Natural wood resources and human demand: use of wood in Iron Age houses in the wetlands of Midden-Delfland

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The Middle Iron Age occupants of the peaty deposits of the Midden-Delfland polders used mainly wood of alder (Alnus spec.) and ash (Fraxinus excelsior) for the construction of their houses. Fraxinus excelsior was not commonly found in the surroundings of the four settlements discussed and we may therefore infer a preference for this species. The range of species used in Midden-Delfland was smaller than that in two other areas containing Iron Age occupation remains which have been intensively studied.

The woodworking methods used were rather uniform. Little use was made of timber; the worked wood consisted mainly of round wood. The wood was usually split; it was worked with axes only. Research has been done into the individual tools used to determine the minimum width of the axes and the minimum number of tools used. In the case of site MD 11.17 this research was unsuccessful: the number of toolmarks was so large that we could not see the wood for the trees.

1. Introduction

Although wood is a commonly used material, it is rarely found in archaeological excavations. In an uncarbonised form this organic material is only preserved under specific conditions involving, for example, peaty soils and a high groundwater level. The polder area of Midden-Delfland (see Abbink this volume fig. 1 for the situation of Midden-Delfland) is one of the places where such conditions can be found. Since 1988 the Institute of Prehistory Leiden has been doing research into the Iron Age occupation of this area. Archaeological and complex post-depositional processes (Abbink this volume) have inverted the archaeological remains and have caused them to sink into so-called peat-fissures. As a consequence of these disturbances it is difficult to reconstruct the plans of the houses. The processes have, however, led to better preservation conditions for the floor layers and parts of the wooden structures which, having sunk into the peat, have been cut off from oxygen by the high groundwater level. Thanks to these processes parts of wood which had been dug and driven into the ground, but even parts of the upper structure of the houses have been preserved.

This article is the first publication on the Middle Iron Age (*c.* 400-200 B.C.) use of wood in Midden-Delfland. It discusses wood from the Duifpolder sites Nos 7 and 17 (MD 11.07 and MD 11.17) and additional information from the Foppenpolder site No. 4 (MD 15.04) and the Aalkeet-Buitenpolder site No. 59 (MD 16.59). After a short introduction to the sites a review will be given of the species that grew in the area and the species which were used in the construction of the houses. Possible preferences for specific wood species will be discussed. Subsequently attention will focus on the observed evidence for different woodworking methods. Finally the toolmarks that have been traced on the wood will be discussed and the way in which those toolmarks were recorded and compared will be explained.

Little research has been done on archaeological wood and only few articles have so far been published on the subject (Coles 1982; Heal 1982). With this article the authors hope to illustrate the extra information that such research can provide on prehistoric man's knowledge of the properties of different wood species, on his skills in working (with) wood and on the tools that he used, which are rarely preserved in the archaeological record.

2. The excavations

Site MD 11.17 in the Duifpolder yielded the remains of a settlement consisting of two NNE-SSW oriented houses (fig. 1: an impression of the excavation of house 1 of MD 11.17) Both houses had been disturbed by fissures. In spite of the disturbances we were able to form an impression of the dimensions of the houses and the positions of posts, stakes and walls by analyzing the excavation plans thoroughly. The fissure of house 1 measured 25 × 5 m at most and that of house 2, 30 × 5 m at most. These reflect the minimal length and width of the houses. The floor layers of both houses were still 80 cm thick in the deepest part of the fissure. Because of their exceptional lengths we assume that both houses had been rebuilt. The presumed (partial) continuity of the different phases is currently being investigated (Koot in prep.). To the east of the houses, at right angles to their longitudinal axes, there was a third shallow fissure of at most 8 × 3 m. It contained some massive posts and fragments of wattle. No clear floor layers

Figure 1. An impression of the excavation of house 1 of MD 11.17, the posts are part of the internal construction of the house.

could be observed in this fissure. Most of the floors consisted of layers of dung alternating with layers of reed and mixed with occupation debris. This small fissure contained only reed and some sherds. Further analysis of the excavation results will hopefully provide an explanation for this.

About 70 m to the northwest of MD 11.17 the site MD 11.07 was found, also a settlement consisting of two houses, of which the E-W oriented western house had been completely undermined. The other house was oriented NNE-SSW; the maximum dimensions of the fissure were 20 × 5 m. The floor layers were about 1 m thick.

In the Foppenpolder the settlement MD 15.04 has been investigated (Abbink 1989). The excavation of this site revealed the remains of six houses, two of which had been relatively well preserved (houses 1 and 2). The orientations of the houses varied; three were oriented NE-SW, two NW-SE and one roughly E-W. The lengths of the fissures associated with the houses ranged from 12 to 20 m. In this case, too, it is almost impossible to discuss the structures of the individual houses because of the disturbances. However, it proved possible to determine the original function of much of the wood recovered from houses 1 and 2: it had served mainly as roof supports and as parts of the walls. A less common discovery was an approximately 2.5 m wide planking in house 2, which may have formed part of an entrance or a partition between the living area and the byre. In addition to the wood of houses 1 and 2, which has been studied and will be discussed in this article, about 350 other pieces of wood were identified. Most of these were found in an area that may have been a kind of industrial platform, as suggested by the iron slags and part of an oven grate found there (Abbink *pers.comm.*).

