**Sowing the seed ? : human impact and plant subsistence in Dutch wetlands during the Late Mesolithic and Early and Middle Neolithic (5500-3400 cal BC)**
Out, W.A.

**Citation**

# 8. Evidence of human impact and plant subsistence from pollen diagrams, wood and charcoal

## 8.1 INTRODUCTION

This chapter aims firstly to investigate the indications of human impact in pollen and macroremains diagrams from the studied Late Mesolithic and Early and Middle Neolithic wetland sites, secondly to analyse the indications of plant use in the wood and charcoal, and thirdly to study the evidence of forms of management of the natural vegetation.[1] The indications of human impact from pollen and macroremains diagrams are summarised on a regional level and a more general level. Under investigation is whether and how evidence of human impact derived from diagrams is related to neolithisation, and how the results relate to data that are available from other macroregions. The wood analysis includes the analysis of evidence pertaining to selective use of wood for artefacts and for fuel. Wooden artefacts without a clear interpretation on the function are not taken into consideration, unless being relevant. The discussion on management includes an analysis of the possible indications of fire ecology, hedges, and pollarding and coppicing. The evidence of human impact that has been derived from sources other than pollen, wood and charcoal is presented in chapters 9, 10 and 11.

## 8.2 EVIDENCE OF HUMAN IMPACT IN POLLEN DIAGRAMS FROM THE STUDIED REGIONS

### 8.2.1 CENTRAL RIVER AREA

Detailed information is available on human impact in the central river area. Pollen diagrams sampled at a relatively large distance from sites or investigated for non-archaeological purposes are not very useful for the analysis of human impact (Bergambacht, Goudriaan, diagrams of Van der Woude). At the non-agricultural sites Polderweg and De Bruin there are possible indications of human impact, but it is not possible to distinguish them accurately from natural factors of disturbance, with the exception of a single phase during which the sample location was probably located in the middle of an activity zone. This is also the case for the early semi-agricultural phases at Brandwijk-Kerkhof. It is furthermore not possible to detect separate occupation phases in the diagrams of Polderweg and De Bruin.

In contrast to diagrams from the early sites in the region, human impact can be clearly detected in the diagrams of the later phases of the semi-agricultural sites Brandwijk-Kerkhof and the Hazendonk. In the diagrams of the Hazendonk it is even possible to recognise the impact of separate occupation phases, including minor occupation phases. The signals of human impact represent disturbance of the woodland (especially *Tilia* sp., *Quercus* sp. and *Alnus glutinosa*) due to small-scale deforestation and grazing by domestic animals. The disturbance resulted in the development of shrub vegetation (discussed below), an increase in both dryland and wetland herbs including disturbance indicators and the presence of Cerealia-type pollen. The strength of the evidence of human impact at the Hazendonk is correlated with occupation intensity. The difference between Polderweg, De Bruin and the early phases of Brandwijk-Kerkhof on the one hand and late phases of Brandwijk-Kerkhof and the Hazendonk on the other hand is possibly related to the introduction of crop plants, but this is not absolute since several co-varying factors are involved (see chapter 2 and the discussion below).

### 8.2.2 COASTAL REGION

The pollen diagrams from the coastal region do not allow detailed analysis of human impact since the natural vegetation that was present, consisting of shrubs, was scarce and produced little pollen (see chapter 3).

---

1 See the first part of this thesis for a detailed discussion and references of the primary data.

Therefore, deforestation cannot be used as a measure of human impact in this region. In the pollen diagrams of Schipluiden there are small indications of a decrease in the dune shrub vegetation after the first occupation phase, and indications of an increase in herb vegetation. At Ypenburg there are possible indications of a decrease in the dune shrub vegetation, and indications of the development of herb vegetation during the later occupation phases (Van Beurden 2008b). For the other archaeological sites informative pollen diagrams (contemporaneous with occupation) are not available. Further evidence of human impact comprises anthropogenic indicators such as Cerealia-type pollen and disturbance indicators, present in small quantities only. The pollen diagrams of non-archaeological locations give no useful information on human impact.

### 8.2.3    Vecht region
Pollen diagrams from the Vecht region that show detailed information on human impact are scarce (see chapter 4). The pollen diagrams of Swifterbant-S3 are not directly related to occupation and do not show distinct human impact. The pollen diagrams of Schokland-P14 do not show clear evidence of human impact either, and only indicate that human impact was restricted. The pollen analysis of Urk-E4 is based on a few samples from features that indicate that the vegetation was very open. However, the specific context of the samples and the small number of samples are not representative of the development of the vegetation through time. The macroremains analysis from Schokkerhaven-E170 is based on a relatively small group of samples that cannot be related precisely to archaeological information since the site was not excavated. For Emmeloord, a macroremains diagram is available that shows weak indications of clearance of alder carr. The best palynological indications of human impact in this region are the (restricted) presence of Cerealia-type pollen and disturbance indicators.

### 8.2.4    Eem region
The pollen diagrams from the sand ridge soil at Hoge Vaart show various indications of human impact. Maximal disturbance that is probably related to human impact occurred during the presumably most intensive occupation phase (phase 3) and resulted in an increase in the diversity of shrubs and herbs including disturbance indicators. Earlier and later occupation phases resulted in weaker disturbance, and it is more difficult to distinguish this disturbance from natural disturbance factors such as the submerging of the site, storms, foraging of wild animals or water activity.

The pollen diagrams from the bank zone at Hoge Vaart show increased values of *Pteridium aquilinum* during a specific occupation phase (phase 2) that are probably related to human impact. The increase in *P. aquilinum* at Hoge Vaart plays a more important role in the recognition of human impact than at sites in other regions. This is probably related to the unique soil conditions and natural vegetation at Hoge Vaart compared with other wetland sites, and possibly to the presence of large numbers of hearths that may have offered a good substrate for *P. aquilinum* (see chapter 5).

### 8.2.5    Other sites
The pollen diagram of the Late Mesolithic site Randstadrail CS shows small-scale deforestation, consisting of a small decrease in *Quercus* sp. and *Corylus avellana*, and an increase in Poaceae, *Hedera helix* and dryland and wetland herbs indicative of disturbance. The pollen diagram of Bergschenhoek shows a slight decrease in the curves of *Alnus glutinosa* and Poaceae and an increased variety of herbs, mainly wetland herbs. The pollen analysis of Hüde I (Schütrumpf 1988) does not discuss human impact in detail, and evidence of human impact is difficult to distinguish with certainty. Interestingly, various diagrams show a decrease in *Alnus* sp. contemporaneous with an occupation horizon.

8.2.6    SUMMARY AND COMPARISON OF THE REGIONS

*8.2.6.1  Trees and shrubs*
In regions with woodland vegetation, human impact and the presence of domestic animals generally resulted in small-scale deforestation and disturbance of the dryland and wetland terrain, mainly affecting *Tilia* sp., *Quercus* sp. and *Alnus* sp., and in an increase in shrubs. The available evidence shows that people left most of the woodland present around their sites relatively undisturbed, and there is no evidence that human presence led to destruction of populations of specific taxa, although *Tilia* sp. did suffer considerably from the combination of human impact and the rising water level. Human impact affected both dryland and wetland vegetation, and trees, shrubs and herbs. Human impact on wetland vegetation including alder carr is also known from other Northwestern European prehistoric sites (Chiverell *et al.* 2004 discussing Bronze age evidence from Britain; Mighall *et al.* 2007 discussing evidence from Ireland; Waller and Schofield 2006 discussing evidence from England).

In the coastal region where the natural vegetation consisted of dune shrub vegetation, human impact probably resulted in a decrease in shrub vegetation. Although human impact was not necessarily stronger than in other regions, it possibly resulted in the removal of most of the trees and shrubs on the dunes. The attested indications of deforestation are however very small compared with the evidence available from the river area. This difference can be related primarily to the open character of the natural vegetation in the coastal region and the low pollen production of the taxa that dominated its natural vegetation. Further research on human impact in the coastal region (not necessarily focussing on cereal grains) is necessary since the data do not yet allow a detailed analysis of the development of the vegetation on the dunes to be made, nor do the current data provide detailed knowledge about human impact. The pollen analysis at such sites has to be very detailed, including analysis based on a total pollen sum of 1000 grains to avoid overrepresentation of local taxa, the extraction of several pollen cores taken next to occupied dunes and pollen analysis from wells present on the dune itself. Pollen analysis in the coastal region could furthermore focus on the detection of arable plots at the edge of dunes and/or on the high salt marshes.

*8.2.6.2  Herbs and non-pollen palynomorphs*
Occupation in all regions resulted in an increase in herbs that are indicative of the presence of open patches, disturbance, eutrophic conditions and light, including both dryland and wetland herbs. The increase involves both the classical anthropogenic indicators (Behre 1981) as well as taxa that are part of the natural vegetation and that are not commonly mentioned in relation to human impact during the Mesolithic and Neolithic, including wetland taxa (*e.g. Allium* sp., Apiaceae, *Galium*-type, *Lythrum salicaria*, *Mentha aquatica/arvensis* and *Sparganium* sp.). The increased values of wetland taxa can be related to the importance of wetland vegetation and the fact that human activity was not restricted to dryland terrain. At certain sites in the river area, the herbs do not only increase during occupation, but gain maximal values just after occupation, indicating undisturbed growth of anthropogenic indicators before the real recovery of the natural vegetation. The occurrence of presumed anthropogenic indicators is furthermore not always restricted to occupation periods since natural processes result in disturbed and open terrain as well.

Although the relationship between human impact, openness of the vegetation and NAP percentages is not always direct and straightforward, the NAP percentages can be considered as an indication of human impact. Table 8.1 shows the NAP percentages from vegetation of dry terrain during occupation based on an upland pollen sum (including dryland trees, shrubs, herbs, spore plants and crop plants) for sites in the central

| site | pollen sum | a | b |
|---|---|---|---|
| *Central river area* | | | |
| Hazendonk, Vlaardingen phases | | 15-25 | |
| Hazendonk, phases Hazendonk 1, 2 and 3 | | 10-25 | |
| Brandwijk-Kerkhof, late phases (L50/L60) | | 10-20 | |
| Brandwijk-Kerkhof, early phases (L30/L45) | | 5-10 | |
| De Bruin | | 0-5 | |
| Polderweg | | 0-5 | |
| *Coastal region* | | | |
| Sion | | 4-60 | 2-12 |
| Wateringen 4 | | 20-40 | 1-8 |
| Schipluiden | | 4-80 | 2-8 |
| Ypenburg | | 5-20 | 2-10 |
| *Eem region* | | | |
| Hoge Vaart | | 10-20 | |

a = pollen sum that includes Chenopodiaceae

b = pollen sum without Chenopodiaceae (only calculated for sites in the coastal region)

Table 8.1 Sites in the central river area, the coastal region and the Eem region, the percentage of non-arboreal pollen from dryland terrain, based on an upland pollen sum (including dryland trees, shrubs, herbs, spore plants and crop plants).

river area, the coastal region, and the Eem region.[2] The pollen percentages of the sites in the coastal region have been recalculated. This recalculation has been made with and without Chenopodiaceae in the pollen sum because a major part of this pollen probably represents local salt marsh vegetation.

