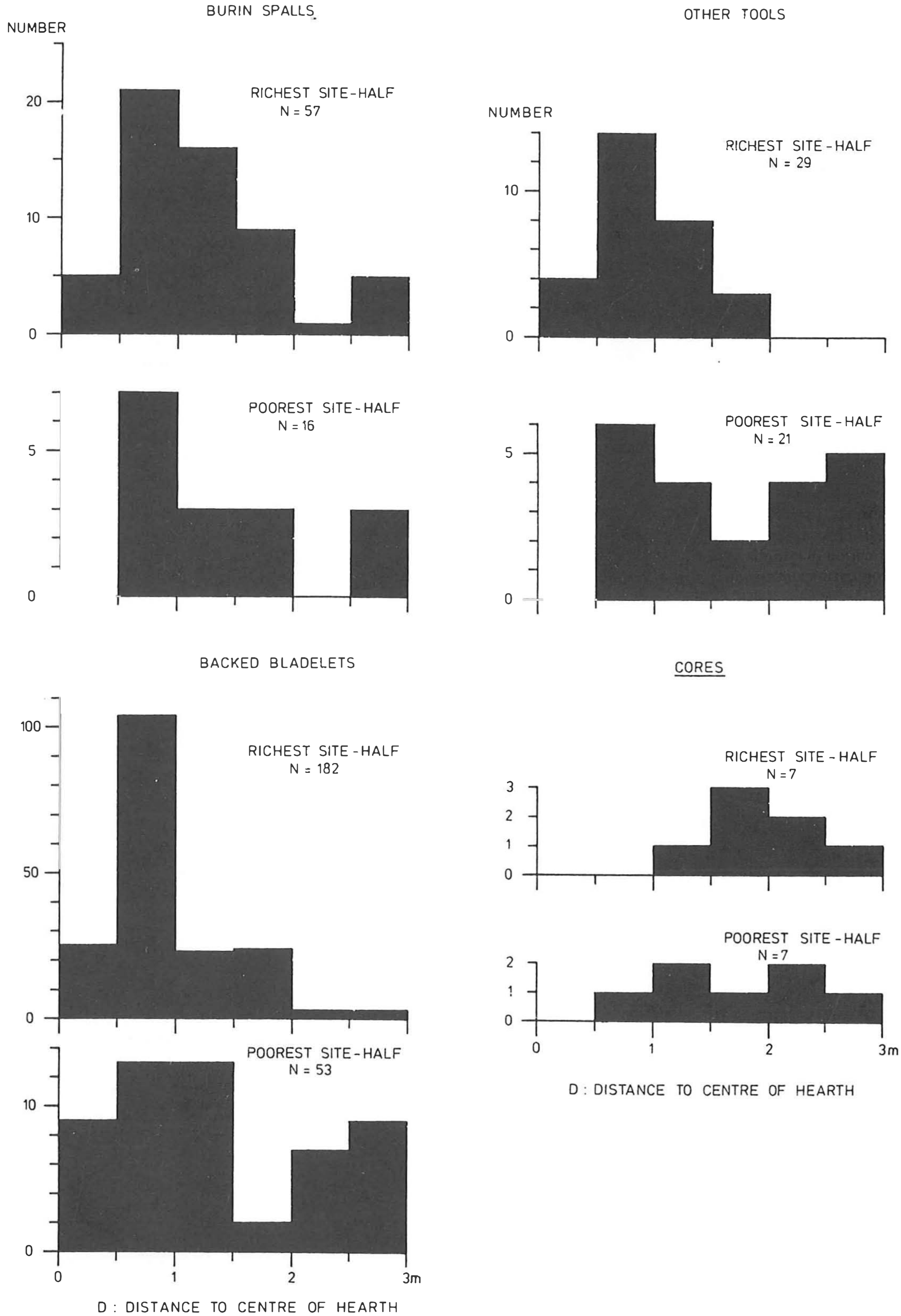

Fig. 64. Pincevent, M89. Ring distributions for four categories of artefacts, treating the richest and poorest site-halves separately. The distributions in the richest site-half are unimodal, and have the mode in the 0.5-1 m class for burin spalls, backed bladelets and other tools. The distributions in the poorest site-half are irregular; it is interesting to note that they tend to be bimodal, indicating that part of the poorest site-half (represented by the first mode) belonged to the drop zone, at least for some time during habitation (see section 12).

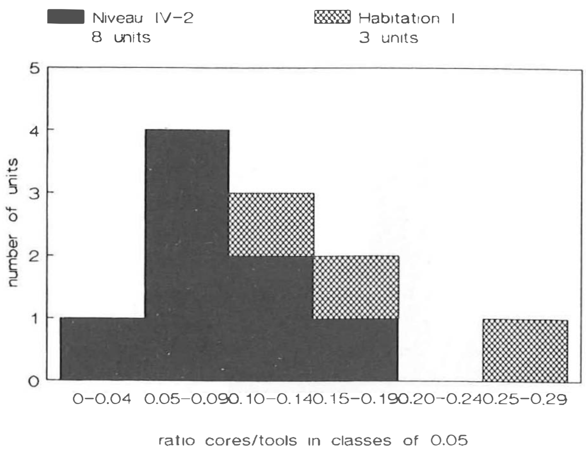

Fig. 65. Pincevent. Ratio of number of cores to number of tools for all eleven units, in classes of 0.05. Note that in Habitation 1 the proportion of cores on average is higher than in Niveau IV-2.

17. PROPORTIONS OF CORES TO TOOLS

In the foregoing we have noted several differences between the units of Habitation 1 and most of the units of Niveau IV-2. The most important of these are the following:

1. The centrifugal effect: absent in Habitation 1, present in all units of Niveau IV-2.
2. A tendency to spatial segregation of cores and tools in their sector distributions: absent in Habitation 1, present in most of the units of Niveau IV-2.

In the following I shall investigate whether there are any further differences between Niveau IV-2 and Habitation 1.

This section will focus on the proportions of cores to tools. The relative abundance of cores is expressed as an index: the ratio of the number of cores to the number of tools (within 3 m from the hearth centres). In figure 65 these indexes for Pincevent are represented in classes of 0.05. It can be seen that in Habitation 1 there are proportionally more cores than in Niveau IV-2, though there is an overlap. For Niveau IV-2 the mean index is 0.09, the range being 0.02 (G115) - 0.17 (E74). For Habitation 1 the mean index is 0.18, the range being 0.10 (II) - 0.27 (III). On average, therefore, there are twice as many cores in Habitation 1 as in Niveau IV-2, relative to the number of tools. The impression arises that flint-working was a more important activity in Habitation 1 than in Niveau IV-2, as against activities in which tools were used.

Earlier, we have noted that Bro I and Marsangy N19 are similar to Habitation 1 through the absence of a centrifugal effect and of spatial segregation of cores and tools in sectors. With respect to the core/tool index discussed in this section, these sites again show the same trend as Habitation 1. Of the six other 'unimodal' sites mentioned above, Bro I and Marsangy N19 have the highest core/tool indexes: 0.54 and 0.22 respectively. The indexes for the remaining four sites are as follows: Oldeholtwolde (0.05), Olbrachcice 8 East (0.18), Niederbieber I (0.18), Niederbieber IV (0.15). Of course these indexes must not be taken absolutely. For example, the variation in quality of the raw materials available locally will also be reflected in this index. Therefore, what is important here is the trend that these data show, not the exact figures.

