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POSTDEPOSITIONAL ARTEFACT SCATTERING IN A PODZOL. PROCESSES AND CONSEQUENCES FOR LATE PALAEOLITHIC AND MESOLITHIC SITES

ABSTRACT: Most West European sites are located on aeolian deposits that, probably, were aggraded, anterior to human occupation. Often the deposit top has been eroded or became included in a plough zone. Only under exceptional circumstances, has the whole Holocene soil horizon sequence been preserved. In order to interpret artefact distribution at such sites, one has to answer the question where was the original occupation horizon. Field observations and experimental work suggest that, in the sandy deposits because of faunaturbation, artefacts moved down from their original position. We may presume that the artefacts started their descent from the ancient surface, that in most cases corresponds to the present one. Consequences hereof are very important for the archaeological record. It means that the site, even with buried archaeological material is to be considered as a purely surface site, with all implications of possible mixture of later archaeological materials and restrictions for intra-site analysis.

KEY WORDS: Postdepositional processes – Faunaturbation – Late Palaeolithic – Mesolithic – Podzol – Artefact distribution

Herrn Prof. Dr. Gerhard BOSINSKI, Universität Köln, gewidmet.

INTRODUCTION

In the sandy landscapes of Western Europe, many Late Palaeolithic and Mesolithic sites have been excavated. Artefacts normally occur in sandy deposits, scattered in the Holocene soil horizons of a humic-iron podzol. Stratigraphy *(Figure 1)* of such sites has been discussed only occasionally (Vermeersch 1975, 1976, 1977 and in print). Unfortunately, most authors have not commented on the stratigraphic position of the artefacts they excavated. The pedostratigraphic artefact position can suggest several interpretations regarding their cover up process. The answer given to the question of the original position of a living horizon is essential for the interpretation of the environmental conditions that prevailed during the occupation. It, moreover, determines the conversion of a living floor to an archaeological horizon. Understanding this process is important for evaluating possibilities of an intra-site artefact distribution analysis.

The artefact vertical scatter in eluvial or illuvial horizons should partially be understood as the result of postdepositional processes. These processes are not yet well understood. It might be that aeolian accumulation, posterior to the human occupation, resulted in a covering up of the artefacts. Bioturbation might be responsible for the vertical scatter. However, it might be that only bioturbation is responsible for the present pedostratigraphic position of the artefacts.

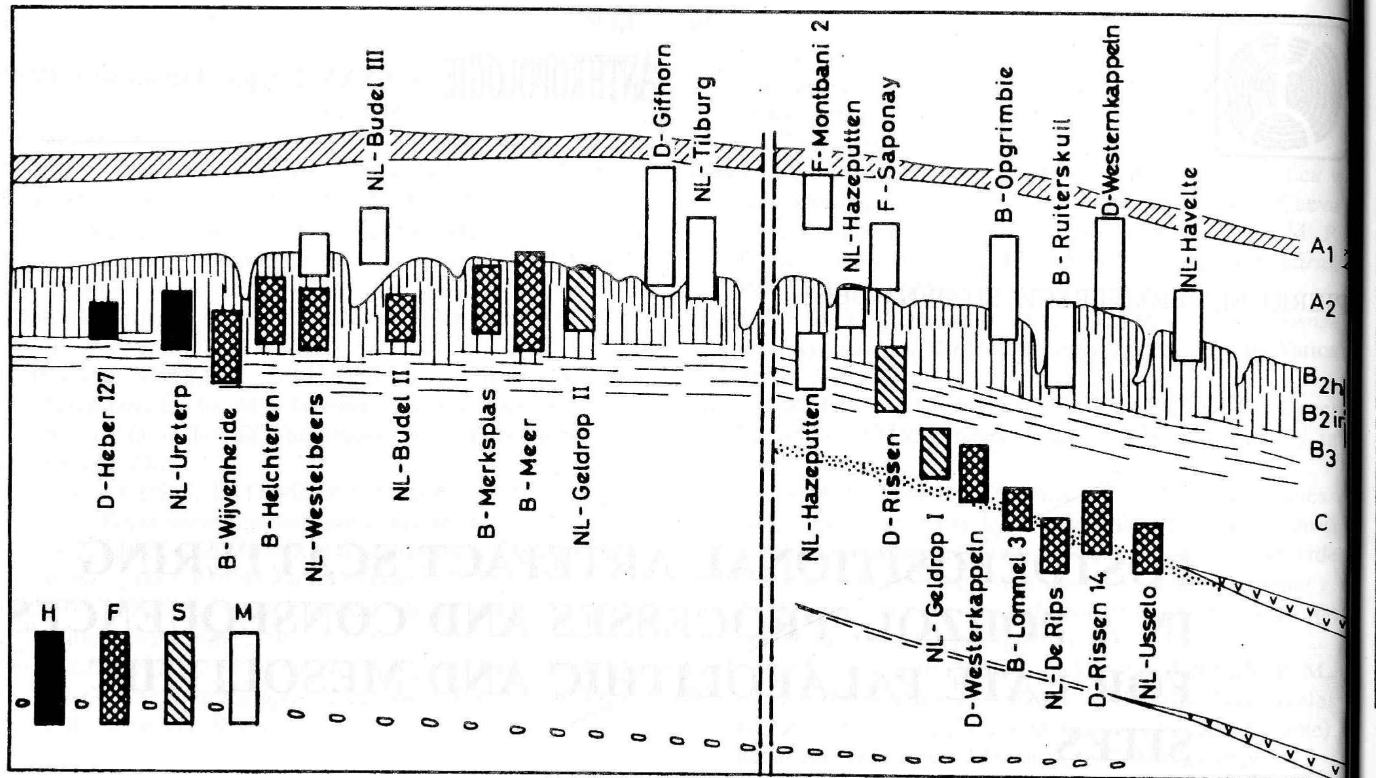

FIGURE 1. Pedostratigraphic position of some Late Palaeolithic and Mesolithic (H: Hamburgian; F: Federmesser; S: Stilespitzen Gruppe; M: Mesolithic) assemblages of Western Europe.