Finally we will discuss the wood from site MD 16.59 in the Aalkeet-Buitenpolder (Abbink/Frank 1991). The occupation remains at this site had been very badly disturbed by several fissures. The largest fissure measured approximately 30 × 3 m and contained the wood of a NE-SW oriented house. At right angles to the north side of this fissure were several smaller fissures containing occupation debris. The chaotic mass of wood in the fissures probably represented the remains of several building phases. The wood comprised a 12 m long part of the southern wattle wall, which had fallen inwards. Roof supporting posts spaced 2 m apart were observed outside this wall. The wood from the southern part of the site, including that of this wall, has been studied.

3. The wood spectrum resulting from the excavations

Of the three structures of MD 11.17 486 pieces have been described and identified. The following species were encountered: ash (*Fraxinus excelsior*), alder (*Alnus* spec.), hazel (*Corylus avellana*), birch (*Betula* spec.), oak (*Quercus* spec.), willow (*Salix* spec.), blackthorn (*Prunus spinosa*) and maple (*Acer* spec.). In the following discussion the wood of "structure 3" will be left out of consideration, because a) it is unknown what it represents and b) it consists mainly of a small part of wattle.

Houses 1 and 2 yielded 200 and 266 pieces of wood, respectively. It is certain that most of these pieces had been used in the construction of the houses. The pieces probably represent the remains of several building phases, but we have not yet been able to analyze the effects of the post-depositional processes sufficiently to be able to say how many phases there were. We hope to solve this problem through further analysis of the excavation plans in combination with dendrochronological research. Until the results of that research are known we will not estimate the minimum number of trees used for posts and stakes in the construction of the houses. It is, however, possible to make a conversion to pieces of round wood used by adding up the split wood. 'Posts' are here understood to be the upright parts of the structure which served primarily as roof supports. 'Stakes' are the upright parts in walls whose primary function was to add stability to the wall, but they also had a supporting function. Table 1 shows the distribution of the wood species.

The dominance of *Fraxinus excelsior* is obvious. This species was used especially for the load-bearing parts of the structures: the posts and stakes. Thin branches and twigs of *Alnus* and *Corylus avellana* were used for wattle. *Fraxinus excelsior* was also used for wattle, in which case its branches were usually split. Split wood was commonly used for the load-bearing parts of structures. In figure 2a

Table 1. The woodspectrum of the excavation MD 11.17 (the construction of the houses 1 and 2 is also showed separately).

	total	house 1	house 2
Fraxinus excelsior	382 (78.6%)	175 (87.5%)	201 (75.6%)
Alnus spec.	63 (12.3%)	20 (10.0%)	41 (15.4%)
Corylus avellana	20 (4.1%)	3 (1.5%)	17 (6.4%)
Betula spec.	8 (1.6%)	1 (0.5%)	2 (0.8%)
Quercus spec.	4 (0.8%)	-	4 (1.5%)
Prunus spinosa	1 (0.2%)	1 (0.5%)	-
Acer spec.	1 (0.2%)	-	1 (0.4%)
Salix spec.	1 (0.2%)	-	-

and b the results are given of the research discussed above.

Site MD 11.07 was found 70 m to the north of MD 11.17. The two sites were very similar. In total 119 pieces of wood were identified, 19 of which were *Alnus* (16%), the other 100 being *Fraxinus excelsior* (84%). (fig. 3). It is likely that all of the identified pieces were used to construct the two houses although we have not yet been able to ascribe all of the pieces to one of the two houses. In the following discussion the evidence from this site will be considered as one sample.

About 650 pieces of wood from site MD 15.04 have been identified; 93 of these pieces have been ascribed to house 1 and 201 pieces to house 2. Table 2 shows the use of *Alnus*, *Fraxinus excelsior*, *Corylus avellana*, *Salix*, *Acer*, *Prunus avium/cerasus* and *Quercus* as building materials. The other identified pieces which have not yet been ascribed to one of the two houses include pieces of the above range of wood species plus a number of new species: purging buckthorn (*Rhamnus catharticus*), guelder rose (*Viburnum opulus*), bog myrtle (*Myrica gale*) and probably spindle-tree (*cf. Euonymus europaeus*).