The NAP percentage of the sites in the central river area is 0-25%. Furthermore, the data of the central river area sites suggest a gradual increase in the percentage through time (further discussed below). The NAP percentage of the coastal sites is up to *c*. 10% when Chenopodiaceae are excluded and up to 80% when Chenopodiaceae are included. The comparison of the NAP percentage of the coastal region without Chenopodiaceae and of the river area suggests that human impact was stronger in the river area. However, the two regions cannot be compared directly due to the differences in the natural vegetation and the sampling methodology (*e.g.* location, interval) between the two regions. The suggested difference in the strength of human impact is therefore not demonstrated. In view of the vegetation, the pollen diagrams of the river area are presumably better comparable with diagrams of sites in other regions than the coastal region. The future

---

2   The data in table 8.1 are collected from diagrams that were already based on an upland pollen sum and diagrams of which the primary data were directly available to the author.

analysis of human impact in pollen diagrams from those regions would benefit from approaches that facilitate the comparison of diagrams, such as the deposition or publication of the original data and the additional use of calculations based on an upland pollen sum of at least 300 pollen (apart from the preferred pollen sum).

The increase in herbs during occupation comes not only to expression in pollen diagrams, but also in macroremains diagrams. Firstly, macroremains diagrams show changes in the composition of the vegetation, such as a decrease in certain taxa that reflect the natural vegetation and an increase in anthropogenic indicators (see the data of Brandwijk-Kerkhof and the Hazendonk, appendices III and IV). Secondly, macroremains diagrams from the river area show that occupation results in an increase in the number of macroremains and the number of taxa represented in the macroremains diagram (discussed in paragraph 2.8.3.5). This pattern may be related to more favourable growth conditions, but the precise causes of this need further research.

The non-pollen palynomorphs (NPP) diagrams from the Hazendonk show that several NPP's increased during occupation. Analysis of NPP's at Dutch archaeological sites dating to prehistory has received increased attention since the analysis of NPP's has a relatively long research history in the Netherlands. The Hazendonk sample series indicate that type 44 (*Ustulina deusta*) and type 361 are relatively good indicators of human impact (see appendix III), although their occurrence is not restricted to periods of human impact.

### 8.2.7  EVIDENCE OF HUMAN IMPACT IN POLLEN DIAGRAMS IN RELATION TO METHODOLOGY

Some of the studied pollen cores were collected at the edge of refuse layers that wedged out in the peat (where accumulation of palimpsests plays a relatively restricted role), especially in the central river area. The refuse layers are the result of the accumulation of waste that was presumably influenced by post-depositional processes like human activity, trampling, erosion, colluviation and flooding. As a result, the presence of good chronological stratigraphy is not always assured for the refuse layers. Furthermore, the deposition and post-depositional processes may have resulted in overrepresentation of the evidence of human impact, *e.g.* due to the deposition of eroded material at the lower parts of slopes, or underrepresentation of evidence, *e.g.* due to complete erosion of sediment that is contemporaneous with occupation.

Indeed, curves of many relevant diagrams and of most taxa show either a single general increase or decrease during occupation periods, indicating that the sediment corresponding with occupation is presumably not chronologically ordered anymore (although there are some exceptions). Such changes presumably reflect the result of human impact during a complete occupation period instead of the precise development of the vegetation during occupation. This is supported by the fact that none of the diagrams enables the distinction of possible sub-phases in occupation, not even when sub-phases are archaeologically recognised (see Out 2008a). The chronological resolution of the pollen data concerning human impact during occupation periods thus appears to be restricted.

On the other hand, there is no reason to assume that the sampling of refuse layers hampers the possibility to reconstruct human impact or that it influenced the signals of human impact drastically. The sediment of the investigated pollen cores and sections represented the edge of the refuse layers, where disturbance by human activity and trampling was presumably relatively low compared to the centre of the refuse layers, so that part of the original stratigraphy remained intact. Furthermore, the pollen analyses of refuse layers presented here usually include investigation of the vegetation before, during and after occupation, which enables the distinction of human impact (which would be more difficult when sampling material from the refuse layers only). Also, the archaeobotanical results show in two ways that the influence of depositional and post-depositional processes is not necessarily prohibiting fine-scale reconstruction of the vegetation and human impact.

Firstly, the analysis of the transects of cores from Brandwijk-Kerkhof and the Hazendonk show that it is still possible to distinguish spatial vegetation differences over a distance of a few metres. This indicates that erosion and colluviation did not necessarily result in the disappearance of evidence of spatial variation in the vegetation. Secondly, the curves of some pollen and macroremains diagrams show changes that can be

related to changes that took place during occupation or shortly after occupation, showing that major shifts in human impact and plant use can be detected within the time scale of occupation. Moreover, these changes can sometimes be interpreted as a succession series of the vegetation in reaction to human activity (see also Out 2008d).

An advantage of sampling at the edge of refuse layers is that this sampling method provides possible palynological evidence of human impact a strong anthropogenic context due to the stratigraphical correlation with occupation indicators such as eroded sand, charcoal, sherds, (burned) bone and fish remains and flint, therefore facilitating the interpretation of pollen and macroremains diagrams. Sampling in refuse layers shows that thick refuse layers with a large extent (number of square metres) representing long-lasting occupation provide more distinct evidence of human impact than thin refuse layers with a small extent that represent short occupation phases (see appendices III and IV). Assuming that the amount of refuse is related to the number and length and frequency of visits and the number of people, this indicates that the strength of the evidence of human impact is related to occupation intensity.

Analysis of the pollen diagrams from the sites studied shows that pollen cores need to be taken preferably at the edge of or near to dryland patches in order to register Late Mesolithic and Early and Middle Neolithic human impact at Dutch wetland sites where woodland vegetation was present. The ideal distance varies between sites, depending on the openness of the vegetation. On the one hand, a minimum distance away from the main zone of activity would be required, in order to avoid sampling in the middle of completely disturbed zones that are not informative anymore and where refuse of different phases is not stratigraphically separated anymore. On the other hand, a maximal distance could be *c.* 25 metres from the dry surface of the river dune. Sampling at such a distance away from the dry surface of a dryland patch generally results in a detectable signal of human impact in the case of intensive occupation. Sampling at larger distances may result in the loss of information, while sampling at *c.* 75 metres away from the dry surface of the river dune can result in the absence of information on human impact.

Transects of cores have been analysed from Brandwijk-Kerkhof and the Hazendonk, and these give contrasting results about the effect of distance on the evidence of human impact, which may be related to differences in the openness of the vegetation (compare Brandwijk-Kerkhof to the Hazendonk, see chapter 2 and Out 2008a). Similar transects are not available for other regions, and would be particularly useful for the Vecht region where dryland patches were wooded but for which there is little information on human impact. The results of the transects from the Hazendonk demonstrate that the signal of human impact may decrease over a distance of several meters. The decrease in the visibility of human impact over a limited distance indicates that most sample locations represent very small forest hollows surrounded by woodland vegetation where pollen dispersal is very limited (*cf.* Bunting *et al.* 2005; Sugita 1994). This implies that human impact was restricted and that much woodland vegetation remained present on the dunes during occupation.

In the coastal region, where dryland patches are hardly covered with woody vegetation, sampling at the edge of the dunes provides only minor indications of human impact, which can be related to the natural vegetation in the first place, and possibly also to the research methodology of the available studies (see paragraph 8.2.6).

8.2.8    Evidence of Neolithic subsistence and neolithisation in pollen diagrams

The presence of domestic animals at Dutch wetland sites must have resulted in impact on the vegetation caused by grazing, trampling and eutrophication. The increased presence of various taxa in pollen diagrams from agricultural sites is therefore probably partly related to the presence of domestic animals. Taxa that are often mentioned in relation to grazing are *e.g.* Poaceae, *Plantago* sp., *Rumex* sp. and Asteraceae (*e.g.* Behre 1981; Groenman-van Waateringe 1971, 1992). The increased presence of these taxa can indeed be observed in various pollen diagrams from the sites studied, and these increases may be related to grazing by domestic animals.

In the pollen diagrams analysed in this study, it is however hardly possible to detect the influence of domestic animals with certainty and to distinguish it from other aspects of human impact. It is therefore hardly possible to relate changes in the curves of specific species to grazing by domestic animals directly. Moreover, the comparison of sites with and without domestic animals does not give detailed information on the impact of domestic animals on the natural vegetation, which can partly be related to the similarities of the impact of wild and domestic animals on the vegetation. Importantly, the number of domestic animals present at a site during a single phase may have been rather small, resulting in restricted grazing impact. The understanding of the influence of domestic animals on the vegetation could be improved by the analysis of pollen and macroremains from coprolites.

The evidence of arable farming from pollen diagrams and the interpretation of the available data are extensively discussed in chapter 11 and are shortly summarised in the following paragraph. Cerealia-type pollen and pollen of potential arable weeds are regularly found at Early and Middle Neolithic sites where cereal macroremains have been identified. There is no presumed pollen evidence of cereals (that is interpreted as such) that is older than the attested macroremains evidence (*cf.* Behre 2007, 208). Cerealia-type pollen helps to distinguish human impact on the vegetation, since the occurrence of this pollen contemporaneous with other anthropogenic indicators is likely to be related to human impact. These pollen identifications however do not necessarily indicate local crop cultivation since cereal pollen is mainly released during threshing activities (*cf.* chapter 11). Pollen of potential arable weeds does not demonstrate local cultivation either since these taxa may represent local disturbance indicators (see chapter 10).

Comparison of indications of human impact from sites without and with crop plants shows that there is no straightforward relationship between human impact and neolithisation. One the one hand, comparative analysis of pollen diagrams of the central river area shows that human impact is easier to recognise in diagrams of sites/phases with crop plants. The introduction of crop plants may be an important factor explaining the increase in human impact, although other factors may play a role as well (see chapter 2), including the possibility that the people changed their attitude towards nature after the introduction of crop plants. On the other hand, the comparison of sites from different regions shows that the possibility to detect human impact in pollen- and macroremains diagrams is not dependent on the stage of neolithisation only. Human impact can be detected in diagrams of some non-agrarian sites (*e.g.* Randstadrail CS and Hoge Vaart), while at the same time it is not possible to detect human impact at every agrarian site (sites in the coastal region and the northern region). Site function may play an important role here. Furthermore, the absence of evidence of human impact at various Neolithic sites can also be related to the possibilities for research and research methodology.