STRATIGRAPHIC POSITION OF SITES

In some instances, the deposits above the artefacts have been interpreted as resulting from aeolian accumulations, posterior to the late-Palaeolithic or Mesolithic occupation. It is important to remember here that an aeolian cover requires specific environmental conditions allowing deflation. All over the sandy areas of western Europe, the very dry conditions of the Late Glacial Maximum resulted in an aggradation of cover sands, which created a sand sheet topography, so typical for sandy areas in north-western Europe. Aeolian activity was stopped when vegetation was covering the landscape, in casu during the Bölling and the Alleröd. Renewed, but always locally restricted, aeolian activity existed during the Dryas-periods and the early Preboreal (Vermeersch, Munaut, Hinout 1973) because of the restricted vegetational cover of the landscape at that time. Once the vegetation cover was dense enough, which clearly was already the case during large parts of the Preboreal, all aeolian activity was stopped and pedogenesis affected the aeolian sand surface. Because of a very dense vegetational cover, generally no aeolian activity was recorded in Europe during the Boreal and the Atlantic period. We may thus presume that some of the Epipalaeolithic sites can be situated on Tardiglacial dunes whereas others and most of the Mesolithic ones have been installed on the surface of Late Glacial deposits.

Only very rarely, are single occupation horizons restricted to a thin sediment horizon with very restricted vertical artefact scatter. If such an occupation horizon can be identified, aeolian sands covering it up refer to certain environmental conditions posterior to the occupation. Most often, artefacts are not restricted to a thin occupation layer but are vertically scattered over more than 30 cm, making it very difficult for prehistorians to decide if they are excavating a single or a multiple occupation site. Deforestation by Neolithic and later human occupation created renewed possibilities for aeolian deflation and dune formation. Such dune sand accumulations are restricted in extent and occur only locally. They do not cover extensive landscape surfaces in western Europe. When such dune sand cover Epipalaeolithic or Mesolithic sites, an important sedimentation hiatus, characterised by a long period of pedogenesis, is to be considered. In order to explain the difficulties that arise in the interpretation of the stratigraphy and the pedostratigraphic position of sites, we will review some sites.

Archaeological remains covered by aeolian deposits

Hainholz-Esinger Moor

The Federmesser Hainholz-Esinger Moor site in northern Germany (Bokelmann, Heinrich, Menke 1983) is clearly covered by Younger Dryas aeolian sand. The excavation report is not explicit, but it seems that the occupation horizon is thin and resting on top of an Alleröd soil. There is, apparently, no important vertical artefact scatter.

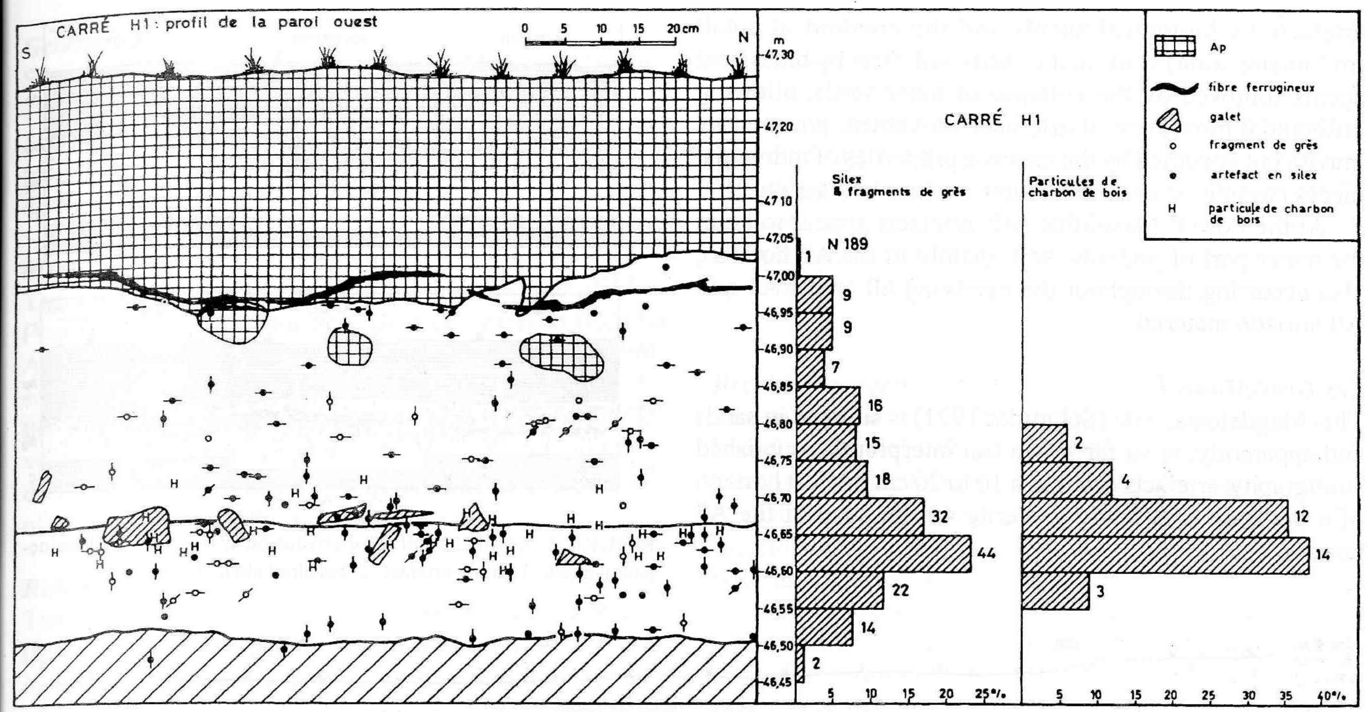

FIGURE 2. Vertical artefact distribution at the site of Neerharen-De Kip.

Neerharen-De Kip

The early Mesolithic site of Neerharen-De Kip (Lauwers, Vermeersch 1982), near the Rekem site, was situated in aeolian sands and was covered by plaggen of Iron Age period. Soil horizons were not well developed, probably because they were destroyed by the Iron Age occupation. Vertical artefact scattered had a unimodal distribution over about 50 cm (*Figure 2*). In the best represented artefact depth class, large hearth stones seemed to be lined in a single horizon, corresponding with the modal class of charcoal particle density. One gains the impression that the original occupation surface can be traced by the vertical position of the large hearth stones. Here, the Mesolithic occupation level was probably covered by aeolian sand and the artefacts were later scattered in upwards as well as in downwards movement. In the horizons above the maximal artefact density, an important burrowing animal activity was clearly observed.

Archaeological remains near the surface in soil horizons

Westerkappeln

The stratigraphic position of a Federmesser and a Mesolithic assemblage near Bielefeld, Germany (Güther 1973) was studied by K. Brunnacker (1973). The site is situated in a low dune, on top of which a humic podzol was formed. The Mesolithic artefacts were scattered over 10 cm in the A2 horizon, whereas the Federmesser assemblage was scattered over a thickness of about 20 cm in the B/C horizon of the humic podzol. No vertical scatter plans have been published. Brunnacker vainly tried to differentiate the deposits in order to identify several aggradation phases. He recognises the cover up of the Mesolithic material but is not in favour of accepting a prolonged sand accumulation phase into the Postglacial period. He suggests that the artefacts were "etwas in den Boden eingearbeitet" but is unable to identify the active process. The stratigraphic position of the Federmesser cannot be classified because specific horizons, such as the Usselo, are lacking The analysis of opal phytholits in the profile is suggestive for a mixing up of later phytoliths in lower deposits.