Table 2. The woodspectrum of the houses of the excavations MD 15.04 and MD 16.59

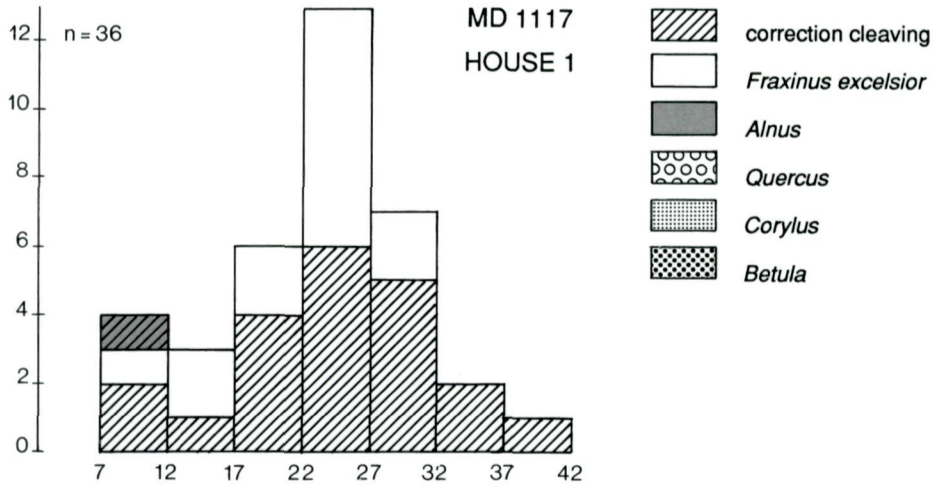
	MD 15.04 house 1	MD 15.04 house 2	MD 16.59
Fraxinus excelsior	47 (51%)	95 (47.3%)	70 (28.7%)
Alnus spec.	35 (38%)	89 (44.3%)	155 (63.5%)
Corylus avellana	-	1 (0.5%)	5 (2.0%)
Quercus spec.	-	1 (0.5%)	-
Acer spec.	3 (3%)	1 (0.5%)	4 (1.6%)
Salix spec.	2 (2%)	8 (4.0%)	8 (3.3%)
Prunus avium/cerasus	-	1 (0.5%)	-
Rhamnus catharticus	-	-	1 (0.4%)
Ulmus spec.	-	-	1 (0.4%)

224 pieces of wood from the southern part of site MD 16.59 have been identified, 33 of which belonged to the aforementioned wattle wall: *Alnus*; 16 (49%), *Fraxinus excelsior*; 14 (42%) and *Corylus avellana*; 2 (6%). All of these pieces had been used in the construction of the same house; see table 2 for the distribution of species. The high percentage of *Alnus* is striking compared with the evidence obtained for the other sites. This species was frequently used in wattle, at least in Midden-Delfland. *Alnus* may be overrepresented because many pieces of wood had diameters of less than 5 cm, which implies that they probably formed part of wattle. If these pieces are left out of consideration the distribution becomes: *Alnus*; 72 (63.3%), *Fraxinus excelsior*; 38 (33.6%), *Corylus avellana*; 1 (0.9%), *Salix*; 1 (0.9%) and *Rhamnus catharticus*; 1 (0.9%). The proportions hardly change and the conclusion must therefore be that *Alnus* was the main species used in the construction of MD 16.59. Table 2 shows the distribution of wood species ascribed to the houses of MD 15.04 and 16.59.

In summary it can be concluded that *Fraxinus excelsior* and *Alnus* were the most commonly used species; next came *Corylus avellana*, which was used much less frequently. Species like *Quercus*, *Betula*, *Acer* and *Salix* were used incidently. Other species encountered are *Prunus spinosa*, *Prunus avium/cerasus*, *Rhamnus carthartica*, *Ulmus*, *Viburnum opulus*, *Myrica gale* and *Euonymus europaeus*. The greater part of the identified wood had been used in the construction of the houses.

4. The local wood vegetation and preferences for specific types of wood

By reconstructing the environments in which the settlements were situated we can determine how prehistoric man used the local wood vegetation. The four settlements studied were built on local oligotrophic peat cushions, which were restricted in size. Remnants of these oligotrophic peat cushions were observed beneath the floors of the Iron Age houses in Midden-Delfland. The houses had been built on a decomposed surface peat. In some cases peatmoss (*Sphagnum* spec.) and cottongrass (*Eriophorum* spec.) was observed. Palynological research of samples taken from different places at site MD 15.04 (Brinkkemper 1991, 14) showed the local development. The area was originally a raised bog where *Betula* and Ericaceae predominated. In the bog margins grew *Alnus*. Some *Corylus avellana* and *Quercus* grew on mineral soils further away. Dehydration led to the formation of a bog myrtle brushwood with Graminaeae and Ericaceae. The last stage was a drained raised bog with an oxidised surface. The peat cushions were surrounded by an open, wet reed vegetation



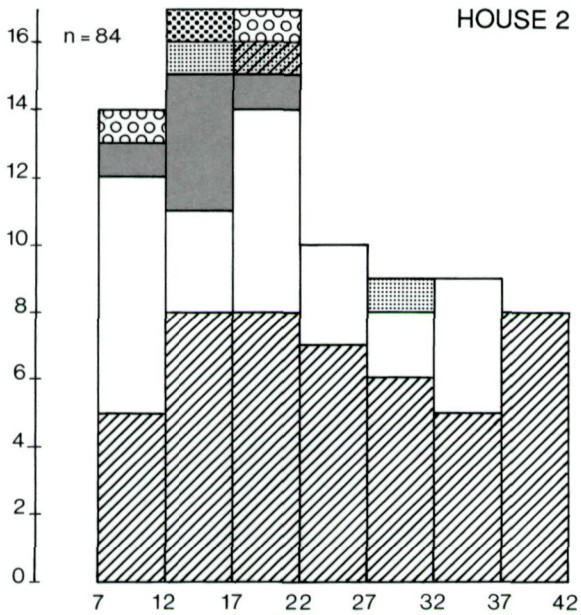


Figure 2. The bardiagrams give the number of pointed stakes and posts (y-axis) per circumference class. The distribution of wood species used is also shown for each circumference class (x-axis, cm). Per species and per class the correction for cleaving is given (hatched). This is the conversion of cleaved wood into round wood. Thus the three stakes of Fraxinus excelsior in the circumference class 7-12 cm of figure 2a represent two pieces of round wood and the stake of Alnus is a cleaved piece of wood and represents therefore one piece of round wood.
Figure 2a refers to the stakes and posts of MD 11.17 house 1 and figure 2b to MD 11.17 house 2.