## 8.3    COMPARISON WITH MACROREGIONS

### 8.3.1    THE MODELS OF HUMAN IMPACT FROM OTHER MACROREGIONS

The discussion of human impact in several comparable macroregions focuses on the analysis of indications of human impact in pollen diagrams that are more or less comparable with the Landnam, since such models have been proposed for various relevant regions and cultures. The classical Landnam was defined by Iversen (1941) for Denmark. The Landnam model of Iversen consists of three phases. In short, the first phase is characterised by a gradual decrease in *Tilia* sp., *Ulmus* sp. and *Fraxinus excelsior*, an increase in the pioneer species *Betula* sp., *Populus* sp. and *Salix* sp., and an increase in anthropogenic indicators such as Poaceae, *Pteridium aquilinum* and Asteraceae, while cereal pollen is occasionally present as well. This phase is interpreted as the clearance phase. The second phase is characterised by high values of *Betula* sp. and increasing values of *Corylus avellana*, low values of *Tilia* sp., *Ulmus* sp. and *Fraxinus* sp. and maximal values of anthropogenic indicators (herbs, ferns and cereal pollen), and is interpreted as the agricultural phase. The third phase is characterised by high values

of *Corylus avellana*, increasing values of the *Tilia* sp., *Ulmus* sp. and *Fraxinus* sp., and a decrease in *Betula* sp. and anthropogenic indicators. This phase is interpreted as the recovery phase. Iversen related the changes in the vegetation to agricultural activities including slash- and burn techniques of the Late Neolithic Funnel Beaker culture. The vegetation was supposed to be cleared by the felling of trees and burning, as indicated by finds of charcoal horizons and the peaks of *Pteridium aquilinum* and *Betula* sp. in pollen diagrams. The resulting vegetation was very suitable for grazing by domestic animals in the first place, and the cleared terrain may additionally have offered space for arable fields (Iversen 1973; Kalis and Meurers-Balke 1998, 3-4).

Troels-Smith (1954) revised the model of Iversen. He observed an earlier presence of cereal pollen and herbs indicative of anthropogenic influence, contemporaneous with a decline of *Ulmus* sp. and before the presence of the first indications of agriculture in the Iversen model. Troels-Smith therefore concluded that agriculture started earlier, and linked this to the Ertebølle culture. In the revised model, the decrease in *Ulmus* sp. is related to leaf-foddering of stabled domestic animals. The practice of agriculture in the Ertebølle culture in the major part of Denmark is however a subject of debate (see also chapter 11).

Kalis and Meurers-Balke (1998, 2001) investigated the evidence of human impact in Eastern Holstein in northeastern Germany, in the young-moraine landscape that was similar to the landscape investigated by Iversen. The analysis is based on a comparison with recalculated diagrams from Denmark. According to Kalis and Meurers-Balke, a combination of Troels-Smith and Iversen phases can be recognised in the diagrams from Eastern Holstein. Based on pollen evidence, Kalis and Meurers-Balke (2001) conclude that leaf-foddering (of wild or domestic animals) and cereal cultivation in northeastern Germany started on a small scale at *c*. 4600 BC during phase Troels-Smith A corresponding with the Ellerbek culture. This is however not supported by indisputable finds of cereal macroremains. Related changes in the pollen diagrams during this phase are a decrease in *Tilia* sp., *Ulmus* sp. and *Quercus* sp., an increase in *Fraxinus* sp. and *Corylus avellana*, and the presence of *Plantago major*, *Rumex* sp. and cereal pollen (anthropogenic indicators). They also state that evidence of human impact strongly increases during phase Troels-Smith B, starting at *c*. 4300 BC onwards, which corresponds with a later phase of the Ellerbek culture (Kalis and Meurers-Balke 1998, 17). Related changes in the pollen diagrams during this phase are a decrease in *Ulmus* sp. and *Hedera* sp., an increase in *Fraxinus* sp. and *Quercus* sp. and the increased presence of cereal pollen.

The Troels-Smith phases in Eastern Holstein are followed by Iversen phases, related to the Funnel Beaker culture. Phase Iversen 1a (4100-3900 BC) is characterised by high values of *Tilia* sp., a decrease in *Ulmus* sp. and an increase in *Quercus* sp., high values of *Pteridium aquilinum* and the occasional presence of anthropogenic indicators. The differences with the previous phases are related to a shift in the agricultural system that concentrated more on specific patches in the landscape. Phase Iversen 1b (3900-3700 BC) is characterised by a decrease in *Quercus* sp. and *Fraxinus* sp., an increase in *Betula* sp., *Corylus avellana* and *Alnus* sp., and the continued presence of anthropogenic indicators. This phase is interpreted as being indicative of woodland clearance by burning. Phase Iversen 2a (3700-3400 BC) is characterised by a decrease in *Quercus* sp., *Tilia* sp., *Fraxinus* sp. and *Ulmus* sp., a maximum of *Betula* sp. and closed curves of anthropogenic indicators. This phase represents further degeneration of the primeval woodland vegetation due to agricultural activity (Bakker 2003; Kalis and Meurers-Balke 1998). The presence of crop plants is from 4100 BC onwards confirmed by finds of cereal macroremains (see paragraph 11.8.2).

Wiethold (1998) investigated the evidence of human impact in Schleswig-Holstein (including Eastern Holstein), based on pollen diagrams that reflect the development of the regional vegetation. His interpretation of the indications of agriculture differs from the interpretations by Kalis and Meurers-Balke. According to Wiethold, characteristics of pollen diagrams dating to the Late Atlantic (before 4000 BC) are the increase in *Fraxinus excelsior*, local decreases in *Tilia* sp., and restricted presence of *Plantago lanceolata*. The presence of Cerealia-type pollen cannot be assigned with certainty in the regional pollen diagrams despite local evidence of cereal pollen. According to Wiethold, the parts of the diagrams that correspond with the Atlantic do not show

regional developments that can be related with certainty to agricultural practices and that would correspond to agricultural practices as described by Troels-Smith. Nevertheless, early agricultural practices are not excluded and small-scale cultivation and animal husbandry of minor importance remains a possibility, particularly from 4300 BC onwards (Wiethold 1994, 268).

For the period from *c.* 3650 BC onwards, Wiethold distinguishes indications of clearance of woodland by burning and grazing on a small scale, consisting of the increased presence of charcoal, decreases in *Fraxinus excelsior* and *Tilia* sp., and increases in *Populus* sp., *Salix* sp. and ferns including *Pteridium aquilinum*. Cereal cultivation on a small scale is concluded to have occurred as well. According to Wiethold, the first well-established evidence of large-scale animal husbandry and cereal cultivation dates to at *c.* 3500 BC and is related to the Funnel beaker culture, as indicated by changes in the pollen diagrams that are characteristic of the three phases of the Iversen Landnam.

Kalis and Meurers-Balke (1988) investigated the evidence of human impact of the LBK (5400-4950 BC), Großgartach culture (4950-4800 BC) and Rössen culture (4800-4570 BC) at the German Aldenhovener Platte (Rhineland), where loess soil was present. For the LBK, three phases of human impact are distinguished. The first phase is characterised by a decrease in *Tilia* sp. and *Quercus* sp. related to the clearance of the woodland vegetation, and an increase in *Corylus avellana* and *Fraxinus* sp. The second phase shows continuous high values of the light demanding species *Corylus avellana* and *Fraxinus* sp., and a slight increase in *Tilia* sp. and *Quercus* sp. The third phase is characterised by an increase and then a strong decline of *Corylus* sp.*,* and an ongoing increase in *Tilia* sp. and *Quercus* sp., which represents the recovery of the vegetation. For occupation of the Großgartach culture it is hardly possible to detect human impact, corresponding to the little indications of occupation. Only values of *Fraxinus* sp. remain slightly increased. For the Rössen culture, again two phases of human impact are distinguished. The first phase is characterised by a decrease in *Tilia* sp. and *Ulmus* sp., and an increase in *Betula* sp., *Corylus avellana* and *Fraxinus* sp. The decrease in *Ulmus* sp. and the increase in *Fraxinus* sp. are interpreted as indications of leaf-foddering. The second phase is characterised by the dominance of *Quercus* sp. and *Fraxinus* sp., a decrease in *Corylus avellana* and continuous low values of *Tilia* sp. and *Ulmus* sp. The increased importance of domestic animals is suggested. During occupation by all three cultures, anthropogenic indicators including cereal pollen are present, but these do not play an important role in the distinction of the various phases of human impact.

Bakels discussed the indications of human impact related to the Rössen culture and Michelsberg culture as observed in a pollen diagram from Maastricht-Randwijck (Bakels 2008). The pollen diagram shows a decrease in *Tilia* sp., *Fraxinus* sp., *Ulmus* sp. and *Alnus* sp., and increased values of *Quercus* sp. and *Corylus* sp. that are interpreted as opening-up of the woodland. The changes probably reflect human impact from people of both cultures. Vanmontfort (2004, 325) has summarised evidence of human impact from pollen diagrams from the Belgian Michelsberg culture, concluding that there human impact mainly affected *Tilia* sp., followed by regeneration.

Behre and Kučan (1994) studied the evidence of human impact in the *Siedlungskammer* Flögeln located on the Pleistocene sand soils of the old-moraine landscape. The study is based on 13 pollen diagrams from kettle-hole bogs and margins of raised bogs. Pollen grains of Cerealia-type and *Plantago lanceolata* were observed before 4000 BC but the authors do not relate these to human impact. Between 4000 and 3200 BC onwards, the diagrams show a decline of *Ulmus* sp. and the presence of Cerealia-type, Poaceae and *P. lanceolata*. These changes are interpreted as indications of small-scale arable farming and leaf-foddering as described by Troels-Smith. These changes were related to the 'Early Funnel Beaker culture' but no archaeological evidence was available. From *c.* 3200 BC onwards, human impact increases, as indicated by a decrease in *Quercus* sp. and *Tilia* sp. and an increase in Poaceae, *Calluna* sp., Cerealia-type, *P. lanceolata*, *Artemisia* sp, *Rumex acetosella*-type, Brassicaceae and Asteraceae tubuliflorae. The changes, which are compared with the Iversen Landnam, are interpreted as evidence of increased opening of

the woodland by grazing and deforestation (without clearance by burning). The changes after 3200 BC can directly be related to occupation by people of the Funnel Beaker culture.