Hengistbury

At Hengistbury (Barton 1992), a Late Palaeolithic (ABP-complex) site in southeast England, artefacts are scattered in a very gently undulating band, 50 cm to 60 cm thick, of fine sand (2.5–3) of local origin in which occur the horizons of a podzolic soil. The authors invoke later aeolian activity (deflation and accumulation) to explain the present buried position of the western concentration at Hengistbury. Charcoal fragments from the same level as the artefacts were dated by AMS and provided the following dates: 8.6; 8.1; 7.9; 7.7 and 4.8 ka BP. This situation suggests the charcoal fragments are not contemporaneous with the artefacts but belong to various ages. Collcutt *et al.* (1992) initiated some research on the vertical artefact scatter. They arrived at the conclusion that the dominant processes producing vertical dispersal of the artefacts were various types of biological activity. It was the smaller scale effects, cumulated over relatively long periods, which caused the general vertical distribution pattern to develop. Those effects are direct displacement of at least the smallest artefacts by biological agents and the creation of small (millimetre scale) voids in the sandy sediment by biological agents followed by the collapse of these voids, allowing differential movement of artefacts, movement powered by gravity but governed by the intrinsic properties of individual pieces (weight, shape, orientation, surface texture, etc.).

At the Powell Mesolithic site, artefacts appear to be in the upper part of podzolic soil, mainly in the A2 horizon, also occurring throughout the overlying 60 cm of A1 and A0 horizon material.

Les Gros-Monts I

This Magdalenian site (Schmider 1971) is situated in sands and apparently, in so far as we can interpret the published stratigraphy, artefacts occur in a 10 to 20 cm thick B horizon of a podzolic soil, below a sterile 40 cm sand of the A2 horizon.

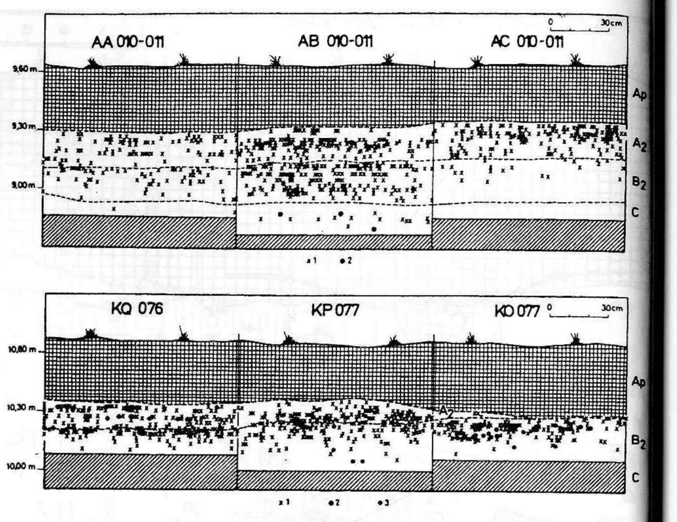

FIGURE 3. Vertical artefact distribution at the site of Weelde-paardsdrank; 1: stone artefact; 2: hazelnut shell; 3: charcoal.

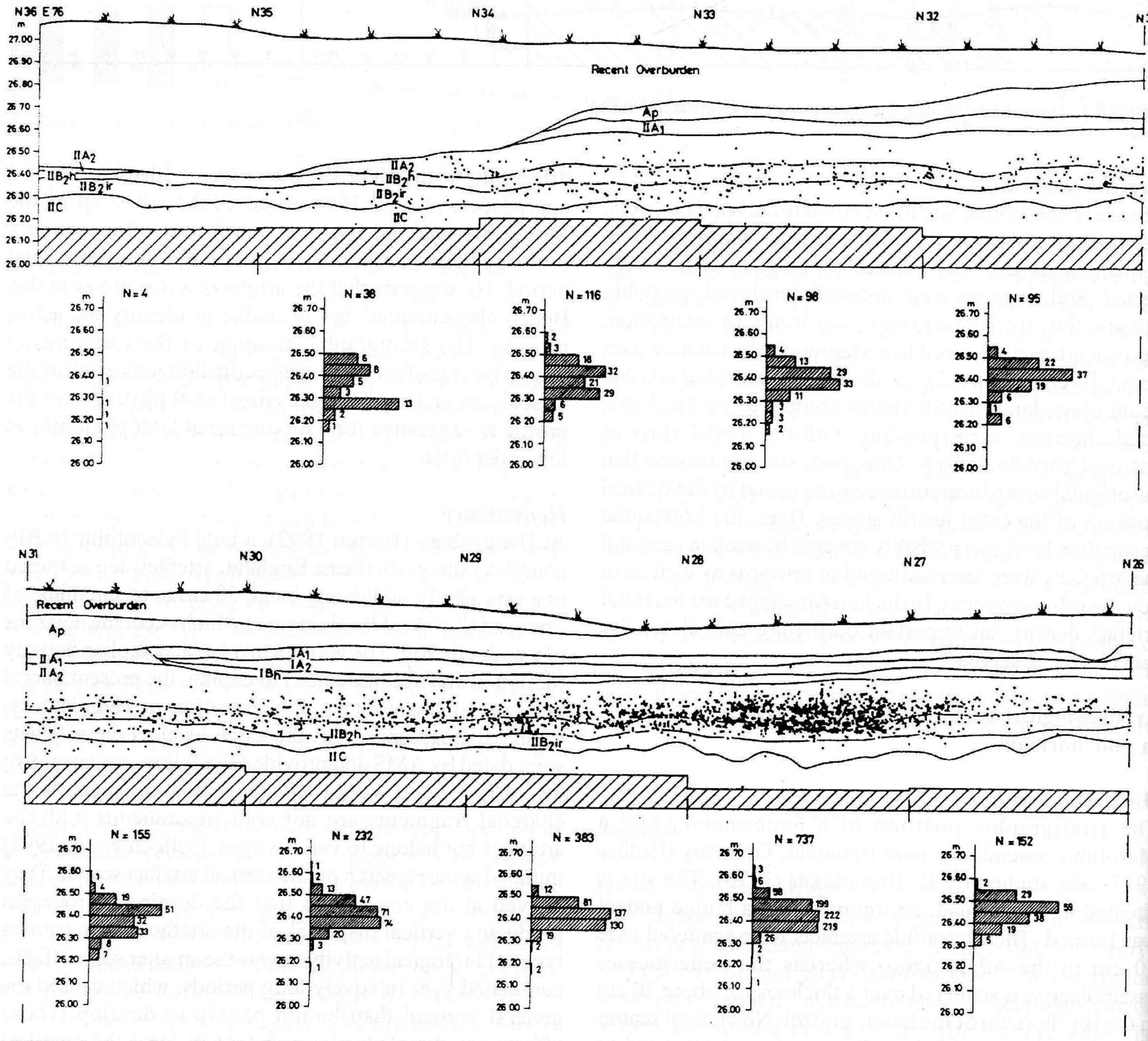

FIGURE 4. Vertical artefact distribution at the site of Brecht-Moordenaarsven 2.