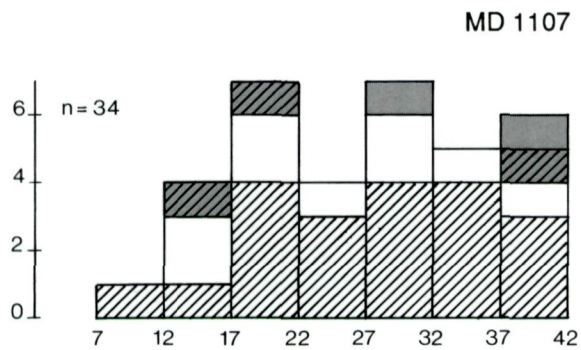


Figure 3. The distribution of stakes and posts among species and circumference classes for site MD 11.17, see figure 2 for the description of the diagram.

(Brinkkemper 1991, 20). This development corresponds well to developments due to marine influences observed in other Dutch coastal pollen diagrams (Brinkkemper 1992).

A similar environment has been reconstructed for "house Q", an Early Iron Age settlement which has been excavated in the Assendelver Polders (Therkorn *et al.* 1984). The pollen diagram of this site shows, in order of their dominance, *Salix*, *Alnus*, *Quercus*, *Fagus sylvatica*, *Betula* and *Ulmus* (Groenman-van Waateringe 1988, 142). The first two species grew in the environment described above, the others in the dunes. The species used most in the construction of house Q are *Alnus* and *Salix*, followed by *Fraxinus excelsior*, *Quercus*, *Betula*, *Corylus avellana* and *Acer*. Five other Iron Age pollen diagrams obtained for the Assendelver Polders present a similar picture. The most common species is *Alnus*. The following three places are taken by *Quercus*, *Fagus sylvatica* and *Salix*, in different orders; sometimes *Corylus avellana* ranks high while species like *Betula* and *Ulmus* rank lowest (Groenman-van Waateringe 1988, 143).

A third region with the same kind of landscape in the Early and Middle Iron Age was on the island of Voorne-Putten, which was covered with a fen peat with some alder carrs, where a few *Salix* trees grew besides *Alnus*. The fen peat included a few small areas of sparsely wooded raised bog. The proper woods were to be found on the higher levees and in the dunes (Brinkkemper/Vermeeren 1993, 113).

From the above it may be concluded that *Alnus* and probably also *Salix* grew in the surroundings of settlements MD 11.07, 11.17, 15.04 and 16.59, although the presence of the last species still has to be confirmed by more pollen diagrams from Midden-Delfland. The other species grew on soils with a higher mineral content, such as levees, stream ridges and the dunes (see also Orme/Coles 1985, 7-14; Van der Meijden 1990 for descriptions of a. the species mentioned and b. peaty wetlands). Those soils were not always to be found close to the settlements.

Comparison of this conclusion with the results of the research into the wood from the four settlements leads to the following observations. *Alnus* was used most in the construction of MD 16.59[1], but *Fraxinus excelsior* is also well represented. Both species had been used in almost equal proportions in the houses of MD 15.04 whereas mainly *Fraxinus excelsior* had been used in the construction of the houses of MD 11.07 and 11.17. This species had been used more than would be expected on the basis of its natural occurrence in the immediate surroundings of the settlements, which suggests a preference for this type of wood.[2] This preference is not strange in view of the elasticity and toughness of this type of wood, which properties make it very suitable for use as tool shafts and posts (Brinkkemper/Vermeeren 1993, 114-15; Orme/Coles 1985, 10). The wood can be easily worked. However, the durability of this type of wood is poor by modern standards: at most 5 years in humid soils to at most 12 years in dry soils. This shortcoming may have been outweighed by the wood's other qualities. A preference for *Fraxinus excelsior* during the Iron Age and the Roman period in the western Netherlands has been ascertained before (Brinkkemper/Vermeeren 1993; Groenman-van Waateringe 1988, 141, 148). *Fraxinus excelsior* grew especially at the edges of the larger levees with a mineral subsoil (Brinkemper/Vermeeren 1993, 113; Groenman-van Waateringe 1988, 141; Orme/Coles 1985, 10).[3]