Bakker (2003) investigated the effect of neolithisation on the natural vegetation similar to the Landnam in the northern part of the Netherlands, resulting in the development of a model on human impact during the Neolithic. The model is based on palynological results from the Gietsenveentje and other Pleistocene areas in in the northern Netherlands and northwestern Germany (including Flögeln). Although there are many archaeological finds dating to the Neolithic including the Swifterbant culture around the Gietsenveentje, there are no details on the chronology and intensity of the occupation near the sample location. Bakkers model of the Neolithic occupation period consists of three phases. The first phase, chronologically related to the Swifterbant culture, is characterised by a gradual decline of *Ulmus* sp., maximal values of *Tilia* sp. and *Quercus* sp. and an increase in herbs including Poaceae, *Calluna vulgaris*, *Plantago lanceolata* and Cerealia-type pollen. The second phase, related to the Funnel Beaker culture, is characterised by a decrease in *Tilia* sp. and maximal values of the herbs and spore plants that were already present in the first phase. The third phase, also related to the Funnel Beaker culture, is characterised by a decrease in *Ulmus* sp., a decrease in the herbs and spore plants including Poaceae and an increase in *Calluna* sp. This model is proposed to be applicable to the Drenthe plateau, and probably also for some other Pleistocene areas in the northern Netherlands and northwestern Germany. Phase 1, representing the first indications of agriculture, is dated to 4050 BC (*terminus ante quem*). Bakker does not show changes in human impact that can be related to the transition from the middle Swifterbant phase to the late Swifterbant phase, which suggests that agricultural practices did not undergo major changes. The changes in the pollen diagrams during phase 1 show some similarity to the Troels-Smith landnam phases as well as the first Iversen phase as defined by Kalis and Meurers-Balke for northeast Germany and Denmark (Bakker 2003, 268). Based on the similarity with the Troels-Smith landnam phases and the changes in the pollen diagrams, Bakker concluded that leaf-foddering was practised by the Swifterbant culture on the Pleistocene soils, which is argued to be supported by the decline of *Ulmus* sp. and the maximal values of *Tilia* sp. that would have been saved for the production of leaf-fodder (Bakker 2003, 268-270). Furthermore, Bakker (2003, 275) observes similarities in the diagrams of the Swifterbant culture and the diagrams from the Aldenhovener Platte that correspond with the Rössen culture, suggesting that the Rössen culture played a role in the introduction of agriculture in the Swifterbant culture (see paragraph 11.9).

Bakker (2003, 34-35) compared his model to the published pollen diagrams of the Hazendonk, Schokland-P14 and Swifterbant-S3. For the Hazendonk he suggested that changes in the pollen diagrams show some similarities with the Troels-Smith phase since human impact is restricted. Bakker additionally observed the absence of an *Ulmus* decline at the Hazendonk (*cf.* Van der Wiel 1982), which does not correspond with the original model of Troels-Smith. For Swifterbant and Schokland-P14 he concluded it is not possible to recognise changes that are similar to his model. Bakker (2003, 275) therefore concluded that the comparison of subsistence strategies at dryland and wetland sites from the Swifterbant culture by comparison of pollen diagrams is not possible (but see below).

8.3.2    COMPARISON OF THE SITES STUDIED WITH THE RESULTS FROM OTHER MACROREGIONS

Comparison of the pollen diagrams of the wetland sites that show human impact with the available models and results on agricultural human impact from other macroregions leads to several observations. Firstly, the pollen diagrams from the studied wetland sites indicate that *Tilia* sp., *Quercus* sp. and *Alnus* sp. are the taxa mostly affected by human impact, *i.e.* the dominant trees in the natural vegetation, while shrubs and anthropogenic indicators increase on a small scale as a result of the clearances. Interestingly, this evidence of human impact shows similarity with some of the changes at the Aldenhovener Platte related to the LBK and Rössen culture, shows considerable similarity to phase Troels-Smith A of the model of Kalis and Meurers-Balke (2001) for northern Germany corresponding to the Ellerbek culture (corresponding with the period before 4000 BC), and

shows some similarity to the changes that were observed at Flögeln, Germany that are related to the Funnel Beaker culture (after 3200 BC). The decrease in *Tilia* sp. also corresponds with evidence of human impact from the Belgian Michelsberg culture. Surprisingly, human impact at the wetland sites is not very similar to the first phase of the model of Bakker that is related to the Swifterbant culture, since this phase is characterised by an increase in *Tilia* sp. and a decrease in *Ulmus* sp., while there is more correspondence with changes in the model of Bakker that are related to the Funnel Beaker culture (showing a decrease in *Tilia* sp).

Secondly, there are no indications of an *Ulmus* decline at the sites studied (*cf.* Bakker 2003 and Van der Wiel 1982), despite the similarity to phase Troels-Smith A. It is therefore not possible to use the *Ulmus* decline as an indication of the start of agriculture at the wetland sites. Human impact does not affect *Ulmus* sp. on a large scale (see paragraph 8.2), and there are no indications that *Ulmus* sp. played an important role in leaf-foddering practices. A single find of a bundle of branches at Swifterbant (Casparie *et al.* 1977) is not sufficient evidence due to a lack of contextual data. There are no other botanical indications of leaf-foddering, except possibly for a concentration of fruits of *Hedera helix* found at Doel (Bastiaens *et al.* 2005). In the coastal region, leaf-fodder would hardly have been present. Moreover, leaf-foddering as defined by Troels-Smith presumes that leaf-fodder is collected for animals that are stabled year-round, while the features excavated at the sites studied did not reveal structures interpreted as stables. Instead, the domestic animals may have roamed freely during large parts of the day, foraging themselves instead of being fed, which reduced the need for leaf-foddering during most parts of the year.

Instead, the presence and dynamics of *Ulmus* sp. at the sites studied is expected to be strongly influenced by the ground water table, since most dryland patches gradually submerged through time, resulting in submerging of *Ulmus* trees. The same is probably true for *Fraxinus excelsior*. The absence of indications of leaf-foddering at the wetland sites occupied by the Swifterbant culture appears to contradict the hypothesis of Bakker (2003) that people of the Swifterbant culture in the northern sandy regions of the Netherlands practised leaf-foddering, and may indicate differences in subsistence between the dryland and wetland regions.

Van der Wiel (1982, 43) suggested the occurrence of a *Tilia* fall at the Hazendonk. Various sites in the river area as well as Hoge Vaart indeed support a decrease in the curve of this tree during the period studied (see appendices I, III and IV and chapters 2 and 5). In the central river area, this decrease in *Tilia* sp. is partly related to human impact and partly due to the increasing water level, since the species usually recovers to a certain extent after occupation phases, but finally disappears due to the gradual submerging of dunes. In addition, other growing conditions may have played a role in the restricted recovery, such as the availability of nutrients. At Hoge Vaart, the submergence of dry terrain appears to be the main reason for the decrease in *Tilia* sp. The decrease in *Tilia* sp. resulting from human impact can primarily be interpreted as representing the clearance and disturbance of vegetation during occupation but not as the result of specific agricultural practices such as leaf-foddering for which evidence from the studied sites is lacking. Therefore, the *Tilia* decrease cannot be compared with the *Ulmus* decline in the Landnam model. A decrease of *Tilia* sp. has also been observed in pollen diagrams from various other sites and regions that relate to other cultures and periods (see paragraph 8.3.1 and in particular Behre and Kučan 1994, 149-150; see also Van Regteren Altena *et al.* 1963). This correspondence can be related to the fact that *Tilia* sp. grew in those parts of the landscape that were suitable for living (particularly in the case of the scarce dryland patches in the Dutch wetlands) and/or the practice of agriculture.

Thirdly, the pollen diagrams from most sites do not show evidence of slash-and burn practices as proposed by Iversen and as incorporated in several of the other models. Clearance by slash-and-burn is not supported since the pollen diagrams do not show increased values of *Betula* sp. or horizons with charcoal that cannot be related to occupation. Increased values of *Pteridium aquilinum* are observed at Hoge Vaart and during some occupation phases in the river area, but there is no evidence that the increased presence of *Pteridium aquilinum* is not just related to general human activity resulting in the presence of open patches, especially at

the non-agricultural site Hoge Vaart (see chapter 5). A major exception however is found in non-palynological evidence from unoccupied dunes in the coastal region (see paragraphs 3.10.4.4 and 11.6.3). The absence of indications of intensive occupation leaves the presence of charcoal on certain dunes unexplained. Burning of the vegetation in order to prepare the soil for cultivation remains a valid model here (as supported by the results of Kooistra *et al.* 2002). The function of the dunes is however unclear and the site formation processes of the dunes have to be investigated in further detail before a relationship with cultivation can be made. Another indication of the burning of (herbaceous) vegetation was obtained from the micromorphological analysis at Urk-E4 (see paragraph 4.5.6).

Fourthly, human impact at the sites studied resulted in considerable impact on the shrubs, at least in the river area and the coastal region, and possibly at Hoge Vaart. Increases in *Corylus avellana* (that can grow as a tree and as a shrub) are mentioned in several of the models, related to increased openness of the vegetation, which corresponds with data from the sites studied. Changes in the curves of shrubs other than *Corylus avellana* however hardly play a role in the models from other macroregions presented above or in general discussion of pollen diagrams from comparable Mesolithic and Neolithic sites in Northwestern Europe. This is unexpected in view of the considerable role of shrubs that are part of *Prunetalia spinosae* in other aspects of the discussion on human impact during the Neolithic (see below).

Fifthly, the changes at most Dutch wetland sites studied indicate small-scale clearance of the vegetation for a restricted time period, related to (various forms of) temporary occupation of the sites. Only in a small number of pollen diagrams can the changes be related to continuous occupation. This does not correspond with several of the above-presented models that show similarity with the Landnam model, since these models are based on the continuous occupation in a region and resulting from continuous human impact (with clear exception of the model by Wiethold and the study by Vanmontfort).

In conclusion, the pollen diagrams from the wetland sites show similarities with the models from other macroregions, but also various differences. There are several reasons for the restricted similarity of agricultural human impact in the various models of human impact. In the first place, the landscape at the Dutch wetland sites does not correspond to the landscape of any of the other studies, and as a result the natural vegetation and abiotic factors at the sites studied are different as well. This explains differences in the importance of trees and herbs in the models. Secondly, the degree of neolithisation, the subsistence and cultivation practices may have differed. Thirdly, the models of human impact are related to specific communities and cultural groups, possibly resulting in differential types of disturbance of the natural vegetation. Fourthly, the locations of the pollen cores at the sites studied are often very close to the zone of human activity, representing an on-site location, while pollen cores from at least the loess regions and the sand regions are often sampled at off-site locations where only small patches of peat are available. This difference in sample location gives a difference in the level of information on human impact. This difference can for example explain the differential information on shrubs, and the difference between long-term vegetation developments as registered in the models and the combination of long-term and short-term vegetation developments as obtained from the sites studied.