Geldrop

Several sites have been excavated at Geldrop (Deeben 1995), in southern Netherlands. Geldrop 3-0, an early Mesolithic site, provided artefacts scattered in the A2 and the top of the B2 horizon of a podzol. The top layer was destroyed.

Meer

The vertical scatter at the Late Palaeolithic site of Meer (Van Noten 1978), in northern Belgium, extends from the A2 of a podzol down to the base of the B/C horizon, sometimes more than 70 cm. Most artefacts are situated in the B2h horizon. Moeyersons (1978) suggests that the vertical scatter might be produced by the microtopography during the occupation, trampling, human pits or the activity of roots and other biological soil activities.

Rekem

The Late Palaeolithic (ABP-complex) site of Rekem (Lauwers 1988, Caspar, De Bie 1996), along River Maas in northern Belgium, was covered by occupation deposits of a Gallo-Roman site. Artefacts are scattered in a loamy cover sand over a depth of about 40 cm in a brown podzolic soil. Charcoal fragments from a dense artefact concentration collected in the same horizons as the artefacts gave several "unacceptable" dates: 2.2; 6.4 and 9.9 ka BP. None of those dates seems to be coeval with the Late Palaeolithic occupation, which was well dated at 11.350 ± 150 BP (OxA-942) (Gowlett *et al.* 1987) by resin from a backed bladelet point. Like at Hengistbury, charcoal fragments, stratigraphically quite well associated with the artefacts, seem to belong to different periods.

Weelde

The late Mesolithic site of Weelde-Paardsdrank (Huyge, Vermeersch 1982) is situated on a Tardiglacial dune nearby a "ven" (fen). On top of the dune a humic iron podzol was developed. Vertical scattering of archaeological material recovered geologically *in situ* varies considerably all over the excavated area. The A2-horizon, ranging from 10 to 20 cm in thickness, is truncated by ploughing. Still, 56 % of the artefactual assemblage from sector 1 was recovered within undisturbed soil horizons. The truncated A2 horizon together with the B2-horizon yielded most of the lithic material. Within the C-horizon artefacts become increasingly rare. As such, the traceable, though truncated vertical artefact scattering, is considerable and amounts to 30–40 cm, as can be read in *Figure 3*.

According to Gullentops and Dickens (1982), pedological homogenization of 85 cm and burrows to 125 cm, reach rather deep. They conclude that Younger Dryas dune sands were aggraded to about 30 cm below surface. A Holocene brown forest soil developed on it. This was followed by a vegetation (birch woodlands) with increased raw humus production and infiltration of the humic fibres, and finally by heather creating the typical podzol. The upper sand layer was brought in by aeolian activity before this final podzolisation, when the formation of an A-horizon was already well under way.

In our opinion, however, assumption such aeolian activity is in contradiction with the vegetation cover during the late Boreal and the early Atlantic, period of the late Mesolithic occupation at that site, which is presumed to be wooded, preventing local aeolian activity. Moreover, that interpretation does not explain how artefacts could move up to be situated in the upper 30 cm of new aeolian sand.

Brecht-Moordenaarsven

The site of Brecht-Moordenaarsven 2 (Vermeersch, Lauwers, Gendel 1992), north-east of Antwerp, Belgium, has a geographical position very similar to that of Weelde Paardsdrank 5. A stratigraphic profile showing the vertical location of lithic artefacts from a one meter wide transect is given in *Figure 4*.

Below the profile drawing, a frequency diagram with 5 cm spit units is provided. Archaeological materials were scattered throughout the upper portion of the dune. The diagram shows that the largest part of the archaeological remains occurs within 15 cm, but the overall distribution normally extends over 35 cm. The distribution displays a more or less normal Gauss distribution in most of the recorded squares. In the most densely populated squares, N29 and N28, artefacts are tightly grouped around the central spit. However, in N33 and N34, the vertical artefact distribution is bimodal, suggesting eventually the presence of two superposed but merging artefact concentration. In the central squares no indications of superposition of two or more distinct artefact horizons are to be recognised.

The authors stated: "The vertical artefact distribution at BM2 fits probably best with a single artefact horizon. It is, however, not clear if the single artefact horizon also corresponds to a single occupation. In order to be sure about that problem, one should understand the postdepositional processes that affected the occupation horizon(s). Unfortunately, one cannot. The main unsolved problem is the question of the original position of the artefacts. Have they been covered, posterior to the occupation as is assumed by F. Gullentops (1992), by 15 to 20 cm of aeolian sands, and/or is the subsequent vertical distribution a result from trampling during occupation and bioturbation after the humans vacated the site? Did all artefacts migrate downwards from the present IIA1-horizon surface due to bioturbation? In the latter event the Mesolithic occupation horizon would have coincided with the Late Holocene surface (below the Ap and recent overburden). For now, we can only state that the profile does not provide arguments for more than one occupation horizon. It cannot, however, be excluded that more than one occupation took place. Typological composition of the assemblage suggests, indeed, that there are two independent occupations that took place on the same spot, but separated in time by at least one millennium. Artefacts can apparently not be separated according to their elevation in the profile.