18. TOOL TYPES: COMPARING NIVEAU IV-2 AND HABITATION 1

We will now turn to another question: are there any significant differences in the tool assemblages of the two levels in Pincevent, and, if so, can the same distinctions be observed among the six other 'unimodal' sites? In figures 66 and 67 the proportions of the four tool classes included in my analysis (backed bladelets, borers, burins and scrapers) are presented as percentages for each separate unit of Pincevent. In the figures also the mean proportions for the two levels of Pincevent are given.

Two important differences between Habitation 1 and Niveau IV-2 are immediately evident from the diagrams:

1. In Niveau IV-2 the proportion of backed bladelets is much higher than in Habitation 1 (mean percentages are 64.3 and 23.1, respectively).
2. In Habitation 1 the proportion of burins is much higher than in Niveau IV-2 (mean percentages are 45.8 and 13.7, respectively).

This suggests that the differences between the two levels could be expressed most clearly by the following index: N backed bladelets / N burins. In figure 68 the indexes for all eleven units are summarized in a bar chart (classes of 2). For Niveau IV-2 the range is 1.00 (R143) - 12.31 (M89), the mean index being 5.82. For Habitation 1 the range is 0.17 (I) - 1.02 (III), the mean index being 0.49.

The only overlap between the distributions of the two levels in figure 68 is created by R143. However, R143 is not really comparable with Habitation 1. What distinguishes R143 from all other units of Pincevent is its high proportion of scrapers (see fig. 66).

If we look at the six other 'unimodal' sites in Europe, we see once again the pattern noted in preceding sections. Bro I and Marsangy N19 show the lowest 'projectile'/burin indexes of all (0.19 and 1.11, respectively). The other sites show higher indexes: Oldeholtwolde (2.55), Olbrachcice 8 East (1.48), Niederbieber I (1.43), Niederbieber IV (2.04). Yet these indexes are much lower than those of most

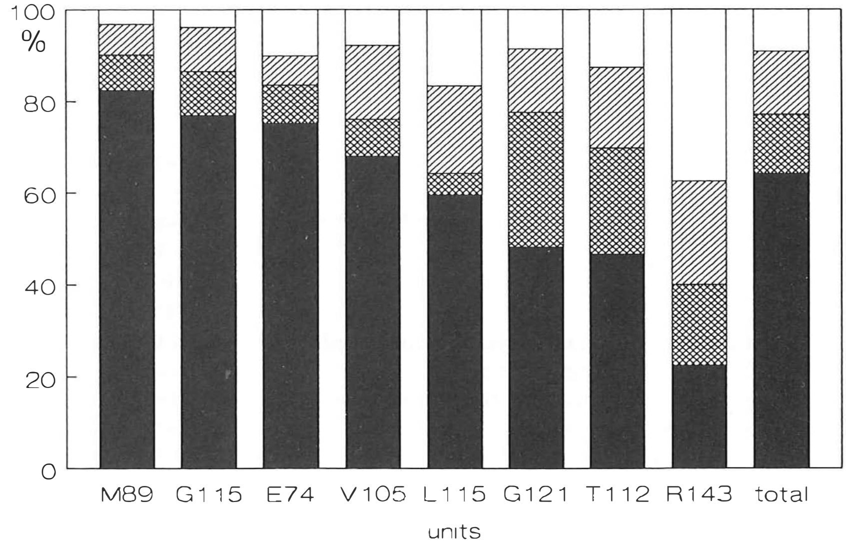

Fig. 66. Pincevent, Niveau IV-2. Percentages of four tool types. Note that G121 and T112 have a relatively high proportion of borers. R143 is different from the other units in that the proportion of backed bladelets is very low, and the proportion of scrapers relatively high.

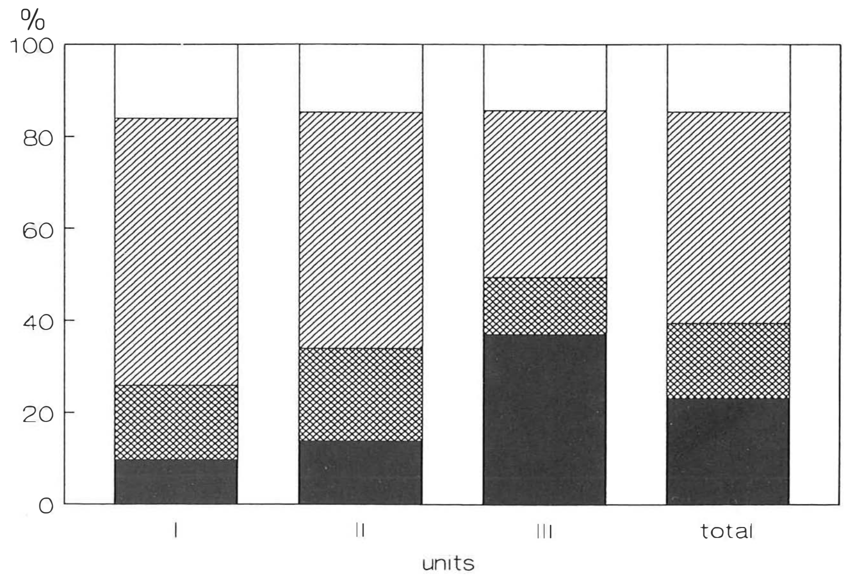

Fig. 67. Pincevent, Habitation I. Percentages of four tool types. Note that the proportion of backed bladelets is much lower than in Niveau IV-2 (fig. 66), and the proportion of burins much higher.

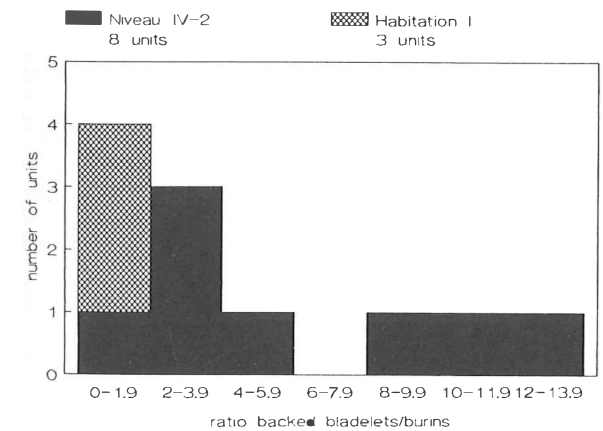

Fig. 68. Pincevent. Ratio of number of backed bladelets to number of burins. Note the difference between Niveau IV-2 and Habitation 1.

units in Niveau IV-2. One reason for this difference could be the over-representation of backed bladelets (as found in Pincevent) with respect to points (as found in most of the other sites). It is known that backed bladelets were often hafted in pairs, or even more, on each projectile (Leroi-Gourhan, 1983). Shouldered and tanged points were most probably hafted individually, as tips (e.g. Moss, 1988). Therefore, for any given number of projectiles there will be more backed bladelets than points.