Some hypotheses can be developed when considering the influence of cultural aspects of human impact and geographical distance. Human impact as characterised in Bakker's model that is related to the northern communities of the Swifterbant culture may especially be expected in the Vecht region (from which only few pollen diagrams are available that give information on human impact) due to the expected cultural similarities and small distance between the two regions. Human impact typical of the Michelsberg culture known from Belgium may be expected in the river area since there is considerable archaeological evidence indicative of influence of the Michelsberg culture on the communities in the river area, and since of all regions the river area was closest to Belgium. However, there has not yet been developed a model of human impact on the vegetation that is comparable with the models presented above for the Michelsberg communities in Belgium. Development

of such a model could facilitate the comparison of human impact between the Michelsberg culture on the one hand and the Swifterbant culture and Hazendonk group on the other hand.

### 8.3.3 Comparison with non-modelled information from other macroregions

A detailed comparison of NAP percentages from the sites studied and comparable European Mesolithic and Neolithic sites is hardly possible because of the differences in the natural vegetation and differences in the pollen sum and pollen diagrams. The weak indications of human impact by non-agricultural communities at the sites studied nevertheless correspond with the general weak human impact in the Mesolithic registered in other parts of Northwestern Europe. The NAP percentage as observed at Neolithic (agrarian) sites studied is furthermore generally comparable with the indications of limited deforestation at Late Neolithic Dutch wetland sites (Bakels 1988; Out 2008d) and at comparable Neolithic sites in Europe (Bakels 1992a; Groenman-van Waateringe 1992, 22; Kreuz 2008; Lüning and Kalis 1992, 43; Richmond 1999, 31).[3] The NAP percentages at the studied sites are possibly in contrast to data from the Belgian Michelsberg sites, for which it was concluded that human impact occurred on a considerable scale (Vanmontfort 2004, 324: "(large-scale) deforestations and *landnams*"). It can however be questioned whether this human impact was larger than in other parts of Europe since the word 'large-scale' is relative. Some other authors consider human impact related to the Michelsberg culture in the Rhineland as restricted, based on comparison to disturbance by earlier Neolithic cultures (Schreurs 2005, 316 based on Kalis and Meurers-Balke).

## 8.4 Evidence of human impact from wood

### 8.4.1 The identifications of wooden artefacts and worked wood

Table 8.2 shows the identifications of wooden artefacts and worked wood from the studied Late Mesolithic and Early and Middle Neolithic wetland sites (N = 11), and from comparable Late Neolithic sites (focussing on the Vlaardingen group and Bell Beaker culture).[4] The number of identifications varies per site, presumably influencing the representativity of the results. The taxa found in this find group at most of the studied sites are *Alnus* sp., *Fraxinus excelsior*, *Quercus* sp., *Corylus avellana* and *Salix* sp. (in order of importance), which are found at eleven to eight sites. This list of taxa is similar to the taxa that are most often found as unworked wood and shows strong correspondence with the taxa found most often as charcoal (see chapter 7). The similarity with the unworked wood identifications indicates that artefacts were generally made of wood that was collected in the exploitation area of the sites, and that availability of wood in the natural vegetation is an important factor influencing the use of wood. There is no strong evidence of the use of wood that was not present in the exploitation area of the studied regions. Of course, the combined wood data give restricted evidence of selective use of wood for specific tools due to the combination of data from different types of artefacts. Therefore, it is investigated in paragraph 8.4.2 whether there are indications of selective use of wood and the import of wood (see paragraph 8.4.3) for separate groups of artefacts.

Comparison of the worked wood identifications between the regions indicates that taxa found at most sites are very similar between regions, except for relatively scarce finds of *Salix* sp. and frequent finds of *Corylus*

---

3 However, precise comparison of the results from the sites studied with Late Neolithic sites in the Netherlands needs further study due to the problems mentioned at the start of this paragraph (see *e.g.* diagrams in Van Regteren Altena *et al.* 1962, 1963a that do not give NAP curves).

4 The number of identifications may exceed the number of artefacts for some sites. The table does not include unidentified finds or identifications of rope. The range of identifications of wooden artefacts from Vlaardingen is based on identifications of wood from postholes. The range of identifications of wooden artefacts from Bergschenhoek is based on all wood identifications except for the identifications of unworked wood of the excavation in 1976, since it is not clear whether the identifications represent unworked or worked wood and since all wood is considered to be brought in from elsewhere.

| site \ taxon | Acer campestre | Alnus glutinosa | Betula sp. | Cornus sanguinea | Corylus avellana | Crataegus-type | Euonymus europaeus | Fraxinus excelsior | Juniperus communis | Lonicera periclymenum | Malus-type | Pinus-type | Pomoideae | Populus sp. | Prunus sp./Salix sp. | Prunus sp. | Prunus spinosa-type | Quercus-type | Prunus padus-type | Rhamnus cathartica | Salix sp. | Sambucus nigra | Sorbus-type | Taxus baccata | Tilia sp. | Ulmus sp. | Viburnum opulus | Viscum album | Identifications (N) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *River area* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bergschenhoek | - | + | + | - | + | + | - | - | - | + | - | + | - | + | - | - | - | cf.+ | + | + | - | - | - | - | - | + | + | + | hundreds** |
| Hazendonk | - | + | - | + | + | + | - | - | + | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | + | + | + | - | 10 |
| Brandwijk-Kerkhof | - | + | + | - | + | + | - | - | - | - | - | + | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | 25 |
| De Bruin | + | + | + | + | + | + | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | + | + | + | + | - | 177 |
| Polderweg | + | + | + | - | + | + | - | - | - | - | - | + | - | - | - | + | - | + | - | + | - | - | + | + | + | + | + | - | 57 |
| *Coastal region* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wateringen 4 | + | + | - | - | - | + | + | - | - | - | - | - | - | - | - | + | - | + | - | - | + | - | - | - | - | - | - | - | 27 |
| Schipluiden | - | + | - | + | + | + | + | + | - | - | + | - | - | + | - | - | - | + | + | + | + | - | - | - | - | + | - | - | 185 |
| Ypenburg | - | + | + | - | + | + | + | + | - | - | - | - | - | + | - | - | + | + | + | - | + | - | - | - | - | - | - | - | 15 |
| *Northern regions* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Emmeloord-J97 | - | + | - | - | - | - | - | - | - | - | - | - | + | - | - | + | - | - | + | - | + | - | - | + | + | - | - | - | 99 |
| Swifterbant-S3 | - | + | + | - | + | + | - | - | + | - | - | + | - | - | - | + | - | + | - | + | + | - | - | - | - | - | - | - | 258 |
| Hoge Vaart-A27 | + | + | + | - | + | + | + | - | - | - | - | + | + | - | - | + | + | + | + | + | + | - | + | + | - | - | - | - | 336 |
| total (N sites) | 4 | 11 | 5 | 8 | 0 | 3 | 10 | 3 | 1 | 2 | 0 | 4 | 2 | 1 | 1 | 9 | 3 | 8 | 1 | 1 | 3 | 4 | 4 | 1 | | | | | |
| *Late Neolithic* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Emmeloord-J97 | - | + | - | + | - | - | - | - | - | - | - | - | - | - | - | + | - | + | + | - | + | - | +* | - | - | - | + | - | 320 |
| Hekelingen III | + | + | - | + | - | + | - | - | - | - | - | + | - | - | + | - | - | + | + | - | + | - | + | - | + | - | + | - | 104 |
| Vlaardingen | + | + | - | + | + | + | + | - | - | - | - | + | - | - | - | + | - | + | + | + | + | - | + | - | - | + | + | - | 345 |
| Hazendonk | - | + | - | + | + | + | + | + | - | - | + | - | - | - | - | + | + | + | + | + | + | - | + | + | + | + | + | - | 88 |

+ = present
- = not present

\* = artefact dates to the Neolithic or Bronze Age
\*\* = including worked and possibly unworked wood

Table 8.2 The sites studied and comparable Late Neolithic sites, wood identifications of artefacts and worked wood.

*avellana* in the river area, and the frequent use of *Juniperus communis* in the coastal region. The diversity of taxa is greatest in the river area (19 taxa) and smallest in the northern regions (13 taxa). The maximal diversity in the river area may be related to the assignment of all taxa found at Bergschenhoek as artefacts despite uncertainty whether these taxa represent artefacts/worked wood or unworked wood. The maximal diversity of artefact and worked wood identifications in the river area is in contrast to maximal diversity of the unworked wood and charcoal identifications in the coastal region. The number of artefact finds may play a role here, which can be tested against the results of future excavations.

The importance of taxa in the identifications of wooden artefacts and worked wood of the Late Mesolithic and Early and Middle Neolithic sites has also been investigated at site level (see table 8.3). The three taxa dominant at a single site were given 3, 2 and 1 points in order of importance, and the total scores of taxa were compared (see also chapter 7 for this method). *Alnus* sp. is most commonly used for artefacts at most sites, followed by *Fraxinus* sp. and *Quercus* sp. (all three taxa are dominant or relatively important at more than two sites). Only at Schipluiden and Bergschenhoek *Prunus cf. spinosa* and *Cornus sanguinea* are dominant in the artefact assemblage respectively. The dominance of *C. sanguinea* at Bergschenhoek is related to the finds of several fish traps made of this species.

| site / taxon | Acer campestre | Alnus glutinosa | Cornus sanguinea | Corylus avellana | Fraxinus excelsior | Juniperus communis | Prunus cf. spinosa | Quercus sp. | Salix sp. |
|---|---|---|---|---|---|---|---|---|---|
| *River area* | | | | | | | | | |
| Bergschenhoek | - | 2 | 3 | - | - | - | - | - | - |
| Brandwijk-Kerkhof | - | 3 | - | 2 | - | - | - | 3 | - |
| De Bruin | - | 3 | - | - | 2 | - | - | 1 | - |
| Polderweg | - | 3 | - | - | 2 | - | - | 1 | - |
| *Coastal region* | | | | | | | | | |
| Wateringen 4 | 2 | 3 | - | - | - | 3 | - | - | - |
| Schipluiden | - | 2 | - | - | - | 1 | 3 | - | - |
| Ypenburg | - | 3 | - | - | 2 | - | - | 1 | 1 |
| *Northern regions* | | | | | | | | | |
| Emmeloord-J97 | - | 3 | - | - | - | - | - | - | 2 |
| Swifterbant-S3 | - | 3 | - | 2 | 1 | - | - | - | - |
| Hoge Vaart-A27 | - | 3 | - | - | - | - | - | 1 | 2 |
| total (sum of dominance) | 2 | 28 | 3 | 4 | 7 | 4 | 3 | 7 | 5 |

1 = the third most important taxon    3 = the most important taxon
2 = the second most important taxon    - = not one of the three most important taxa

Table 8.3 The three most important taxa in the assemblage of wooden artefacts and worked wood at each site.