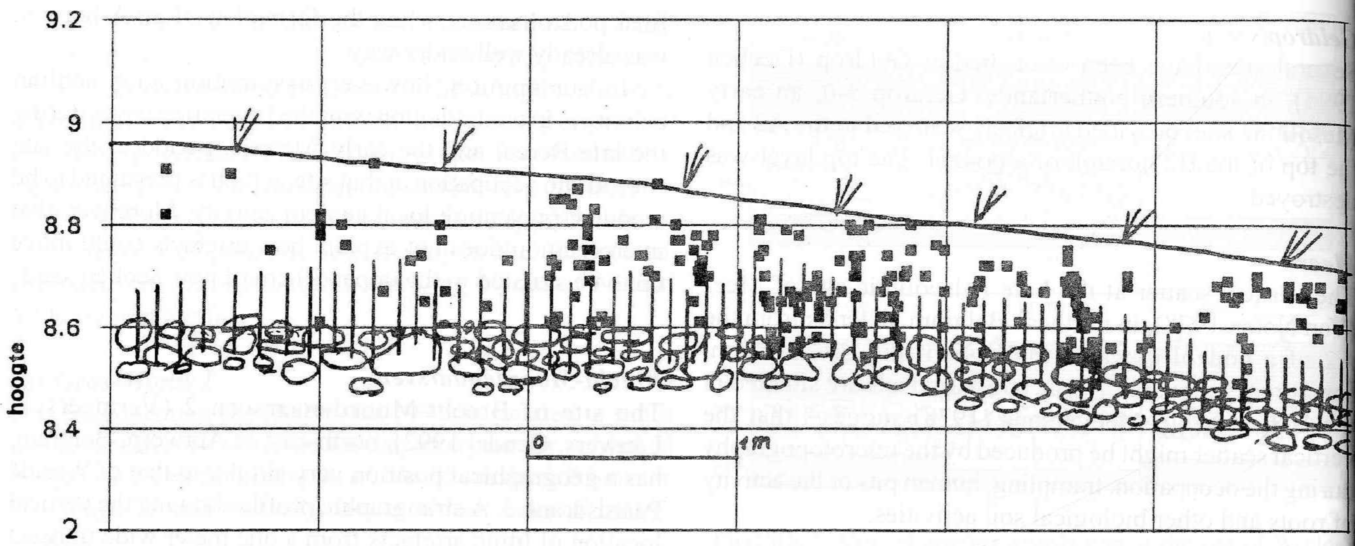

FIGURE 5. Vertical artefact distribution at the site of Zonhoven-Molenheide, where the gravel is preserved. Vertical lines indicate the position of the B-horizon.

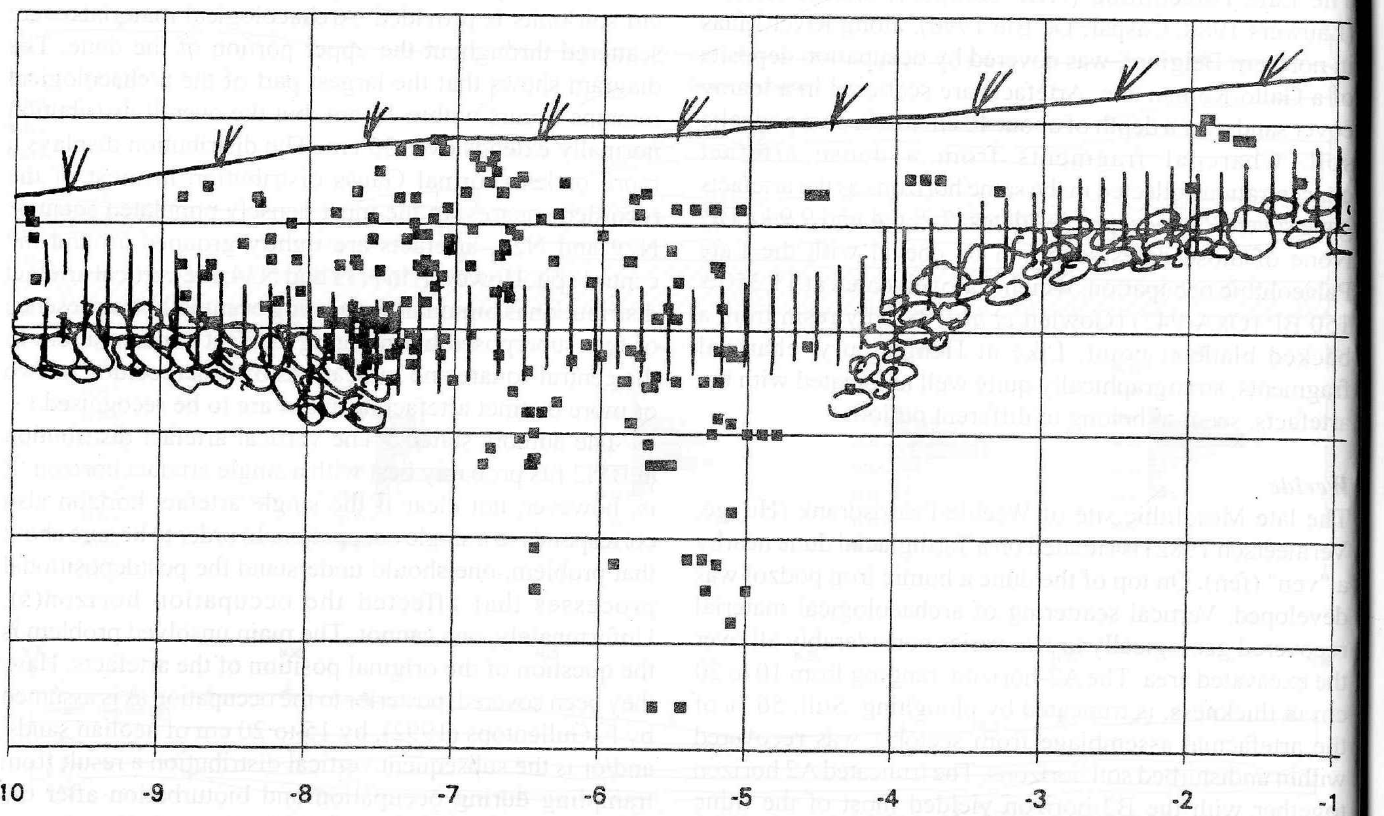

FIGURE 6. Vertical artefact distribution at the site of Zonhoven-Molenheide, where the gravel is not preserved. Vertical lines indicate the position of the B-horizon.

Poppel

Ongoing excavations, under direction of C. Verbeek and one of us in a flat cover sand area at Poppel, north of Antwerp, Belgium, are exploring low density Mesolithic and late Palaeolithic sites. They reveal small artefact concentrations that are mainly restricted to the plough zone. The plough zone is often thick and has destroyed the A and B horizons of a podzol. When, occasionally, parts of the B-horizon have been preserved from destruction by ploughing, they can contain artefacts. Horizontal artefact distribution in the B horizon is the same as in the plough zone, suggesting an original vertical scatter of the artefacts from the surface down into the B horizon.