Remarkable is the little use made of *Salix* and *Betula* in the construction of the houses in Midden-Delfland. *Salix* was appreciated especially for its suitability for wattle (Orme/Coles 1985, 12). In house Q *Salix* had been used in the wattle walls of the living area, but it had not been used at all in the byre. This has been attributed to a belief known from medieval sources which has been extrapolated to prehistory: it was believed that the twigs of this species had a negative influence on the milk production and fertility of cows that gnawed on them (Therkorn *et al.* 1984, 362). However, in recent investigations of some Iron Age settlements on Voorne Putten *Salix* has been found in wattle walls of byres (Brinkkemper/Vermeeren 1993, 116). We can think of two explanations for the little use made of *Salix* in Midden-Delfland. The first is that *Salix* was probably less common here than in the other areas. However, this will have to be confirmed by more pollen diagrams than the three so far obtained from MD 15.04. If prehistoric man had a preference for *Fraxinus excelsior* and was willing to make an effort to obtain it, why did he not make the same effort for *Salix*? Perhaps because *Corylus avellana*, which was also suitable for wattle, was available in the surroundings (Orme/Coles 1985, 9). A second possibility is that sufficient branches and twigs for wattle were produced in the preparation of trees for posts and stakes and that the branches of the species in question, *Fraxinus excelsior* and *Alnus*, were considered good enough for this purpose.

A comparison of the evidence of the Midden-Delfland settlements with that of the Iron Age settlements of the Assendelver Polders and Voorne Putten reveals a greater variation in the types of wood used in the last two regions. Posts and stakes had been made from *Alnus* and *Fraxinus excelsior,* but also from *Quercus*, *Ulmus* and *Acer*, which species are also very suitable for that purpose. The use of *Salix* for wattle has already been mentioned. We assume that the types of wood used reveal certain preferences,

Figure 4. Four examples of pointed post and stakes made from Fraxinus; a. a split stake showing remaining chips and an axe impression, b. a partly pointed split post, c. a typical example of a post with a blunt point and d. an exceptional example of a partly pointed post showing very fine facetting.

influenced by the availability of the species in question in the surrounding vegetation.

5. Woodworking

Thanks to the good preservation conditions for wood in Midden-Delfland we have been able to study prehistoric woodworking and construction methods. Due to the post-depositional processes in this particular area wood and parts of wood which, not dug or driven into the ground, are rarely encountered in the archaeological record have been preserved here. This was for example apparent from the lengths of some of the pointed posts, which exceeded 1.5 m.

Split round wood had been commonly used for the houses of MD 11.07 and 11.17. Timber, defined as split round wood with little or no remains of the outer surface (Orme/Coles 1983, 19), was rarely found. The few examples of timber had not been worked into posts or stakes. Two pieces of timber found in house 1 of MD 11.17 may have constituted a threshold. Some pieces from house 2 may have formed part of the superstructure (or may have been re-used in the wall). Other examples of timber from this house are the planks of *Alnus* and *Fraxinus excelsior*. Some of these had been made by splitting a trunk tangentially instead of radially. These planks were found beneath two hearths and hence probably served as the bases of the hearths. A similar use of timber has been observed before in Midden-Delfland. The *Alnus* planks were from much thicker trees (up to 40 cm in diameter) than the pointed *Alnus* posts in this house.[4] The wood of posts and stakes made from split wood had mostly been split radially. More stakes than posts had been made from split wood. Moreover, the points of the posts were less sharp than those of the stakes. The points of the posts were probably given larger areas to prevent them from subsiding in the peaty soil. Figure 4 shows some examples of posts and stakes.

The houses of Midden-Delfland yielded no examples of posts or stakes with traces of woodworking at the level of the floor, which suggests that the risk of the posts and stakes subsiding in the peat was prevented by means of joints. The posts and stakes were held in place by pens that were driven into the ground. The same was observed on Voorne Putten but we also know of examples of cross bonds at floor level (Brinkkemper/Vermeeren 1993, fig. 4).

MD 11.17 produced only one piece of wood with a notch. Some other pieces of carefully shaped wood were probably pegs (one of which had been made from *Prunus spinosa*).

The other two sites, MD 15.04 and 16.59, provided little new information. In MD 15.04 timber had been used for a planking. The planks had been split radially, tangentially and in a direction between the two. Some notched pieces and wooden pegs indicated the use of joints, but two joined pieces of wood were not found.

Another method of woodworking is wattling, which has already been mentioned regularly. It was used for walls, but also for baskets. MD 15.04 yielded two pieces of wattle of *Salix* twigs which may have formed part of baskets. Some pointed pens (of up to 15 cm long with diameters of about 1 cm wide) were found which appeared to have been cut using a knife. Their function is not clear. A few of these pens had carbonized points. They may have been burned because they were no longer considered fit for use but another possibility is that the points were deliberately burned during the preparation of the wood: burning hardens the surface and is also a good protective measure against woodrot. Of the other wooden artefacts found we will only mention a paddle and a piece of wood which probably served as a chopping-block. Both of these were of *Fraxinus excelsior* and both came from MD 16.59.

The many wood chips found at the Midden-Delfland sites indicate that part of the woodworking was done at the sites themselves. The chips were left lying on the ground and became incorporated in the layers of the floors. Samples of chips have been identified; they were all of *Fraxinus excelsior* and *Alnus*. Although large amounts of wood have been preserved, only few examples of wooden artefacts which were not used in house construction have been found. A lot of refuse was used for the floors; discarded wooden artefacts probably ended up in the hearth.