Other taxa that are relatively important at a few sites are *Cavellana*, *Juniperus communis* and *Salix* sp. The general similarity between the combined data of all sites and data of single sites indicates that the choice of wood for artefacts was similar at the sites studied.

Comparison of the worked wood identifications from Mesolithic (non-agricultural) and Neolithic (agricultural) sites shows little changes in wood use that can be related to the neolithisation process, although the small number of Mesolithic sites from which wood identifications are known (N = 3) and the absence of agricultural sites in the Eem region restricts the validity of the analysis. Comparison of the worked wood identifications from Mesolithic and Neolithic sites show a trend that the use of *Acer* sp. possibly decreased in the Neolithic. This may be related to the availability of the species. Identifications of unworked wood, macroremains and pollen indicate that *Acer* sp. was available in the Neolithic in the central river area and the coastal region in the Neolithic, though scarce. At sites of the Vlaardingen group in the Late Neolithic *Acer campestre* is used on a considerable scale for posts (discussed below).

Comparison of the Late Mesolithic and Early and Middle Neolithic sites on the one hand and Late Neolithic sites on the other hand show the increased use of *Taxus baccata*, presumably related to its availability and not to the neolithisation process. Use of this species may have increased already earlier during the Neolithic, since it became part of the natural vegetation of the studied sites from at least the Middle Neolithic onwards (see chapter 7).

8.4.2    Selective use of wood for artefacts

The selective use of wood, *i.e.* use of a specific taxon for a specific type of artefact, reveals specific details of plant use. The type of wood selection that is often discussed in the literature on the studied sites is related to the qualities of the wood of a taxon and the function and desired qualities of an artefact. This type of selection is usually characterised by use of the most suitable taxon that was available to people. When the preferred species was not available due to scarcity in the natural vegetation in the region (exploitation area), it is expected that a second best species was used instead, or that wood from the preferred taxon was imported from outside the region. In addition to the selection based on the technical qualities of the wood and the artefact, there are alternative reasons for the selection of wood, such as the symbolic or ritual meaning of a taxon. Such a motivation for selective use is however difficult to demonstrate. The opposite of selective use is the use of wood of those taxa that are most plentifully available in the exploitation area, independent of the specific characteristics of the taxon and the function of the artefact.

This paragraph aims to investigate whether people selectively used wood for various artefacts at the Late Mesolithic and Early and Middle Neolithic Dutch wetland sites. The results are compared with the available data from comparable Late Neolithic Dutch wetland sites with focus on sites of the Vlaardingen group and Bell Beaker culture. Indications of selective use are further discussed and compared with evidence from comparable sites, countries and artefacts. It is additionaly investigated whether there is a relationship between selective use and the neolithisation process.

Most data are based on data from sites and literature that are presented in the first part of this study or in the appendices (Van Beek 1990; Bottema-MacGillavry 2003; Casparie *et al.* 1977; Casparie and De Roever 1992; Kooistra 2008b; Louwe Kooijmans 1987; Louwe Kooijmans, Hänninen and Vermeeren 2001; Louwe Kooijmans and Kooistra 2006; Louwe Kooijmans, Vermeeren and Van Waveren 2001; Raemaekers *et al.* 1997; Van Rijn 2002; Van Rijn and Kooistra 2001, wood data in appendix II based on unpublished data of Leiden University, wood data in appendix III based on unpublished data by Van den Berg and the National Museum of Antiquities; wood data in appendix V based on unpublished data by Casparie and the National Museum of Antiquities). Less extensively discussed sources are given in the tables. The data of the studied sites that are presented in the tables are ordered by region.
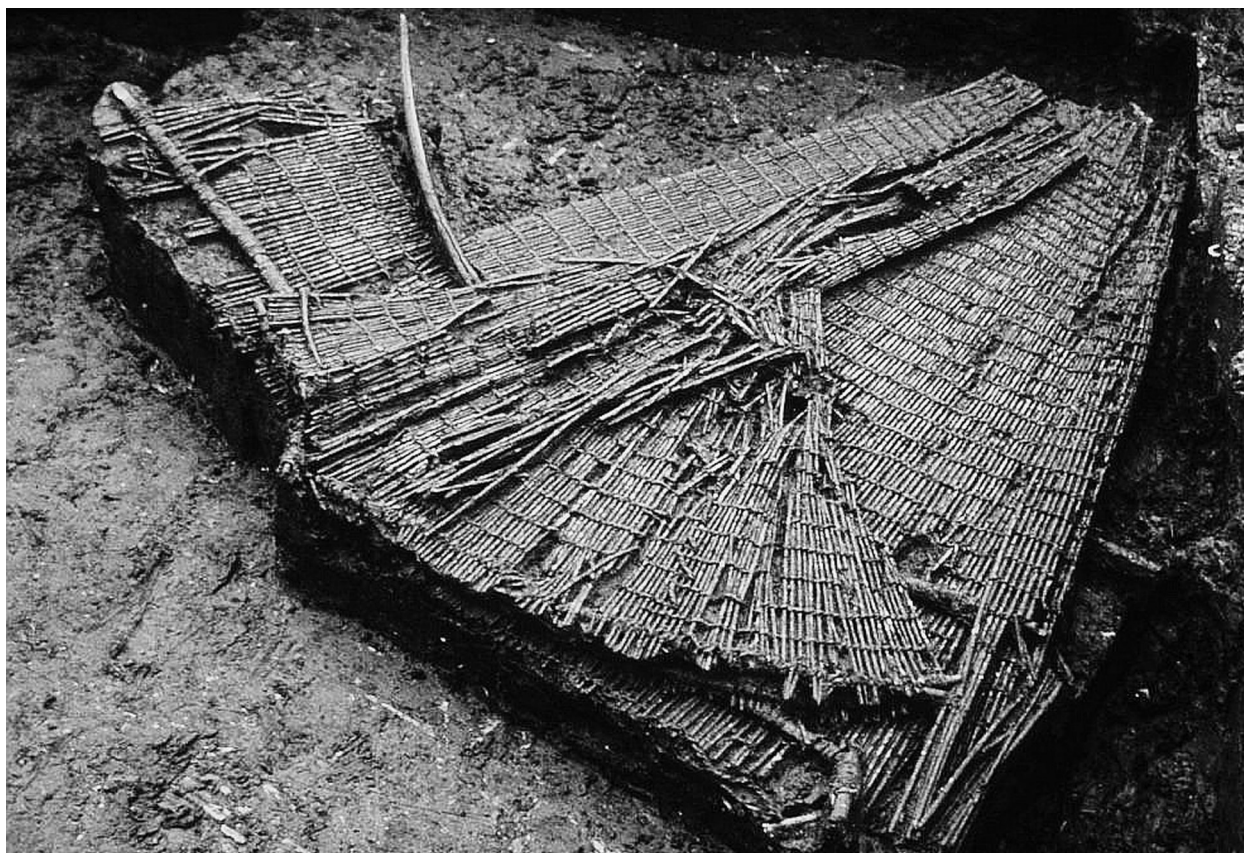
Figure 8.1 Bergschenhoek, a fish trap (National Museum of Antiquities, see also appendix V).

### 8.4.2.1  Fish traps and wattle work

Figure 8.1 shows an example of a fish trap. Table 8.4 shows the wood identifications of long withies of fish traps found at the Late Mesolithic and Early and Middle wetland Neolithic sites (the sites studied), and comparable Late Neolithic Dutch wetland sites. In addition, wattle work found at Ypenburg of *Cornus sanguinea* may represent a fish trap in preparation (Kooistra 2008b). The data strongly support the selective use of wood for the long withies of fish traps. Fish traps found in the southern regions are made of *Cornus sanguinea*, while fish traps found in the Vecht regions are generally made of *Salix* sp. and *Corylus avellana*. The large number of identifications from fish traps from Emmeloord shows that some other taxa were occasionally used as well in the Vecht region (*Betula* sp., *Corylus* sp., *Quercus* sp. and *Viburnum opulus*), but this concerns minor additions and never includes *Cornus sanguinea*. The difference between the southern and Vecht regions can be explained by cultural preferences or by differences in the natural vegetation (Out 2008b).

Remains of wattle work with an unknown function found at other sites may represent fish traps as well. At Swifterbant-S3 and Jardinga (*c.* 8500-8200 BC), withies of *Salix* sp. were found (Bottema-MacGillavry 2003; Casparie *et al.* 1977), but there is not enough contextual evidence to interpret these finds as remains of fish traps. At Schipluiden, finds of wattle work were identified as *Alnus* sp., *Salix* sp. and Pomoideae (Louwe Kooijmans and Kooistra 2006, 242). The context of these finds suggests that they do not represent fish traps.

| site | culture/group | taxon | N |
|---|---|---|---|
| *Sites studied* | | | |
| Bergschenhoek | Swifterbant | Cornus sanguinea | 3 ? |
| De Bruin | Late Mesolithic/ Swifterbant | Cornus sanguinea | 1 |
| Emmeloord-J97 | Swifterbant | Salix sp. | 1 |
| | | Indet. | 2 |
| Hoge Vaart-A27 | Swifterbant | Alnus sp./Quercus sp./Salix sp. | 1 |
| | | Salix sp. | 2 |
| *Late Neolithic* | | | |
| Emmeloord-J97 | Bell Beaker | Salix sp. | 15 |
| | | Corylus avellana | 21 |
| | | Corylus sp./Salix sp. | 3 |
| | | Corylus sp./Quercus sp. | 1 |
| | | Betula sp./Corylus sp. | 1 |
| | | Salix sp./Viburnum opulus | |
| Vlaardingen* | Vlaardingen | Cornus sanguinea | 1 |

* = pers. comm. Troostheide 2005

Table 8.4 The sites studied and comparable Late Neolithic sites, wood identifications of long withies of fish traps.

Fish traps from other Late Mesolithic and Neolithic sites in Northwestern Germany, Denmark and Ireland are made of *Betula* sp., *Corylus avellana*, *Salix* sp. and *Tilia* sp. (Andersen 1995, 56; McQuade and O'Donnell 2007; Mertens 2000; Pedersen 1995, 82; Pedersen *et al.* 1997). The absence of fish traps of *Cornus sanguinea* in other countries is remarkable. Further research is needed to investigate the relative importance of cultural selection and the availability of *Cornus sanguinea* in other regions of Europe where fish traps have been found (*cf.* Out 2008b).