19. TWO DIFFERENT SITE TYPES?

If we look at the general picture, not at individual units, we can state that there are significant differences between Niveau IV-2 and Habitation 1.

So far, we have found that this applies to the following four attributes:

	Niveau IV-2	Habitation 1
1. Centrifugal effect	Present	Absent
2. Spatial segregation of cores and tools in sectors	Mostly present	Absent
3. Relative abundance of cores	Low	High
4. Ratio of backed bladelets to burins	Mostly high	Low

These attributes were expressed as simple indexes:

1. Mean D cores / mean D tools.
2. Percentage of N tools in the richest site-half / percentage of N cores in the richest site-half.
3. N cores / N tools.
4. N backed bladelets / N burins.

These results suggest that in Pincevent we are dealing with two different types of sites, one represented by Niveau IV-2 and the other by Habitation 1. Before we interpret these results, it is necessary to establish whether these differences are significant, and could not have arisen by chance. In my opinion the strongest 'test' is to compare the patterns found in Pincevent with those of the six other analysed 'unimodal' sites in northern Europe. Admittedly, these reference sites belong to different cultural traditions, and are scattered widely geographically. On the other hand, they all date from the Late Glacial, and share the same basic spatial structure: a central hearth with debris concentrated around it. If the trends found at Pincevent should repeat themselves with these other sites, we may feel reasonably assured that they are relevant.

What we need to demonstrate is that the four attributes listed above are related to each other in a systematical way. If the grouping into two site types on the basis of these attributes makes sense, there should for example be a trend for the centrifugal effect to be present especially at sites with relatively few cores, and vica versa. One way to demonstrate such trends is to produce scatter diagrams comparing each pair among these attributes. Correlation coefficients can be calculated to summarize the relationships between each pair of these attributes.

I have calculated the mean values of the four indexes for the units of Habitation 1 and those of Niveau IV-2. In the scatter plots these mean indexes for the two levels of Pincevent are compared with the indexes for six other 'unimodal' sites in Europe: Oldeholtwolde, Niederbieber I and IV, Olbrachcice 8 East, Marsangy N19 and Bro I (the data can be found in table 1). The main question then is: do the

Table 1. Pincevent (eight units in Niveau IV-2 and three units in Habitation 1) and six other 'unimodal' sites in Europe. Attributes: 1. % of N tools in R, the richest site-half; 2. % of N tools in R / % of N cores in R; 3. 'Centrifugal index': mean D cores / mean D tools (D is distance to the centre of the hearth); 4. N cores / N tools; 5. N tools of the following types: 'projectiles', borers, burins and scrapers (for Pincevent: within 3 m from hearth centres); 6. N 'projectiles' (in the case of Pincevent: backed bladelets) / N burins.

Sites/units	Attributes					
	1	2	3	4	5	6
Niveau IV-2						
T112	66.8	3.1	1.49	0.07	334	2.64
E74	63.3	4.0	1.83	0.17	109	11.75
R143	70.0	2.1	2.35	0.08	40	1.00
M89	74.0	1.5	1.76	0.05	285	12.31
G115	78.8	-	1.82	0.02	52	8.01
L115	90.5	1.2	1.73	0.10	42	3.13
G121	75.9	0.9	2.17	0.09	58	3.50
V105	61.1	0.9	1.83	0.10	435	4.22
Mean	72.6	2.0	1.88	0.09	169	5.82
Habitation 1						
I	77.3	1.3	0.61	0.16	31	0.17
II	70.8	0.8	0.96	0.10	115	0.27
III	82.7	1.0	1.05	0.27	105	1.02
Mean	76.9	1.0	0.87	0.18	84	0.49
Other unimodal sites						
Oldeholtwolde	62.6	3.7	1.52	0.05	121	2.55
Bro I	66.7	0.9	0.99	0.54	54	0.19
Marsangy N19	67.3	0.9	1.10	0.22	168	1.11
Olbrachcice 8 East	55.3	0.9	1.29	0.18	122	1.48
Niederbieber I	60.6	1.7	1.48	0.18	194	1.43
Niederbieber IV	59.2	1.6	1.32	0.15	129	2.04

other six sites show the same trends regarding the relationships between the four attributes as were found in the case of Pincevent?

The six resulting scatter plots are shown in figure 69. It can be seen that the above question can be answered affirmatively. Each pair of attributes show a significant correlation, positive or negative, and the trend found for Pincevent is invariably the same as that for the six other sites. There is one general difference, however, between the picture for Pincevent and that for the other sites. In most cases the trends in Pincevent are more pronounced; the other six sites show weaker patterns. This is what we should expect, given the fact that the other six sites are from different traditions and regions. What is really important here is the fact that the trends are in each case the same. The strength of the various relationships can be expressed by a correlation coefficient. I have chosen the non-parametric rank correlation coefficient (rho) of Spearman (Siegel, 1956). The calculation is based on eight cases: the six other unimodal sites, and the mean values for the two levels of Pincevent. This is a relatively low number for any correlation analysis, but the aim is to see whether the trends show up clearly, or not. If the correlation coefficients are sufficiently strong, we may be fairly confident that the observed patterns really exist. The results can be found in table 2.

All correlations are significant and the centrifugal index (attribute no 1) especially shows clear correlations with all the other attributes. We have seen that in the case of Pincevent this is the only one of the four attributes that shows no overlap between the values of Habitation 1 and those of Niveau IV-2. Therefore, if one wished to select only one attribute for dividing the sites into two groups, the centrifugal index would be the best choice.

Table 2. Pincevent and six other 'unimodal' sites. Spearman's rank correlation coefficients (rho; see Siegel, 1956) between each pair of four attributes (see fig. 69). In the case of Pincevent mean values for each attribute per site level (Niveau IV-2 and Habitation 1) are used (see table I). Attributes: 1. Mean D cores / mean D tools (D = distance to centre of the hearth); 2. Percentage of N tools in R / percentage of N cores in R (R = richest site-half); 3. N cores / N tools; 4. N 'projectiles' / N burins ('projectiles' are backed bladelets in the case of Magdalenian sites, and points in the non-Magdalenian sites); *. Significant (two-tailed p <0.05).

Pairs of attributes	N	Rho	Two-tailed p
1/2	8	0.81	0.01 *
1/3	8	-0.74	0.03 *
1/4	8	0.90	0.00 *
2/3	8	-0.79	0.02 *
2/4	8	0.74	0.03 *
3/4	8	-0.86	0.00 *

Table 3. Pincevent and six other 'unimodal' sites. Spearman's rank correlation coefficients (rho; see Siegel, 1956) between each pair of four attributes. In this case the indexes of all individual units at Pincevent are included (see table 1). For the four attributes see the caption of table 2.

Pairs of attributes	N	Rho	Two-tailed p
1/2	16	0.41	0.12
1/3	17	-0.58	0.01 *
1/4	17	0.72	0.00 *
2/3	16	-0.34	0.20
2/4	16	0.30	0.26
3/4	17	-0.54	0.02 *

The conclusion of this exercise must be that the relationships between the four attributes prove to be quite strong. Moreover, the scatter diagrams show that they are systematically the same for Pincevent and for the six reference sites. Therefore, we may conclude that we are indeed dealing with two different types of sites.