Zonhoven-Molenheide

Recent observations at Zonhoven-Molenheide 2, northern Belgium, have produced opportunities for a better understanding of artefact burying processes. This site has been created by an Ahrensburgian band and is dated by AMS on charcoal at 10,760 ± 40 (UtC-3720). It served as a hunting camp of short duration (Vermeersch, Creemers 1994, Peleman *et al.* 1994). The site is situated on Oligocene sands that are covered by a discontinuous thin layer of coarse gravels, which are a remnant of a very eroded Middle Pleistocene Meuse terrace. On top of the gravel, about 0.5 to 1 m of homogeneous sands occur.

Presently, a humic-iron podosol has developed, but traces of an older soil, maybe a podzol, are still visible. The older soil attests conditions that were less acid than the present one. Such conditions existed all over the sandy area, anterior to the heath vegetation, that started, due to humans" clearing of the original Atlantic forest, to cover the area from the Bronze Age on (Munaut 1967). This resulted in an increased eluviation of raw humus and the formation of the present podzol (Scheys 1954). In the BC-horizon of that pre-Bronze Age soil, which often can be found below the Bir-horizon of the present soil, numerous animal burrows can be observed. In the present soil, only scarce traces of present faunal activity can be detected. During excavations no traces of soil animals have been encountered. Roots are concentrated in the A1 and in the Bh-horizon. The area was never under agriculture and consequently the original A-horizons are well preserved. The soil horizons are adapted to the position of the gravel layer. Where the gravel deposit is present, the Bh is coinciding with it *(Figure 5);* when absent, the A2-horizon is much thicker. Vertical artefact distribution also clearly relates to the presence of the gravel layer. Where ever the gravel layer is present, artefacts are scattered from the present surface (the original A1-horizon of the soil) down to the top of the gravel layer. When the gravel layer is absent, artefacts have a much more important vertical scatter and can reach to a depth of 1.20 m below the top of the A1-horizon *(Figure 6)*.

There are no reasons to believe that prehistoric man made a pit through the gravel layer dumping his artefacts in it. We presume that the disclosed phenomenon, and especially the important vertical artefact scatter in the gap, could be related to postdepositional processes, which are mainly the flora- and faunaturbation. The question is of course when and how this turbation occurred as, in its present state, the soil is nearly devoid of burrowing animals.

POSTDEPOSITIONAL PROCESSES

From the examples cited it can be inferred that artefacts form only very occasionally a thin occupation layer. This is the case only when the site has been rapidly covered by a thick aeolian sand sheet. This is a rather exceptional situation. Most often, Late Palaeolithic and Mesolithic sites occur near the present surface and their artefacts are scattered in the horizons of the present podzol. Over the past century it has been discovered that cultural patterns, such as the presence of a thin occupation horizon, can be destroyed by the activities of man and any of the many natural processes. The archaeological record is a product of both behavioural and natural environmental processes (Schiffer 1972). Archaeologists are only now realising the danger of directly connecting past cultural activities with the spatial patterning of archaeological remains. The question today remains, to what extent has the original position of the artefacts changed, and if their present position is a representation of the occupation period. Study of taphonomy and postdepositional processes became a necessity. Let us shortly review the most important postdepositional processes, which could affect sites on sandy deposits.

Trampling

Trampling was often invoked as an important process to lower artefacts into sediments. However, contrary to what had been expected, a trampling experiment by Barton (1987) revealed that few of the pieces from an artefact scatter on a sandy surface had travelled more than one or two centimetres downwards from their original positions. One may consequently presume that, at the time of abandonment, due to the effects of trampling, artefacts would have been present in a relatively narrow band, at and just below the surface. It is reasonable to assume that within relatively small areas this band was more or less horizontal. Therefore, trampling cannot be held responsible for a deeper position of the artefacts.

Tree fall or treethrow

For a long time, controversy existed over the origin of some three-dimensional soil features at archaeological sites. Some consider these soil features to be remnants of pit houses (Gramsch). Others consider many of these features to be natural bioturbation features – namely treethrow depressions (Kooi 1974, Newell 1981). We will not discuss in more detail the effects of wind fall, creating specific vertical scatters. This has recently been reviewed by Crombé (1993) and Langohr (1993). The latter argues that, within the area of study, at least one trace of tree fall, reaching a depth of 1 m or more relative to the soil surface at the moment of the event, can be observed over a surface of 100–150 m². This figure is valid for the areas with well-drained soils. In soils with shallow water table or shallow rock substratum this figure increases, but here most of the windthrow structures are not that deep. In our sandy regions, on average one deep windthrow (> 1 m deep) occurred per hectare every 100 years. It is thus an important postdepositional process. Windthrows result in a vertical artefact scatter. According to Crombé (1993), different types occur, resulting from the relative chronological position between windthrow and human occupation. It seems that wind throws are certainly responsible for more extensive changes in horizontal and vertical artefact scatter. Their large scale impact is still to be evaluated. It seems, however, that they could be responsible for very important scatter lay out structure changes, preventing a sensible intra-site distribution interpretation.

According to Schaetzl *et al.* (1990), pit/mound microrelief, characteristic for treethrow, affects pedologic processes. In many regions, soil development is accelerated beneath pits more than beneath mounds. Strongly developed podzolic soils with thick A2 horizons, suggestive of concentrated leaching, are commonly found in pits beneath trees that produce acidic litter. During large scale excavation of Mesolithic artefact concentrations mainly restricted to the plough zone, we observed that artefacts also occurred below the plough zone, but in that case, they always were included in cup-like leached sand, probably due to an earlier treethrow as recorded at Poppel. Similar observations could be made at Donk (Vynckier, Vermeersch 1995).

Earthworm burrowing

Atkinson (1957) and more recently Armour-Chelu and Andrews (1994) have attracted the attention to the effects of earthworm burrowing. Most farmers and gardeners know well that material deposited on the surface of a field or lawn, even if not soluble by rain, will gradually disappear and after a lapse of several years will be found, still as an integral layer, at some distance below the surface. The most obvious example is the mass of stones that litter the surface of any ploughed field, yet soon disappear when the field is put down to grass. On the one hand, soil is brought up to the surface as worm-casts and gradually accumulates there, while on the other hand disused burrows below the surface are constantly collapsing, and thus producing local subsidence of the overlying soil. The net effect of these two related processes is to cause objects lying on the surface to sink below it, while the absolute level of the surface remains unchanged. The resultant rate of sinking of stones and other bodies may amount to as much as 5 mm annually (Cornwall 1958).