6. Wood and Toolmarks

Research into the methods of woodworking can provide information on the tools which were used to shape the wood. This can be done directly, by recording the toolmarks observable on the wood, or in a more indirect manner, via experimental archaeology. At the same time additional information can be obtained on the material culture, because traces of objects which are seldom preserved may be observed.

This kind of research is still very rarely carried out. The best known example of an investigation of this kind is that of the Iron Age house Q in the Assendelver Polders, conducted by M. Taylor (Therkorn *et al.* 1984, 363-367). She examined the structural wood of the house and some wooden artefacts and concluded that two or three different gouges had been used and between seven and eleven axes or adzes. In another investigation carried out on Voorne-Putten the researchers were only able to determine what type of tools had been used because the full potential of this kind of research was not recognised until later (Brinkkemper/Vermeeren 1993, 115). The Iron Age wood has yielded evidence for the use of axes having cutting edges with widths of at most 9 cm. Gouges were also used in this period and there are indications of the use of saws.

Toolmarks were also studied in the research of the wood from the four Midden-Delfland sites. M. Taylor has distinguished five classes of surviving toolmarks (Therkorn *et al.* 1984, 363-365):

1. No actual toolmarks survive, although the wood was obviously shaped.
2. Slight indications of toolmarks, such as facetting.
3. Toolmarks surviving well enough to provide limited information.
4. Marks showing the full outline of the tool or of part of it.
5. Toolmarks with their own "fingerprints".

In our analysis we have reduced these five classes to three, because we believe that the marks of classes 2, 3 and 4 are more or less the same:

1. No toolmarks on the worked wood.
2. Toolmarks that allow determination of the kind of tool used.
3. Toolmarks with their own "fingerprints", the distinguishing marks of individual tools. An example of marks of this class is shown in figure 5.

In our research we focused on marks of class three in particular because we were interested in the number of tools which prehistoric man had at his disposal. Individual tools can be recognised by the number of wire edges and their positions along the edge and by the specific shape of the cutting edge. Cutting edges cannot be recorded simply by copying the end of a facet. Facets can only be of use if several wire edges are also observable because then the number of wire edges and the distance between them can help to identify individual tools. Instead, one must look for the place where the axehead cut into the wood before being pulled clear without the chip being detached completely. The remaining chip covers the mark of the cutting edge (fig. 6). With help of a razor-blade this last part of the chip can be removed and the transition to fresh, rough wood then marks the line of the cutting edge. We recorded our cutting edges by covering them with plastic and copying the edges with a marker pen. These copies were then traced onto tracing paper and photocopied. The individual cutting edges were compared by placing the originals over the photocopies. This of course meant that we were comparing reflected images of the original axe blade.

Some authors argue that this method can only be followed in the case of metal blades (Coles/Orme 1985, 27; Orme/Coles 1983, 22; these authors also give other indications for distinguishing between stone and metal blades). In view of our own experiences we do not agree with them. We have seen posts from a late Neolithic site