This conclusion needs at least two comments:

a. It is possible that the two groups of sites are also different in other aspects than the ones I have selected (see section 20).

b. The fact that on the basis of the above-mentioned four attributes two site types can be defined does not preclude the existence of sub-groups among each of these two groups. It is even possible that other types of grouping are obscured by the approach adopted here; I shall return to this possibility below.

Using mean values for the two levels of Pincevent is an artificial and arbitrary procedure. If we use the indexes for all individual units of Pincevent (see table 1), the same trends show up, but the correlation coefficients are weaker, and only three among them remain significant (see table 3). This is caused by the fact that the units in Niveau IV-2 show quite a lot of variability for most of these four attributes. Since I wanted to compare the general differences between Niveau IV-2 and Habitation 1 with the trends found for the other 'unimodal' sites, it seemed appropriate to use the mean values per level at Pincevent instead of including the indexes of all the individual units, thus reducing this variability. We can note, however, that if we use the indexes of all the individual units, the trends shown in figure 69 are found to remain the same. Once again the centrifugal index shows the clearest correlations with the other attributes.

The two groups of sites observed on the basis of the four above-mentioned attributes will be named Group X and Group Y.

Group X includes sites such as Habitation 1 at Pincevent, Marsangy N19 and Bro I. These sites do not show a clear centrifugal effect (centrifugal index

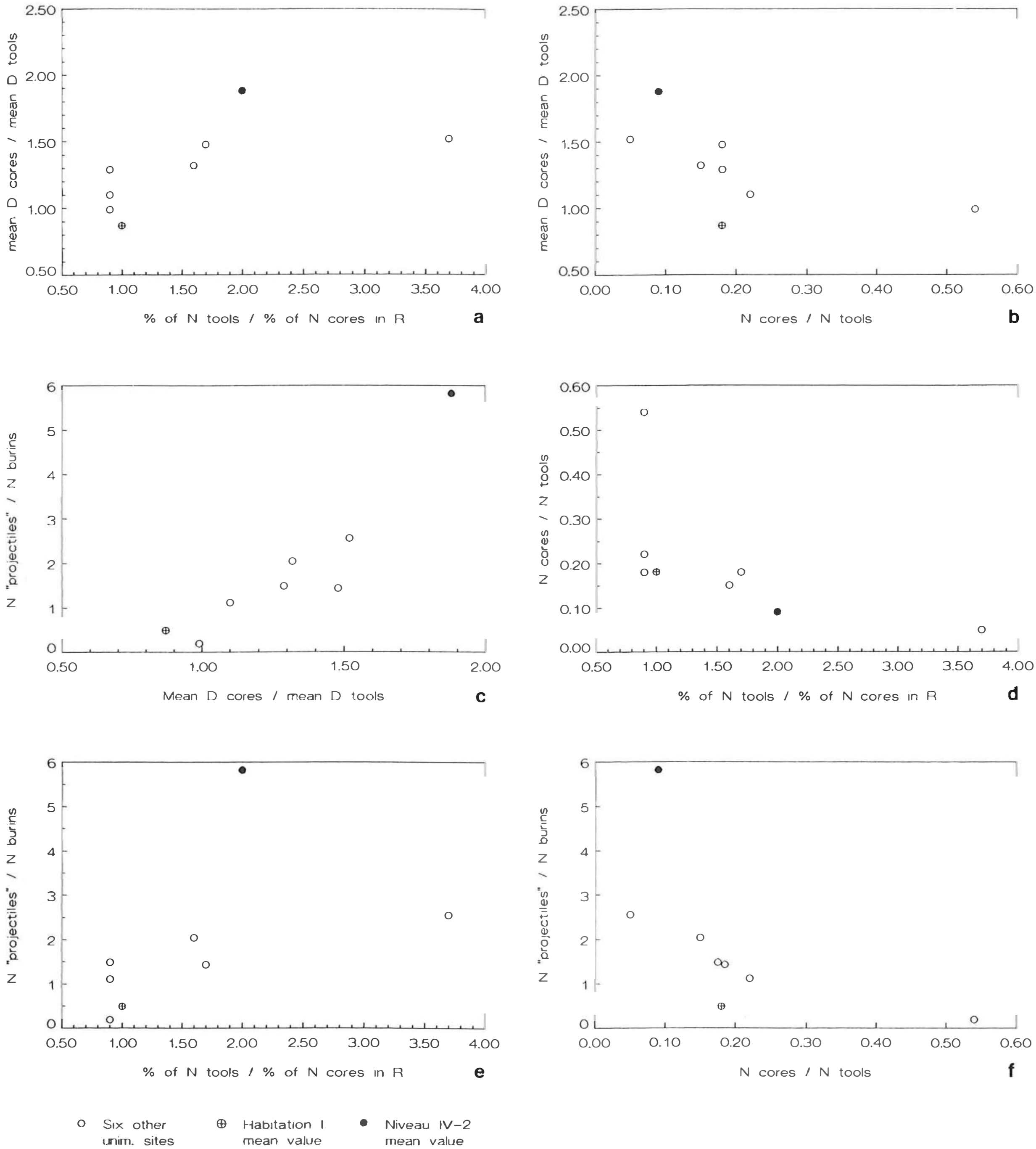

Fig. 69. Pincevent (Niveau IV-2 and Habitation I) and six other 'unimodal' sites in Europe (Oldeholtwolde, Olbrachcice 8 East, Marsangy N19, Bro I, Niederbieber I and IV). Six scatter diagrams, illustrating the relationships between each pair among four attributes. A. Centrifugal effect against ratio % of N tools in R / % of N cores in R; B. Centrifugal effect against ratio N cores / N tools; C. Centrifugal effect against ratio N 'projectiles' / N burins; D. Ratio N cores / N tools against ratio % of N tools in R / % of N cores in R; E. Ratio N 'projectiles' / N burins against ratio % of N tools in R / % of N cores in R; F. Ratio N 'projectiles' / N burins against ratio N cores / N tools. For both Habitation I and Niveau IV-2 mean values are used. It can be noted that in each case a clear correlation exists, and that the trend found in Pincevent is invariably repeated with the six other sites.

<1.15), there is no tendency to spatial segregation of cores and tools in sector distributions (% of N cores in R not significantly smaller than that of tools), there is a relatively high proportion of cores to tools, and the ratio of 'projectiles' to burins is low (index <1.25).

Group Y includes sites such as Niveau IV-2 at Pincevent, Oldeholtwolde, Olbrachcice 8 East and Niederbieber. These sites show a clear centrifugal effect (index >1.20), a tendency to spatial segregation of cores and tools in sector distributions (% of N cores in R clearly smaller than % of N tools in R), a relatively low proportion of cores to tools, and a high ratio of 'projectiles' to burins (index >1.25).

It will be noted that the third variable, the ratio of cores to tools, is not quantified in the above summaries. Though the correlations with the other variables are convincing, there is nevertheless a great deal of variation, preventing the definition of a boundary. This is hardly surprising, given the fact that the sites under study are widely scattered geographically.