### 8.4.2.2 Dugout canoes

Figure 8.2 shows an example of a dugout canoe. Table 8.5 shows the wood identifications of dugout canoes from the sites studied and comparable Late Neolithic sites. The different taxa used for the dugout canoes do not directly demonstrate the selective use of wood, which may be related to the small number of dugout canoes that are found in different regions and that date to different periods. The data nevertheless correspond with other Northwestern European finds that show a shift from *Tilia* sp. in the Late Mesolithic to *Alnus* sp. and *Quercus* sp. in the Neolithic (Arnold 1995; Christensen 1990; Coles *et al.* 1978, 21; Louwe Kooijmans and Verhart 2007; Mertens 2000; Schmölcke *et al.* 2006). The similarity of the data from the sites studied with data from other countries may therefore support the selective use of wood for dugout canoes after all. The use of *Alnus* sp. at Bergschenhoek may on the one hand be explained by selective use since similar finds are known from Mesolithic and Neolithic sites in Germany and especially Denmark (Arnold 1995; Christensen 1990). On the

Figure 8.2 Hardinxveld-Giessendam De Bruin, a dugout canoe (Louwe Kooijmans, Hänninen and Vermeeren 2001).

| site | culture/group | taxon | N | dimensions (cm) |
|------|---------------|-------|---|-----------------|
| *Sites studied* | | | | |
| Bergschenhoek | Swifterbant | Alnus glutinosa | 1 + ? | 64-130 x 14-21 x 3-4.5 |
| De Bruin | Late Mesolithic/ Swifterbant | Tilia sp. | 2 | 549 x 49 x 14 150 x 50 x 2 |
| *Late Neolithic* | | | | |
| Dijkgatsweide* | ? | Quercus sp. | 1 | 740 x max. 86 |
| Hazendonk | Vlaardingen | Quercus sp. | 1 | > 250 |

/ = and

? = unknown

* = Kruidhof *et al.* 2007

Table 8.5 The sites studied and comparable Late Neolithic sites, wood identifications of dugout canoes.

other hand, the use of *Alnus* sp. does not necessarily support the selective use of wood since *Alnus* sp. was most frequently/easily available in the near surroundings of Bergschenhoek (see appendix V).[5]

### 8.4.2.3 *Paddles*

Figure 8.3 shows an example of a paddle. Table 8.6 shows the wood identifications of paddles from the sites studied and comparable Late Neolithic sites of the Vlaardingen group. All paddles are oblong. The data indicate the selective use of wood, since most paddles are made of the resilient species *Fraxinus excelsior* that is flexible though strong (Louwe Kooijmans and Verhart 2007; Mertens 2000). This especially concerns paddles from the river area and coastal region. The common use of *Fraxinus excelsior* for paddles is also known from Ertebølle sites, where they are heart-shaped instead of oblong (Mertens 2000; Schmölcke *et al.* 2006). The paddles of Swifterbant and Hoge Vaart, located in the northern regions, are however made of *Quercus* sp., *Alnus glutinosa* and *Acer campestre* (*contra* Louwe Kooijmans and Verhart 2007). The paddles thus confirm the pattern of the fish traps that wood selection in the northern Vecht and Eem regions does not correspond to that of the southern regions. Possible explanations are differences in the natural vegetation and differential cultural preferences. The information on the natural vegetation in the Vecht region is however too limited to make firm conclusions on the availability of the relevant taxa (see chapter 7). Exceptions to the choice of *Fraxinus excelsior* for paddles are also known from oblong paddles from Maglemose sites in Denmark where people used *Salix* sp. and *Corylus* sp. (see references in Mertens 2000), from the German Early Mesolithic site Friesack were people used *cf. Sorbus* sp. (Gramsch and Kloss 1988), and from the British sites Star Carr and Sweet Track where paddles from *Betula* sp. and *Quercus* sp. were found (Coles *et al.* 1978). Christensen (1990, 133) also mentions a paddle made of *Tilia* wood from Stone Age Denmark.

| site | culture/group | taxon | N |
|---|---|---|---|
| *Sites studied* | | | |
| De Bruin | Late Mesolithic/ Swifterbant | Fraxinus excelsior | 2 |
| Polderweg | Late Mesolithic/ Swifterbant | Fraxinus excelsior | 4 |
| Schipluiden | Hazendonk | Fraxinus excelsior | 2 |
| Swifterbant | Swifterbant | Alnus sp. | 1 |
| | | Quercus sp. | 1 |
| Hoge Vaart* | Swifterbant | Acer campestre-type | 1 |
| *Late Neolithic* | | | |
| Hazendonk | Vlaardingen | Fraxinus excelsior | 1 |
| Hekelingen III | Vlaardingen | Fraxinus excelsior | 1 |

* = pers. comm. L. Koehler and J. Nientker 2005

Table 8.6 The sites studied and comparable Late Neolithic sites, wood identifications of paddles.

5  Another dugout canoe, made of *Pinus* wood, is known from the earlier Mesolithic site Pesse in the northeast part of the Netherlands, although there is some discussion whether it represents a dugout (Beuker and Niekus 1997; Louwe Kooijmans and Verhart 2007). The contrastive choice for coniferous wood can be explained by the fact that *Pinus* sp. probably was a very common species at the relevant location and period. Parallels for the use of this taxon for dugouts are known from Mesolithic and Neolithic sites in Germany, France and Switzerland (Arnold 1995, 25-26; Mertens 2000, 35).
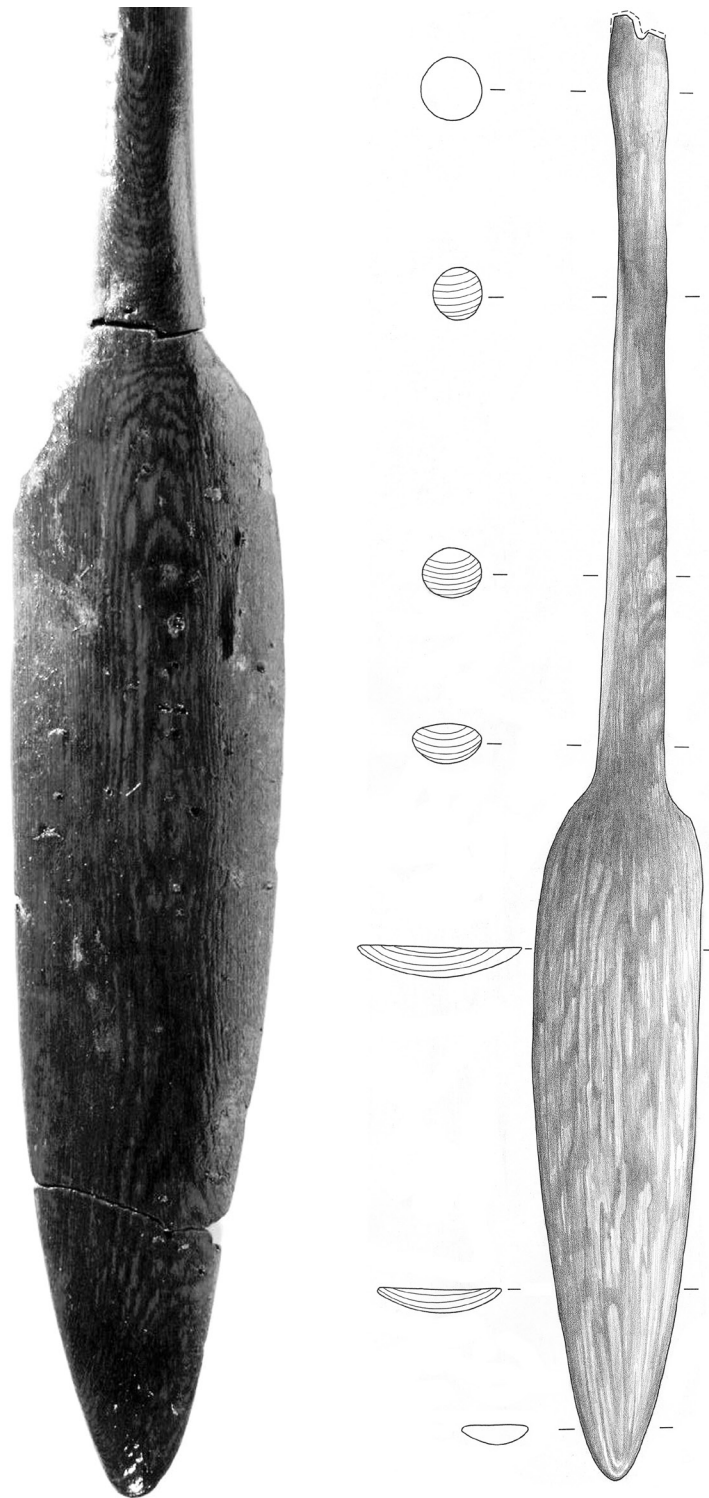
Figure 8.3 Schipluiden, a paddle blade (Louwe Kooijmans and Kooistra 2006).

*8.4.2.4  Bows*

Figure 8.4 shows an example of a bow. Table 8.7 shows the wood identifications of bows from the sites studied and comparable Late Neolithic sites. Data from agricultural sites of the Swifterbant culture are not available. The data support that people selected wood taxa to make bows, since Mesolithic bows are made of *Ulmus* sp., while most Neolithic bows are made of *Taxus baccata*. *Taxus* wood is better suitable but became part of the natural vegetation of the studied wetland regions possibly only during the Neolithic (Weeda *et al.* 1985, 59; see also Deforce and Bastiaens 2007 and paragraph 7.3.6). It is not always clear for the presented finds whether the wood of *Taxus* sp. was collected in the exploitation area of the wetland sites or whether it was imported from the sandy soils. Interestingly, the bow from Schipluiden is made from *Juniperus communis*. This choice can be explained by absence or scarcity of *Ulmus* sp. and *Taxus baccata* in the exploitation area of the site (Louwe Kooijmans and Kooistra 2006, 228), although this is strange in view of the presence of *Taxus baccata* in the natural vegetation in the exploitation area of Ypenburg, another site in the same region (Kooistra and Hänninen 2008). All bows shown in table 8.7 are of the same type comparable with the Holmegård type (Clark 1963). For Swifterbant, a 'bow' (quotation marks in original publication) made of Pomoideae wood is reported (Casparie *et al.* 1977). It is not possible to interpret this find in the absence of further details. The unusual wood choice could correspond with the data on fish traps and paddles in the Vecht region, if it indeed concerns a bow.