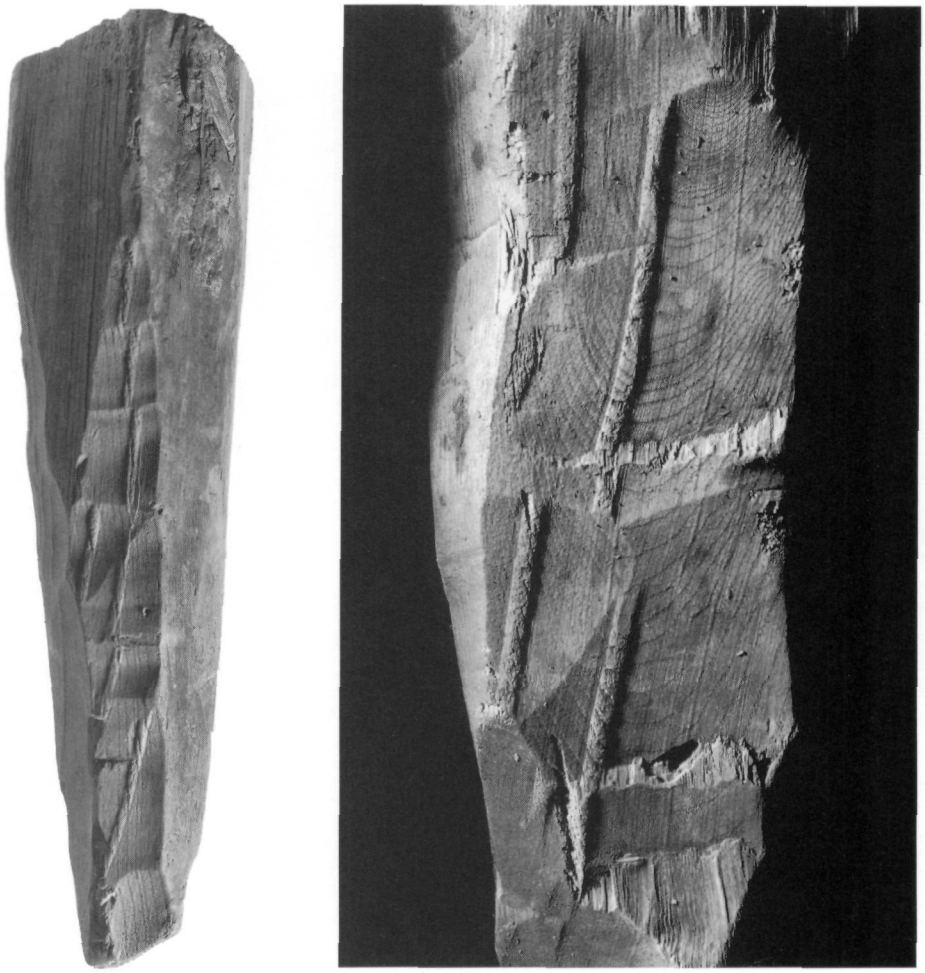


Figure 5. A clear example of two pieces of Fraxinus wood worked by the same axe, which is recognisable by the wire edges.

which had definitely been worked with stone axes and which showed the same kind of remaining chips on the wood (Jaarverslag ROB 1992).

Settlement MD 11.17, which was excavated almost entirely, yielded a large number of cutting edges for analysis and comparison. In our opinion all of the toolmarks were attributable to axes. Axe marks and adze marks differ in

a) the shape of the facets, those of adzes being curved, and
b) the angle between the wire edges and the cutting edges, which is square in the case of adzes (D. Goodburn *pers. comm.*).

It is often thought that the main difference between axes and adzes concerns the direction of hewing: in the case of adzes the direction of hewing must be parallel to the length of the wood, although a skilled adze user will be able to hew from any position.

Cutting edges were copied from 33 posts and stakes.[5] The first conclusion was that the individual pieces of wood had been worked with the same axe.[6] We found only one piece with toolmarks of two different axes. Secondly, we constructed "compositions" of several overlapping impressions of cutting edges. See for example post MD 11.17; 457 and the copied cutting edges A, B and C (fig. 7). With impression C on the left the minimum width that can be inferred for the cutting edge amounts to 7.5 cm. The alternative, with C on the right, leads to a minimum width of 9.5 cm.

The next step, attempting to recognise individual tools, proved to be more difficult than we had expected. The comparison of all the toolmarks led to much confusion and we eventually decided that between 1 and 34 different tools must have been used. What complicated our task was the possibility of wire edges having been obliterated during the later use of the tool (Coles/Orme 1985, 30). We moreover

Figure 6. The removal of the remaining chip.

believe that some wire edges may have become wider. Another factor that must be born in mind is the possibility of interim grinding. To facilitate our analysis we decided to study the toolmarks of the two houses separately. House 1 yielded 14 pieces of wood with toolmarks. The number of tools used ranged between four and eight. The number of axes used to sharpen the posts and stakes of house 2 ranged from four to ten. Because we do not know how many occupation phases there were, it is possible that these axes were used over long periods of time. We do not have any evidence that a particular axe was used during the construction of house 1 as well as that of house 2. The cutting edges were not as distinctive as we had hoped and the results of our analysis could play only a minor part in the discussion about the contemporaneity of the two houses of site MD 11.17.

Site MD 11.07 yielded the smallest number of posts and stakes because only a small part of the settlement was excavated and, furthermore, because one of the houses had been completely disturbed. Only marks of axes were found. We recorded ten cutting edges on three posts of one of the houses. One axe had produced nine of those marks on all three of the posts; the minimum width of the cutting edge was 5.2 cm. A second axe had been used at the bottom of one of the posts; its cutting edge was at least 6.5 cm wide. This post was probably a pointed post of round wood originally, which was later split into three parts for re-use.

The same kind of research (although not so thoroughly) was carried out for MD 15.04 and MD 16.59. Again all the observed toolmarks were ascribed to axes. MD 15.04 yielded only two impressions of the cutting edges of two different axes. One had a minimum width of 6.5 cm, the other of 8 cm.

The 38 cutting edges observed on 18 pieces of wood indicated that at least three different axes had been used in the construction of the house(s) of MD 16.59.

It is still too early to draw any conclusions about the usefulness of toolmark analysis. We have to admit that the results of the analysis of the evidence from site MD 11.17 are rather disappointing. The cutting edges of the axes or the width of the facets on the wood may have been too narrow to enable us to recognise individual tools. We do venture that wide axe cutting edges are easier to ascribe to