In terms of their spatial structures, we could state that the sites in Group X do not show backward or forward toss zones; at any rate these cannot be demonstrated on the basis of the spatial distributions of flint artefacts. The sites in Group Y show both types of toss zone. Stated even more simply: the sites in Group Y show continual clearing patterns, those in Group X do not.

Furthermore, Groups X and Y are different in that at the sites of the former more flintworking took place than at those of the latter (as reflected by the proportion of cores to tools). Finally, burins played a more important role at sites of Group X than at those of Group Y.

Taking the chance of being branded a sexist, I am inclined to hypothesize that the sites of Group X were occupied by men only, while at the sites of Group Y women were also present. In other words: Group Y might represent camps occupied by families, and Group X hunting camps or 'special-purpose camps' – for example, male camps in which technical work was done. In the next section I shall present some supporting evidence for this hypothesis.

Contrary to what one might intuitively expect if the interpretation offered above should be true, it is at sites placed in Group Y that the proportion of 'projectiles' is relatively high – not at sites placed in Group X. We have to note, however, that we are dealing with proportions here. There is not necessarily a difference between Groups X and Y in, for example, the number of 'projectiles' discarded per man per day. It would be more realistic to state that burins played a more important role at sites of Group X than at those of Group Y. Perhaps hunters fought the boredom during periods when they had to wait for game by doing technical work, for which burins were used?

Groups X and Y are created on the basis of four variables that can be shown to be systematically related to each other. This subdivision is empirically based and can be underpinned statistically. But, of course, it is not the only possible subdivision. Many attributes other than the four selected by me can be considered. Any grouping of sites must be based on one or more quantifiable attributes, and there are many ways of doing so. For example, sites are often grouped on the basis of their size. One method is to base a subdivision on the numbers of tools. Such classifications often use terms as 'small' and 'large', or 'rich' and 'poor', etc. One such subdivision in the case of Pincevent is presented in figure 70.

It should be noted that the X/Y grouping discussed above is independent of size attributes. However, if sites placed in Groups X and Y are compared with each other in terms of total tool numbers (fig. 71), some pattern is visible. Sites of Group X tend to be quite small, while sites of Group Y can be either small or large. One gets the impression, therefore, that sites of Group X were mostly occupied for short periods, while those of Group Y may have been occupied for either short or long periods. This pattern is what one would expect if the hypothesis offered above, concerning the X/Y grouping, should be correct.

As remarked earlier, other types of grouping might exist, within Groups X and Y, or cutting across this classification, definable on the basis of aspects other than those selected by me. In section 11 it was noted

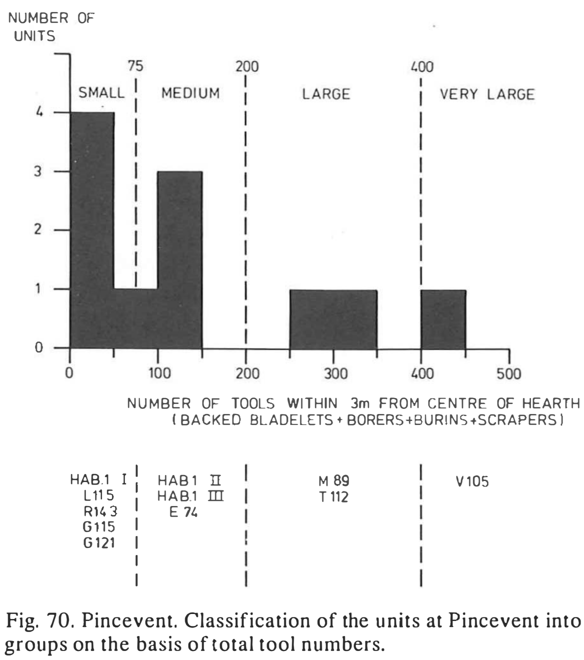

Fig. 70. Pincevent. Classification of the units at Pincevent into groups on the basis of total tool numbers.

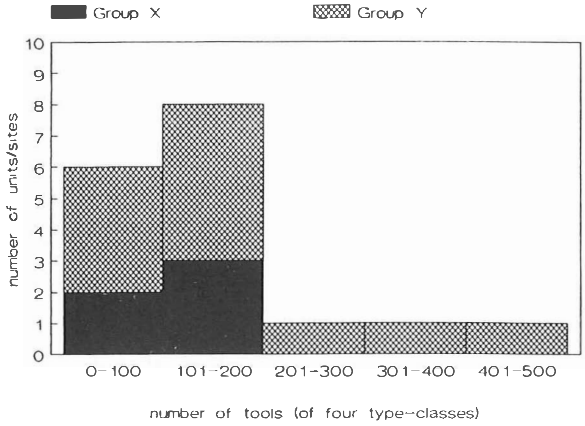

Fig. 71. Comparing site size in terms of total tool numbers with the classification in Groups X and Y (see section 19). It can be seen that Group X especially includes small sites, while those placed in Group Y may be small or large.

that at Pincevent backed bladelets are almost always located close to the hearths, and scrapers far away. One unit, R143, deviated from this general pattern. Therefore, it is possible to subdivide Group Y into two subgroups, on the bases of differences in the ring distributions of the individual tool types:

Y1. Sites showing the 'normal' pattern: backed bladelets close to hearths, scrapers far away (in terms of the ranking discussed in section 11: backed bladelets rank 1 or 2, scrapers rank 3 or 4).

Y2. Sites showing roughly the reverse of the 'normal' pattern (for example, R143).

The same applies to Group X:

X1. Sites showing the 'normal' pattern.

X2. Sites showing roughly the reverse of the 'normal' pattern (for example, Marsangy N19).

20. SUBDIVIDING THE RICHEST SITE-HALVES

Although women of several hunter/gatherer groups participate in some forms of hunting, this is usually the work of men. A very interesting aspect of this matter is that even in cases where women participate in hunting, there is a world-wide taboo on their handling weapons that cut or penetrate the animals, thus drawing blood (Testart, 1986). Although we shall never know for sure, it is not unlikely that this pattern was already in existence in Late Palaeolithic times. This assumption leads to the conclusion that backed bladelets and other (parts of) 'projectiles' (such as Hamburgian points) most probably were left behind by men. Thus backed bladelets and other 'projectiles' would be the only tool class to be associated with one of the sexes. If used 'projectiles' are found, clustered near a hearth, we may be fairly sure that at least one man was present at the site, who among other things repaired his hunting equipment.

This applies to all analysed units of Pincevent, with the exception of R143. Some backed bladelets were present there, but they were not located close to the hearth. Because backed bladelets sometimes had other functions than as insets of projectiles, their presence in R143, relatively far from the hearth, does not necessarily prove the presence of men, or more precisely, not of men who repaired weapons. One alternative hypothesis is that used backed bladelets were discarded far from the hearth during butchering work: they could have been brought to the site embedded in the bodies of killed game. Therefore, if butchering took place at a unit, but no 'retooling' of hunting gear, we might be confronted with a picture as found at R143. As other explanations also are possible, however, we would in such cases need detailed use-wear analyses before anything might be concluded regarding the presence of men.