According to Stein (1983), soils with medium textures create the best habitats for earthworms. Moisture must be available all year. Earthworms require an abundant food source. Tolerance to changes in acidity varies widely depending on the species involved, but most species cannot tolerate pH values below 5. Such conditions, if not optimal, were probably present in sandy soils of the area when under forest cover. For all of the sites considered, the forest cover during Boreal and Atlantic times evolved from a hazel wood to a forest dominated by lime and oak (Munaut 1967). It is very likely that, under forest conditions of the early Holocene, earthworm population was quite extensive. Since earthworm activity decreases with depth, objects nearer the surface will sink more rapidly than those at a greater depth. Materials left on the surface may, over a long period of time, be concentrated into an "artificial" subsurface layer in which vertical stratification is all but erased and objects of different time periods replaced in spurious association. Their activity can be held responsible for moving down artefacts. The inescapable conclusion to be drawn from these facts is that in many cases significant archaeological finds have been displaced downwards from the position in which they were originally deposited; and in some cases at least the amount of displacement may have been sufficient materially to alter the apparent stratigraphic relationship of the objects concerned.

Nowadays, since the installation of very acid conditions, life has become impossible for earthworms and they have disappeared.

Burrowing activity by other biological agents

We also have to take into account the burrowing activity by cockchafers and/or dung chafers. The presence of their burrowing can be observed in the lower soil horizons where parts of the original forest soil have been preserved. Other larger burrowing animals (Bocek 1986, Erlandson 1984, Hole 1981) should also be taken into consideration. Their activities are often easier to detect.

AN EXPERIMENTAL APPROACH

A small scale experimental approach by Collcutt (1992) resulted in understanding that artefacts can migrate downwards into sandy deposits when collapsing burrows are imitated. Armour-Chelu and Andrews (1994) put up an experiment to look at the effects of bioturbation by earthworms. The limited experiment indicates that deep-burrowing earthworms can disperse small mammal remains both horizontally and vertically. Dispersal was limited but attained at least 20 cm vertically and 15 cm horizontally and smaller bones tended to disperse to a greater depth than larger bones.

The immediate aim of our experimental approach (Bubel, in print) was to investigate the effect faunaturbation has on the archaeological horizon within a sandy environment. Our experiment was designed to artificially simulate the activities of soil animals. Careful attention was paid on achieving a good representation between the experiment and an actual site situation. For example, stone flakes were chosen because these materials best represent the actual assemblage of a site, which in reality, more often survive post-depositional processes than the more fragile artefacts, such as bone. Pure sands were utilised not only because ancient animal burrows at sites located in this type of environment are very difficult to identify, but also because the degree of animal activity effecting these types of sites may have been extensive, causing a large amount of vertical displacement. These independent variables remain constant throughout the experiment for complete control over the parameters. Although this experiment by no means accounts for the variation that occurs in the natural environment, it enables one to determine the effects faunaturbation will generally have on a site, and is unaffected by intrusive problems found in nature.

Experimental setup

A large, 550 litre polyethylene box, with outside dimensions measuring 120 cm by 80 cm by 80 cm, was utilised for the experiment. It was reinforced on the outside with ribs running horizontally and vertically to compensate for the pressure of the sand, reducing the inside dimensions to 108 cm by 70 cm by 65 cm. Holes were drilled on one side of the box only, in order to discern a direct relationship between orientation and dip and the burrow collapses. Results will then be applicable to any direction of burrow holes. Four sizes of holes (0.6, 1.1, 3.3 and 6.4 cm) were chosen to best represent the animal burrows which may occur at an archaeological site. Plastic stoppers were then used to seal the holes. The number of holes drilled increases as the diameter of the hole saw and the drill bit decreases. Clearly more 0.6 cm holes will occur in the natural situation than 6.4 cm holes will. Within the natural environment most animal activity occurs in the upper 30 cm of the soil, dramatically decreasing farther down. Therefore, the holes drilled were concentrated between 10 and 50 cm from the top of the box. Smaller holes are more concentrated in the upper 20 cm, while the larger holes are scattered at depths between 10 and 50 cm, thus creating the best representation of the natural activities of these animals.

Tubes were utilised to simulate burrows. Three sizes of tubes were used, with inside diameters of 5.5 cm, 2.7 cm, 1 cm. A metal rod, 0.5 cm wide, was utilised for the smallest holes. The largest tube simulates the burrowing activities of the largest animals. These would include mammals such as the mole, pocket gopher, and ground squirrel. The medium tube (2.7 cm) imitates the burrows of mice, mole-rats, snakes and burrowing lizards. Holes made by smaller tube (1 cm) depict the action of earthworms, digger wasps, bees, crickets, spiders and larger ants. The rod creates very small burrows in the likeness of termite and other small arthropod activities. Most of the sand used was 190 micrometers and had a sorting index of Inman at 0.44.

Procedure

Once the box was filled with sand 10 cm below the top and the flakes were positioned using a template, the experimental trail was ready to begin. For each of the four trial sets a random selection of the boring order was computed. Following the boring order specific to the trial set, the correct tube was placed into the hole, and pushed slowly through the sand until reaching the other side of the box. Once the tube was in place the sand was removed using a long, thin vacuum hose. When all holes, following the random selection table, had been utilised the trial was complete. Orientation, dip and position measurements of the flakes were then recorded. Changes in orientation, strictly a rotational change within the horizontal plane, were calculated in degrees, as was dip.

RESULTS

All observed and recorded data was collected and analysed to determine if the trials within each set were similar enough to compare as a group. Upon clarification of this, averages were calculated for each set of trails. The measuring error for the experiment was calculated to be approximately 3 mm for vertical displacement and 1 cm for horizontal movement. Results of the average vertical movement within each set of trials display movement ranging from about 2 to 15 cm, with most flakes moving down between 3 and 5 cm. All flakes experienced at least 2 cm of downward displacement. Dip indicated a change from a flat lying flake towards a vertical position. Without making exaggerated claims to the outcome of this preliminary experiment, flake characteristics seem to be directly related to the amount of displacement experienced. Flakes with a weight greater than 23 grams moved the most vertically, while the smallest flakes, less than 5 grams, were the most susceptible to horizontal movement and changes in dip and their orientation.

The experiment took into account the different types of animals active in sandy soils, and the varying sizes of artefacts found at an archaeological site, thus giving a good indication of the effects collapsing burrows will have on a cultural assemblage. A control over the parameters enabled a direct relationship to be drawn between the two, where intrusive elements could not interfere with the results.