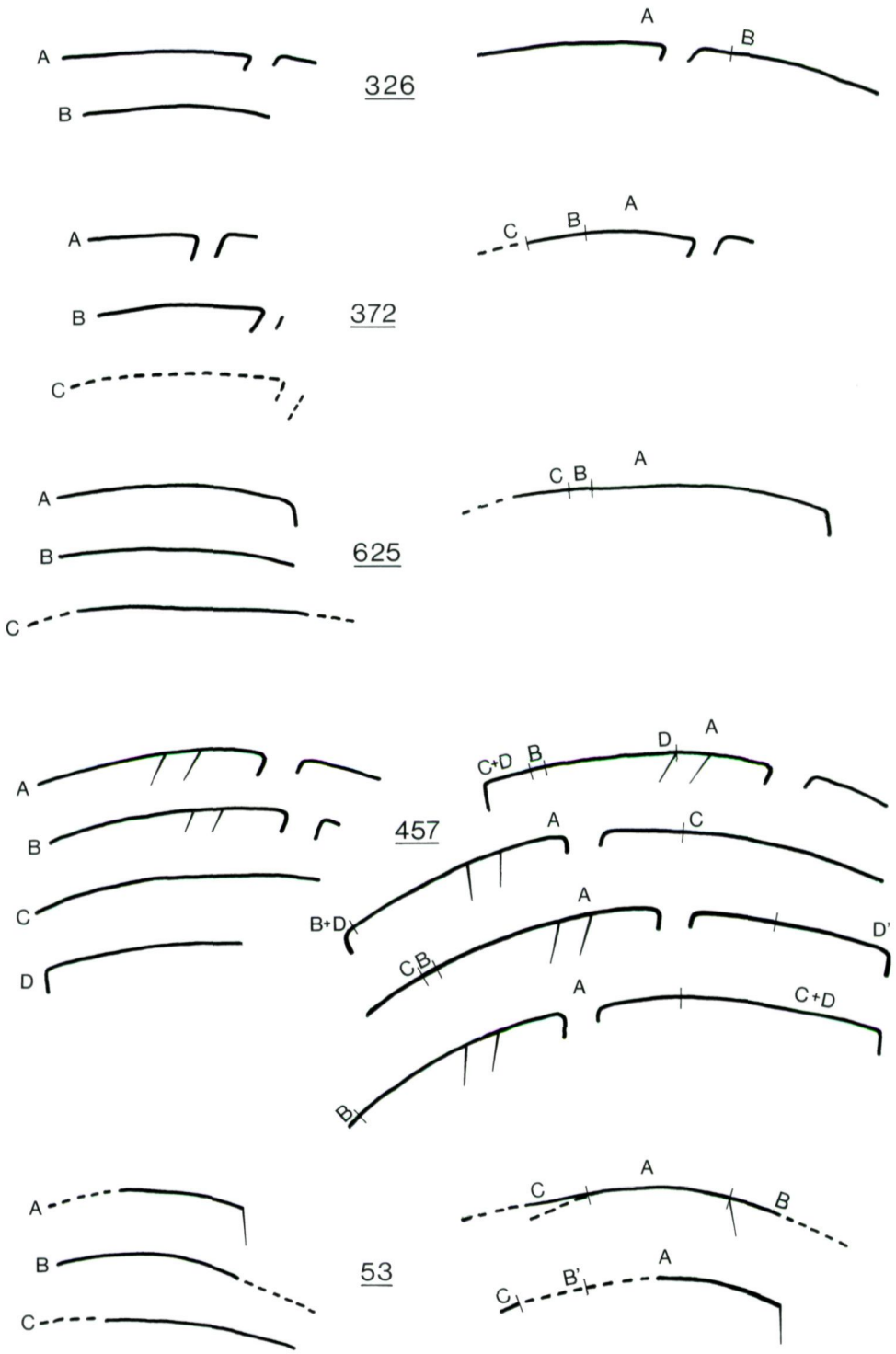


Figure 7. Reconstruction of seven cutting edges from MD 11.17.

individual implements than narrow ones. We hope that further studies will provide us with enough data to be able to say something about the kinds of tools used, about variations in the shape of a particular type of tool and about preferences for certain types of tools for certain activities. Finally, we hope that we will then be able to use these results in research on the contemporaneity of houses and building phases.

notes

1 The wood of *Alnus* is highly valued for its durability in humid soils and under waterlogged conditions (Orme/Coles 1985, 7)

2 Even if we assume that the correction factor for the pollen production of *Fraxinus excelsior* is too low, this species was still rare in the surrounding vegetation.

3 If there was indeed a preference for *Fraxinus excelsior*, what does this imply for the other species that were valued as structural wood, such as *Quercus* and *Fagus*? We are inclined to argue that the environments that were suitable for these two species lay some distance away from the settlements. The fen peats will have included areas with mineral soils, for example levees, where *Fraxinus excelsior* may have grown, but they were at that time probably still too wet for the other species. *Fraxinus excelsior* may have been preferred for the quality of its wood but also because it was more readily obtainable.

4 'Posts' are understood to be pieces of wood with an axed point and a circumference of 35 cm or more (which corresponds roughly to a diameter of 11 cm).

5 This large number of undetached chips is remarkable. It could indicate that the house(s) was (were) constructed in a hurry.

6 If the aim of a toolmark analysis is to estimate the minimum number of tools used, allowance must be made for the material of which the tools were made. Bronze tools were cast and tools cast in the same mould were similar; this must be kept in mind in estimating the minimum number of tools used.
Iron Age axes are rare and this strengthens our assumption that the axes used were made of iron: iron is much less resistant to soil processes than bronze. Iron is moreover harder than bronze and will therefore have been preferred for the manufacture of tools. The decisive factor, however, was probably the availability of iron ore in the form of 'bog iron' in the immediate surroundings.

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