At the ten other analysed units of Pincevent backed bladelets occur clustered near the hearths, and therefore it seems reasonable to conclude that at least one man was present. What about the women? Is it possible to find evidence relating to their presence or absence? We have no *a priori* indications to postulate sex-specificity for tool types such as burins, borers and scrapers. Yet, it might be interesting to do a world-wide survey of hide-working among hunter-gatherers. There seems to be a tendency for most hide-working to be done by women, which would mean that scrapers were used more frequently by women than by men.

In preceding sections I concluded that the richest site-halves, in terms of tool numbers, are the areas where people would have sat and worked near the hearths. Let us suppose that the hypothesis offered in the last section, regarding the X/Y grouping, is correct; in other words: let us assume that families lived at the sites of Group Y. In that case we may postulate that of the two quarters constituting the richest site-halves (called 'subhalves' in figures 72-75), one was occupied by a man and the other by a woman. We would then expect the proportions of backed bladelets and other tools to be different in the two quarters.

This would be because hunting gear was repaired only by men. Even if the other type-classes were used by both men and women, this would lead to differences in the proportion of backed bladelets with respect to the other types. Of course, since we are dealing with a small and intensely used area, we have to anticipate smearing processes, and also mixing as a result of rotation around the hearths due to changing wind directions. Nevertheless, we would expect that at least in some sites of Group Y a difference between the two quarters would be de-

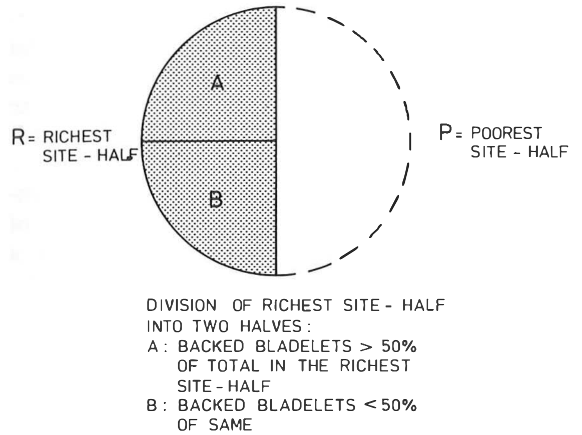

Fig. 72. Subdividing the richest site-half into two quarters ('subhalves') A and B.

monstrable, while we would not expect this to be the case in sites of Group X.

This implication of my hypotheses can be investigated statistically. To this end the richest site-halves are divided into two quarters (see fig. 72). The quarter with the highest proportion of backed bladelets is called A, the other B.

The frequencies of backed bladelets in A and B are counted, and also those of 'other tools': borers, burins and scrapers taken together. We then want to test the hypothesis that differences in proportions of these two tool groups in A and B could have arisen by chance. The null hypothesis, of course, is that there are no differences between backed bladelets and other tools in their proportions in A and B. The alternative hypothesis in this case is that the proportion of backed bladelets is significantly higher in A than in B. This can be investigated by the chi-square test or by the Fisher test (Siegel, 1956). The latter is preferable in cases where the numbers are very low, as with several units of Pincevent.

There are several problems to be faced, however. One arises from the fact that for several units of Pincevent I used six sectors. This means that the richest site-half consists of three sectors, and cannot be divided into two quarters. (It is advisable, therefore, always to use eight sectors when applying the sector method.) Another problem is that in cases where the number of tools is very low, significance tests do not have much value.

As a consequence of these problems, I could not perform tests on all analysed units in Pincevent, but only on a few. Of the units in Niveau IV-2, I selected the three largest: V105, T112 and M89. Of the other sites placed in Group Y, Oldeholtwolde and Niederbieber I were selected.

As noted before, most units/sites placed in Group X are quite small. Moreover, in the case of Habitation 1 we also have the problem that the sectors are rather small, because of the close proximity of the three hearths. Apart from Habitation 1 the test was also applied to Marsangy N19.

Since the alternative hypothesis predicts the direction of the difference, the region of rejection is one-tailed. The results can be found in table 4.

As can be seen, several units of Pincevent and other sites placed in Group Y show significant differences between the quarters A and B with regard to their proportions of 'projectiles' and other tools, and this is not the case with sites or units placed in Group X. Once again, however, the largest unit of Niveau IV-2, V105, falls short of our expectations. As I have noted before, this could be a result of a prolonged period of habitation, with a great deal of rotation.

To give an impression of the difference between Niveau IV-2 and Habitation 1 in this respect, I have added up all A's and B's for these two levels (fig. 73; in this figure proportions of backed bladelets and other tools are given, based on the total number in R; for the application of the Fisher test of course their frequencies in A and B are used). This involved estimation in cases where six sectors had been employed. Moreover, this rough procedure will obscure the possibility of differences between the individual units in Niveau IV-2. Therefore, the outcome of this analysis should only be regarded as an indication of the general trend (see table 4).

Though the analysis performed above is not really satisfactory, I nevertheless believe that the results are worth noting. They can be summarized as follows: in sites placed in Group Y there is a tendency towards a difference between the two quarters A and

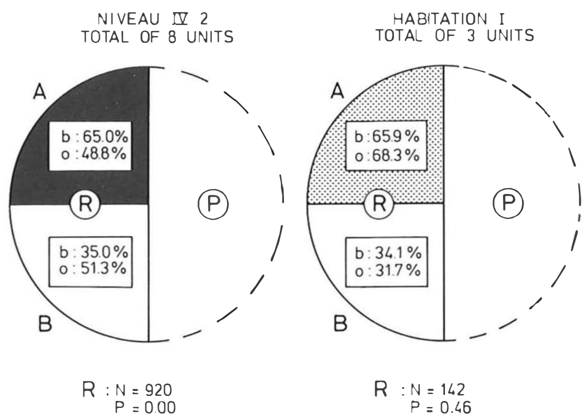

Fig. 73. Investigating the difference between the two quarters A and B in terms of the proportions of backed bladelets and other tools (borers, burins and scrapers). The data for Niveau IV-2 and Habitation 1 have been grouped together per level. It can be seen that in Niveau IV-2 there is a tendency for the two quarters to differ in this respect, which is not the case in Habitation I.

Table 4. Pincevent (three units in Habitation 1 and three units in Niveau IV-2) and three other 'unimodal' sites. The richest site-halves are divided into two quarters, A and B (see fig. 72). The frequencies of 'projectiles' and other tools (borers, burins and scrapers; in the case of Oldeholtwolde: borers, burins, notched pieces and scrapers) in A and B are compared using the Fisher exact probability test (Siegel, 1956). The test is also executed using grouped data for Niveau IV-2 and Habitation 1. *. Significant (one-tailed p <0.05).

Sites or units	One-tailed p
Group X	
Habitation 1-I	0.65
Habitation 1-II	0.46
Habitation 1-III	0.42
Marsangy N19	0.24
Group Y	
M89 (Niv. IV-2)	0.00 *
T112 (Niv. IV-2)	0.02 *
V105 (Niv. IV-2)	0.31
Oldeholtwolde	0.04 *
Niederbieber I	0.07
Pincevent, two levels	
Habitation 1 (grouped data for three units)	0.46
Niveau IV-2 (grouped data for eight units)	0.00 *

B within the richest site-half in terms of the proportions of 'projectiles' to other tools, while this is not the case in sites of Group X. On the basis of the above considerations it is possible to hypothesize that quarter A was occupied by a man, and quarter B by a woman.