The differential movement between the larger and smaller flakes, seen in the experiment, will have disastrous effects on an archaeological horizon. If this is in fact the case, several occupation layers will become effectively mixed, and not stay separated as proposed by previous scholars. Therefore, it would be next to impossible to separate occupational layers of an archaeological horizon. In many cases intra-site relationships will be blurred or even erased from the site.

Application to Zonhoven

The preservation conditions at Zonhoven being exceptional, because of the absence of ploughing destruction, create possibilities for understanding the vertical scatter observed at the site. The older soil attests a vegetation cover that was less acid than the present one. It apparently refers to the vegetation anterior to the heath vegetation, that started to cover the area from the Bronze age on, as a result of human clearing of the original Atlantic forest (Munaut

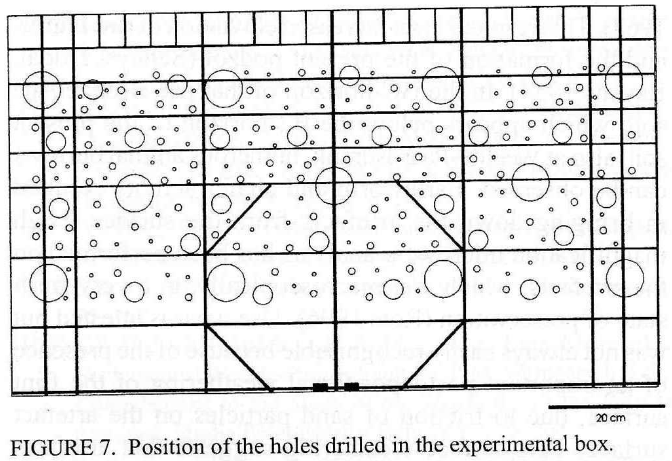

FIGURE 7. Position of the holes drilled in the experimental box.

1967). This resulted in an increased eluviation of raw humus and the formation of the present podzol (Scheys, Dudal, Bayens 1954). In the BC-horizon of that pre-Bronze Age soil, which appears below the B2-horizon of the present soil, also at Weelde-Paardsdrank, numerous animal burrows can be observed. Earthworm and chafer activity resulted in bringing down the artefacts from the surface. High magnification microwear analysis has been performed on the artefacts, which are, macroscopically, in a very fresh state of preservation (Rots 1996). Use wear is attested but was not always easily recognisable because of the presence of an important postdepositional weathering of the flint surface, due to friction of sand particles on the artefact surface. This surface weathering suggests that artefacts underwent an important movement inside the deposits.

The depth of the vertical scatter is here delimited by the gravel deposit that prevents animal burrowing below. Where the gravel layer was absent, the compacting of the deposits may have been reduced, facilitating a deeper burrowing activity. Faunaturbation came to an end when the forest was cleared and heath vegetation was established, probably with the onset of the Subboreal (Munaut 1967). During the excavations it became clear that artefacts occur from the present surface down. As we do not have indication of artefact movement upwards, we can presume that the artefacts were left at the present surface, which was also the surface during the Ahrensburgian occupation. There are also no indications that deposits have accumulated on the surface since the Ahrensburgian people left the site. Such a situation infers that the human occupation occurred on that present surface, from where artefacts have been moving down.

CONCLUSIONS

If we may presume that, on most sites, no sediment accumulation occurred since the onset of the Holocene, than we have to accept that at those sites the Epipalaeolithic, the Mesolithic and all later occupation horizons coincided with the present soil surface. At most sites in the sandy areas of Western Europe, however, the original Early Holocene surface was destroyed by erosion or by ploughing, preventing the observation that artefacts occur from down below the surface. If there was enough time between the occupation and the destruction of the original surface, a situation that fits most of the Epipalaeolithic and Mesolithic sites, artefacts were already moved down into the soil horizons and have consequently (partially) been preserved from destruction. If there was, as probably was often the case, reoccupation of a site during a later period, remains of both occupations moved down, eventually collapsing into a single artefact horizon. This resulted in mixing up the archaeological remains of the successive occupations. We presume that such was the case at the site of Brecht-Moordenaarsven 2 (Vermeersch, Lauwers, Gendel 1992), where remains of a Middle Mesolithic occupation were mixed with those of a Late Mesolithic occupation. Until now, we have no methods to split up such collections. At Brecht-Moordenaarsven 2 (Vermeersch *et al.* 1992), it was tried. One is never sure about the value of the results of such a splitting. As a consequence, it is our feeling that it will always remain difficult to make judgements about the homogeneity of the excavated material of larger sites.

Such conclusions have far reaching consequences. Indeed, most Late Palaeolithic and Mesolithic sites of the sandy regions in Europe can not be considered as closed sites. If several diachronic occupations took place on the same spot, artefacts of the different occupations became mixed in their descent through the sand, caused by bioturbation. If for some sites, doubts rise about the homogeneity of the recovered assemblages, even very precise excavation methods will not clear the problem. The sites should be regarded as surface sites with all the uncertainties, specific for such sites. Even in the cases where sites were covered up by peat deposits from the end of the Atlantic on, we have to consider that the site surface has been open for millennia. It is not astonishing that numerous ^{14}C dates are considered as erroneous: charcoal that has been utilised for dating very often was submitted to the same migration processes as the flint artefact. Even when charcoal fragments are clearly from the same level as the artefacts, there is no reason the accept that the are coeval.

We should try to have a better understanding of the behaviour of the different archaeological remains, which probably do dot display similar migration velocities. Experiments have shown to be useful for understanding the processes involved. More experiments are needed to asses the impact of the faunaturbation on the vertical and horizontal displacement velocities, in relation to shape and weight of the archaeological remains.

The situation of preservation of our prehistoric heritage in sandy soils is in a very bad shape and prospect for the future is grim. The impact of agriculture with its ploughing habit has been very destructive for sites under consideration as the original occupation surface has thereby been destroyed. For most of the Epipalaeolithic and Mesolithic sites in the sandy area of northwestern Europe, where an important vertical artefact scatter occurs, the present surface acted as the prehistoric occupation horizon. That original horizon is now mostly destroyed by human activity. If ploughing was not too deep, an important number of the archaeological artefacts may be preserved below the surface. They are, however, no longer in their original position and should not be considered as remains in primary context. They underwent a movement down from the surface but suffered also a horizontal displacement of unknown magnitude.

We should be very careful in interpreting the intra-site horizontal patterns of archaeological materials. Research will be facilitated if the remains belong to a single occupation. How can we be sure? A very small occupation

scatter can possibly be an indication that the site has been occupied only during a very restricted period. Such an artefact scatter can be the result of a specialised activity. In those situations, only a limited aspect of total material variability may be present, thus limiting the scope of inter-site typological and technological comparisons.

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