As a further step, it would be interesting to compare the inventories of quarters A and B in terms of individual tool classes for the sites that show a significant difference between these two quarters.

In the case of Pincevent, only T112 was selected for this purpose, because M89 has very low numbers of tools other than backed bladelets.

In figure 74 percentages per quarter are given for four type classes ('projectiles', borers, burins and scrapers), for T112, Oldeholtwolde and Niederbieber I. The most interesting result is that in all three cases the proportion of scrapers is clearly higher in B than in A. Thus, there seems to be a general trend for quarter A to be characterized by a higher proportion of 'projectiles' and quarter B by a higher proportion of scrapers. The picture for the other two type classes is less differentiated.

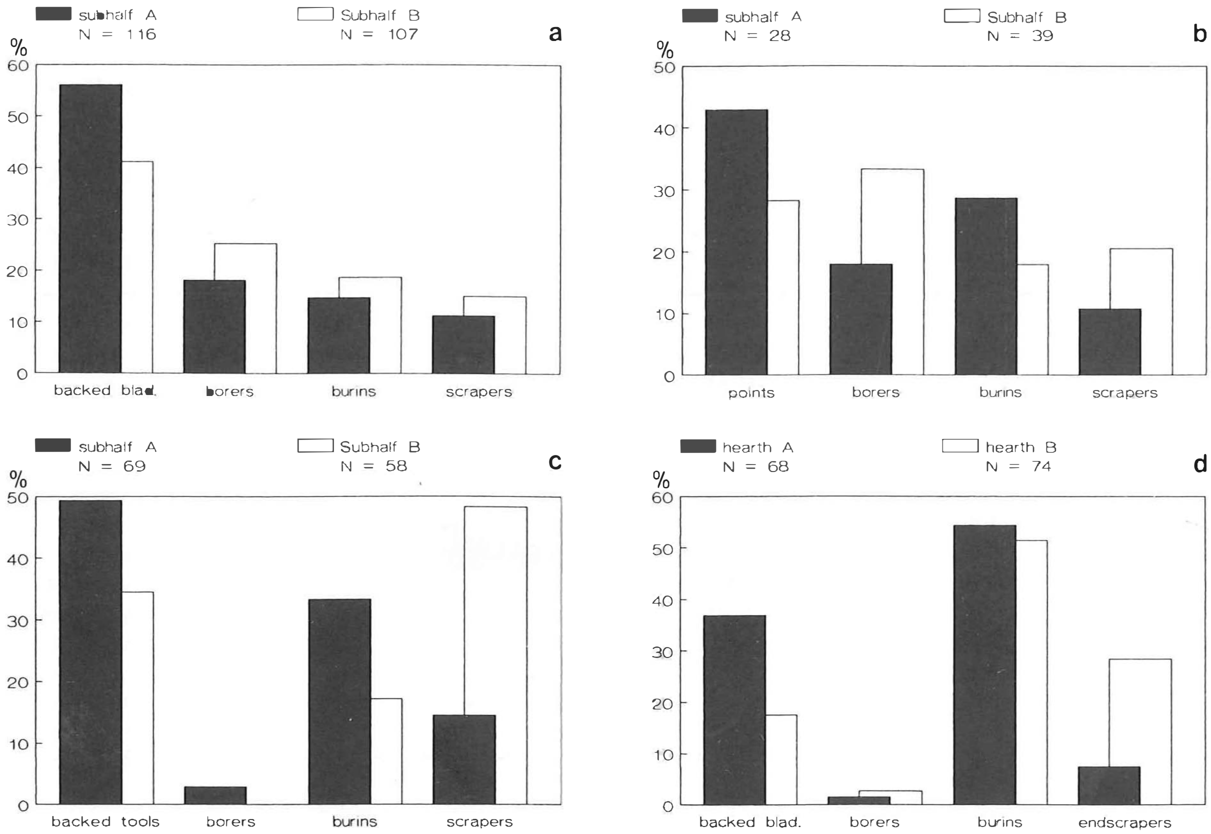

Fig. 74. Proportions of four tool types in the two quarters within the richest site-half. A. Pincevent T112; B. Oldeholtwolde; C. Niederbieber; D. Orp East. In the case of Orp the proportions are based on the tools present in the two areas within 1 m from the centres of the two stone constructions A and B (see fig. 12). It can be noted that in one of the quarters (or, in the case of Orp, areas within 1 m from the hearth centres) there is a higher proportion of 'projectiles' (A), and in the other a higher proportion of scrapers (B).

I do not want to suggest that scrapers were used exclusively by women. The data only suggest that when both men and women were present, scrapers were used more frequently by women than by men. It is interesting in this connection to return to the site of Orp East. We saw in section 8 that here possibly two hearths were present, set close to one another (fig. 12). The southern one (A) is associated especially with backed bladelets, and the northern one (B) with endscrapers (figs 13 and 14). I have counted the frequencies of backed bladelets, borers, burins and endscrapers within 1 m from both hearth centres, and presented these as percentages per subspace in a similar diagram as used for the quarters A and B in the cases of T112, Oldeholtwolde and Niederbieber I (fig. 74d). A possible hypothesis now is that a family lived here in the open air, and that the man or men and the woman or women used separate hearths, located close together.

Ploux (1989) attempts to distinguish individual flint knappers by studying their *niveaux de technicité* on the basis of refitted nodules. She concludes that at unit M89 about five different flint knappers were active: a young child, at least two adolescents, and two or three adults, of whom the most competent did the bulk of the flintworking documented at this unit.

In my opinion, this result is not necessarily incompatible with my hypothesis that most of the *foyers domestiques* in Niveau IV-2 accommodated families. One of the problems in this connection is that we do not know whether women also participated in flint-working.

Of great interest is an isolated flintworking station in the periphery of unit M89. A core was worked here in an 'academic' way, and all products, many good blades included, were left at the spot. It seems that a highly skilled flint knapper gave a 'demonstration' here for the benefit of young students of the art of flint knapping (see also Olive, 1988; Pigeot, 1987). The presence of children, suggested on the basis of refitting analysis, would seem to imply the presence of women. However, this is not proved beyond doubt, because it is also possible that boys did some flint knapping when accompanying hunters on hunting expeditions.

Accepting the evidence presented in this section implies that we can add an attribute to the definition of Groups X and Y: sites in Group Y tend to have different quarters A and B, in terms of tool assemblages, while those of Group X do not (fig. 75).

This tendency towards differentiated quarters within the richest site-halves in my view is the strongest indication for ascribing the sites of Group Y to families. I have not attempted to demonstrate the existence of systematical relationships between this attribute and the four others. However, if one compares the Fisher p's given in table 4 with the centrifugal indexes of the same sites, a significant 'correlation' is found (rho = -0.73, two-tailed p = 0.02), but this is an invalid procedure because the results of significance tests are strongly dependent on sample sizes.

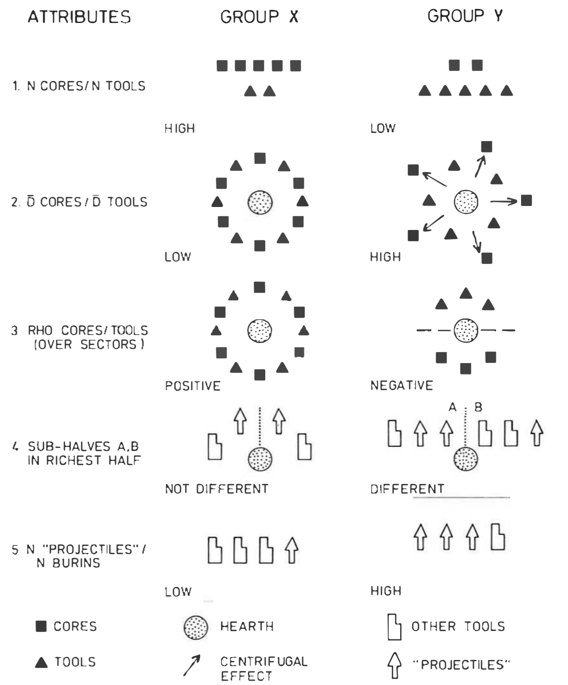

Fig. 75. Classification of units/sites into two groups (X and Y). The sites of Group X show no centrifugal effect, nor any spatial segregation of tools and cores in their sector distributions; moreover, these sites show a relatively large number of cores in proportion to tools, and a large number of burins in proportion to 'projectiles'. For the sites of Group Y the reverse is true. Sites in Group Y show a tendency for quarters within the richest site-half to differ in terms of proportions of 'projectiles' to other tools (borers, burins and scrapers), while this is not the case in the sites assigned to Group X. One explanation could be that most of the sites of Group Y were occupied by families, and those of Group X by small groups of men (hunting camps or 'special-purpose camps').

I would like to summarize the results in the form of some rough generalizations. These are largely speculative, of course, but nevertheless founded on quantitative data. The problem is that this kind of quantification can never be very strong; there will always be a large gap between data of this type and convincing interpretations. Therefore, I regard the following sweeping statements largely as targets for future attack:

a. If 'projectiles' are found clustered near the hearth, at least one man was present.

b. If a clear centrifugal effect can be demonstrated, at least one woman was present.

c. If both phenomena can be observed, probably a family was present.

In the first proposition the important point is the clustering near the hearth (see section 11).

The second proposition needs a comment. Several readers of a first draft of this paper have told me that this is an ethnocentric statement. However, I intend it to be only a summary of the statistical data presented in this paper. Groups X and Y are created on the basis of five attributes (see fig. 75). Only one of these points to the presence of women in sites of Group Y (different quarters within the richest site-half). Of these five attributes, only the centrifugal index does not show an overlap between the units of Niveau IV-2 and Habitation 1 (see sections 14 and 19). Hence, if one wishes to select only one attribute, a 'rule of thumb' for deciding whether women were probably present, the centrifugal index seems to be the best choice.

These three propositions are only a way of summarizing the whole house of cards, which is not only composed of quantified phenomena, but also of hypotheses regarding the meaning of these phenomena. These interpretations may be arbitrary, but the statistical patterns seem to be quite clear, and hence in need of an explanation. It remains to be seen whether these patterns will repeat themselves in sites other than those included in my sample.

21. SOME CONCLUSIONS

In this paper I have investigated the potential of the ring and sector method for intrasite spatial analysis of sites with a central hearth. Some results achieved so far on the basis of eleven units at Pincevent and several other sites on the North European Plain (fig. 11) will be summarized below.

The ring distributions of tools (all types taken together) appear to fall into two groups: unimodal and bimodal distributions. It is concluded that bimodal distributions are characteristic of hearths inside tents, while unimodal distributions are probably associated with hearths in the open air. All analysed units of Pincevent (eight in Niveau IV-2, three in Habitation 1) show unimodal distributions, suggesting that the hearths of Pincevent were all in the open air – not inside tents.

If the ring distributions of individual tool types are investigated, it is found that backed bladelets (and other 'projectiles') are systematically located closest to the hearths, and blade endscrapers farthest away, while borers and burins are intermediate in this respect. This pattern can be explained by assuming that in the retooling of 'projectiles' (backed bladelets) heat was needed, while hide-working (scrapers) required quite a lot of space. There is only one unit at Pincevent that deviates from this general pattern: R143 could be a 'special-purpose' site. The same applies to Marsangy N19.

All analysed sites show a marked asymmetry, in the sense that on one side of the hearth many more tools are found than on the opposite side. It is concluded that the richest site-halves were the halves where people would have been sitting and working most of the time.

Given the above conclusions, it is possible to reconstruct the prevailing wind directions during the various habitations. It is concluded that westerly winds prevailed, as they do nowadays.

The tendency for larger objects to end up farther from the hearth than smaller pieces is called the centrifugal effect. This tendency will show up especially if a backward toss zone as defined by Binford (1983) was present. All units of Niveau IV-2 were found to show a clear centrifugal effect. In Habitation 1, however, this tendency toward spatial segregation of larger and smaller debris seems to be absent, and this is also the case at Marsangy N19 and Bro I.

Habitation 1 and Niveau IV-2 also proved to be different in another respect: the sector distributions of cores. In Habitation 1 the sector distributions of cores are similar to those of tools, while in Niveau IV-2 these two groups of artefacts tend to show a negative correlation, thus pointing to the existence of a forward toss zone. Again Marsangy N19 and Bro I are similar to Habitation 1, in that a forward toss zone cannot be demonstrated.

Hence, there seem to be two types of sites: sites showing clearing patterns and sites that do not. The first is called Group Y, which is furthermore characterized by a relatively low proportion of cores to tools, and by a relatively high proportion of 'projectiles' to burins. For the other type, called Group X, these patterns are reversed. It is hypothesized that sites of Group X might be hunting camps, or 'special-purpose camps', occupied by men only, and most sites of Group Y family camps.

Some support for this hypothesis is provided, by comparing the two quarters within the richest site-halves. It is found that at least in some sites of Group Y there is a tendency for these two quarters to be different: one has a higher proportion of 'projectiles', the other a higher proportion of scrapers. This difference, suggesting the presence of at least one man and one woman, seems to be absent in sites of Group X.

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23. NOTES

1. Niveau IV-2 at Pincevent has recently been relabelled as Niveau IV-20 (P. Bodu, pers. comm.).
2. In 1990 unit J116 in Niveau IV-40 was analysed (Stapert, in prep.; see also Moss, 1987). It turns out to be quite similar to the units in Niveau IV-2, except for the fact that the ratio of cores to tools is higher (but many pieces classified as cores in fact are merely *rognons testés*). For example, again backed bladelets are located closest to the hearth, and scrapers farthest away. On the basis of the five attributes described in sections 19 and 20, unit J1 16 can be placed in Group Y (centrifugal index 1.95; % of N tools in R / % of N cores in R 1.26; N cores / N tools 0.39; N backed bladelets / N burins 1.59; difference between quarters A and B within R: $p<0.01$). The reconstructed prevailing wind direction is roughly NNE.
3. It is satisfying that these three units all have reconstructed westerly prevailing winds (figs 9 and 40).

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