Other finds from Northwestern Europe show the trend that Mesolithic bows are generally made of *Ulmus* sp. while Neolithic bows are generally made of *Taxus baccata* (Coles *et al.* 1978, 10; Junkmanns 2001; Mertens 2000; Schmölcke *et al.* 2006; Weiner 1995). An *Ulmus* bow was found at the LBK site Kückhoven, which can be explained by scarcity of *T. baccata* in the local natural vegetation, or by exchange with Mesolithic people (Weiner 1995). Another exception to the use of *Ulmus* sp. and *T. baccata* is reported from the Sweet Track in Britain (*Corylus avellana*; Coles *et al.* 1978, 10). Parallels for the bow of *Juniperus communis* found at Schipluiden are however not known (yet) from other countries. Topics for future research are the moment of replacement of *Ulmus* sp. by *T. baccata* as the preferred taxon for bows at the sites studied, which taxa were used by the people at agricultural sites of the Swifterbant culture, and whether other additional taxa were used in absence of the preferred taxa.

| site | culture/group | taxon | N |
|---|---|---|---|
| *Sites studied* | | | |
| De Bruin | Late Mesolithic/ Swifterbant | Ulmus sp. | 1 |
| Polderweg | Late Mesolithic/ Swifterbant | Ulmus sp. | 1 |
| Schipluiden | Hazendonk | Juniperus communis | 1 |
| *Late Neolithic* | | | |
| Hazendonk | Vlaardingen | Taxus baccata | 1 |
| Hekelingen III | Vlaardingen | Taxus baccata | 1 |
| Stadskanaal* | ? | Taxus baccata | 1 |

* = Lanting *et al.* 1999

? = unknown

Table 8.7 The sites studied and comparable Late Neolithic sites, wood identifications of bows.

Figure 8.4 Hardinxveld-Giessendam Polderweg, half a bow (Louwe Kooijmans, Vermeeren and Van Waveren 2001).

*8.4.2.5. Hafts*

Figure 8.5 shows an example of a haft. Tables 8.8 and 8.9 show the wood identifications of hafts (including shafts and handles; N = 26) from the sites studied and Late Neolithic sites. An additional hammerhead found at the Hazendonk was made of the wood of Pomoideae. The data do not support the selective use of wood at the studied sites, since at least ten different taxa were used. *Fraxinus excelsior* and Pomoideae are nevertheless used most (N = 6 and N = 5 respectively), indicating moderate selective use after all. Wood of *Fraxinus excelsior* and *Acer campestre* is most suitable to make hafts and are known as preferred taxa (Coles *et al.* 1978; Louwe Kooijmans and Kooistra 2006, 231; Schmölcke *et al.* 2006; see also Casparie *et al.* 1995, 40; Hendrix *et al.* 1996), and Pomoideae forms a good alternative in the case of shortage of *Fraxinus excelsior* and *Acer campestre*. Further selective use may be hidden in the data set, since the large variety of taxa may be related to the different functions of the hafts. The Late Neolithic finds (N = 4) are all made of a different taxon. In contrast to the data of the Mesolithic and Neolithic, a considerable number of Dutch Bronze Age hafts are made of *Quercus* sp., which is possibly related to a symbolic meaning of *Quercus* sp. (Drenth and Brinkkemper 2002).
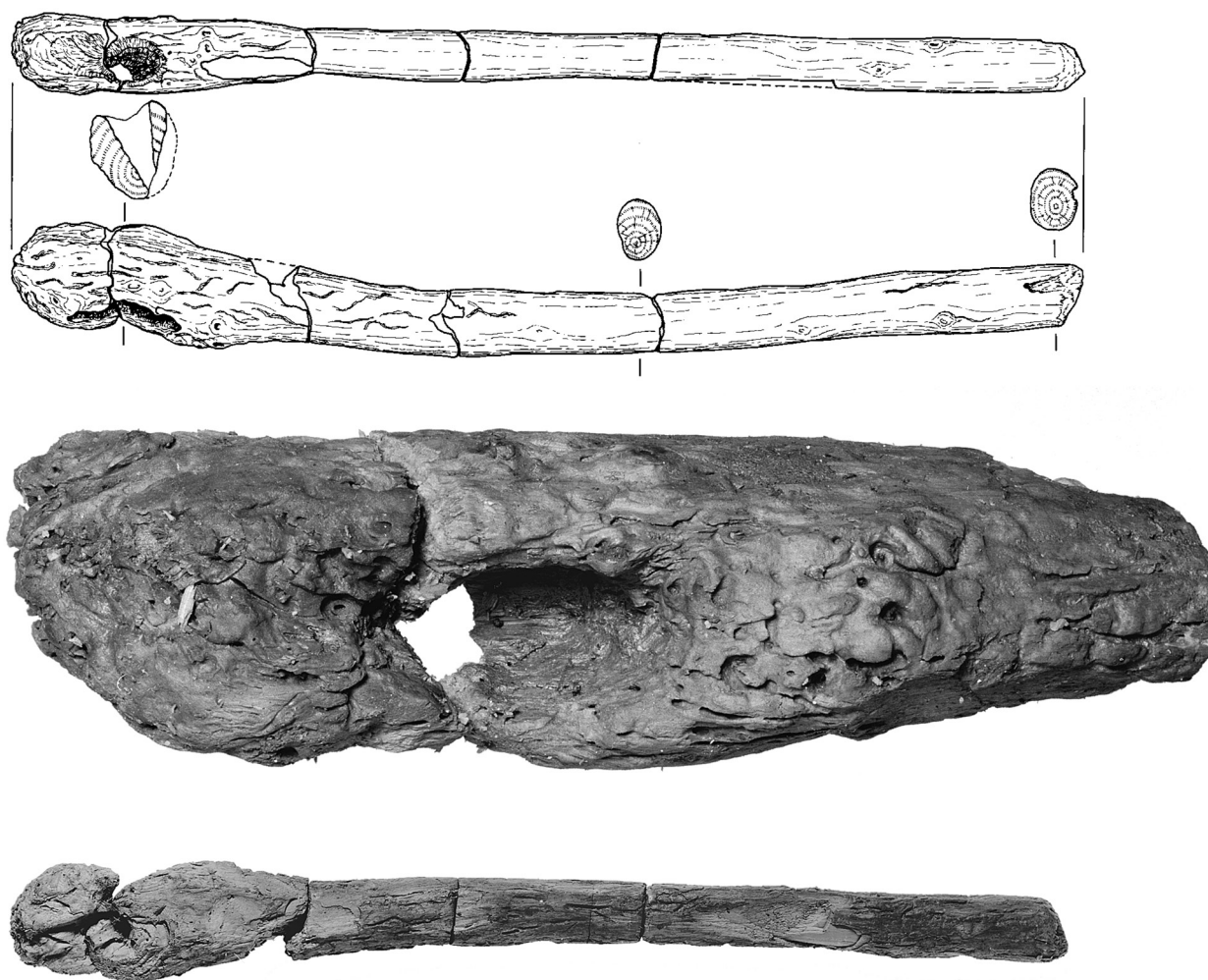


Figure 8.5 Hardinxveld-Giessendam Polderweg, a haft (Louwe Kooijmans, Vermeeren and Van Waveren 2001).

| site | culture/group | taxon | N |
|---|---|---|---|
| *Sites studied* | | | |
| Bergschenhoek | Swifterbant | Alnus glutinosa | 1 |
| | | Fraxinus excelsior | 1 |
| Hazendonk | Swifterbant | Fraxinus excelsior | 1 |
| De Bruin | Late Mesolithic/ | Acer campestre | 1 |
| | Swifterbant | Fraxinus excelsior | 1 |
| | | Quercus sp. | 1 |
| Polderweg | Late Mesolithic/ | Acer campestre | 2 |
| | Swifterbant | Cornus sanguinea | 1 |
| | | Fraxinus excelsior | 2 |
| Schipluiden | Hazendonk | Alnus sp. | 1 |
| | | Corylus avellana | 1 |
| | | Euonymus europaeus | 1 |
| | | Malus sp. | 1 |
| | | Pomoideae | 4 |
| | | cf. Prunus sp. | 1 |
| | | Salix sp. | 1 |
| Ypenburg | Hazendonk | Salix sp. | 1 |
| | | Quercus sp. | 1 |
| Swifterbant | Swifterbant | Corylus avellana | 1 |
| | | Fraxinus excelsior | 1 |
| | | Salix sp. | 1 |
| *Late Neolithic* | | | |
| Emmer-Compascum* | ? | Sorbus aucuparia | 1 |
| Nieuw-Dordrecht** | ? | Taxus baccata | 1 |
| Hazendonk | Vlaardingen | Euonymus europaeus | 1 |
| | | Pomoideae | 1 |

\* = Glasbergen 1957 in Drenth and Brinkkemper 2002

\*\* = Van Zeist 1957

? = unknown

Table 8.8 The sites studied and comparable Late Neolithic sites, wood identifications of hafts.

| taxon | N | % | taxon | N | % |
|---|---|---|---|---|---|
| Fraxinus excelsior | 6 | 23 | Quercus sp. | 2 | 8 |
| Pomoideae | 4 | 15 | Cornus sanguinea | 1 | 4 |
| Acer campestre | 3 | 12 | Euonymus europaeus | 1 | 4 |
| Salix sp. | 3 | 12 | Malus sp. | 1 | 4 |
| Alnus sp. | 2 | 8 | cf. Prunus sp. | 1 | 4 |
| Corylus avellana | 2 | 8 | total | 26 | |

Table 8.9 The sites studied, summary table of the wood identifications of hafts.

### 8.4.2.6 Rectangular split pieces

Tables 8.10, 8.11, 8.12 and 8.13 show the identifications of rectangular split pieces, representing (possible) planks, beams, the waste of wood working and objects with an unknown function. The criteria for interpretation of the finds as such are not given in all publications. Kooistra (2008b) defined planks as (worked) objects of wood that are two times broader than wide. This definition has been applied to all the rectangular split pieces, resulting in a group of planks and objects comparable with planks, and a group of beams that are maximal two times broader than wide. Figure 8.6 shows examples of planks.

There are 74 objects at the sites studied that are classified as planks based on the definition given above (see table 8.10). The planks are in the first place made of *Alnus* sp., and additionally from *Quercus* sp., *Fraxinus excelsior* and *Tilia* sp., as well as from other species in smaller numbers. This range of taxa does not demonstrate the selective use of wood for planks but instead seems to reflect the plentiful availability of trees of these taxa in the natural vegetation with a relatively large diameter and length. The presence of planks of *Tilia* sp. is remarkable since other artefacts made of *Tilia* sp. are very scarce at the sites studied. Some of the planks possibly represent fragments of dugout canoes, and this would support the selective use of *Tilia* sp. (discussed in paragraph 8.4.2.2 and below).

Planks from several taxa have been interpreted as possible fragments of dugout canoes. At Polderweg it concerns all planks of *Alnus* sp. (Louwe Kooijmans, Vermeeren and Van Waveren 2001, 393). At De Bruin, it concerns planks of *Alnus* sp., *Tilia* sp. and *Quercus* sp., although the interpretation of planks from *Quercus* sp. as dugout canoe fragments is tentative (Louwe Kooijmans, Hänninen and Vermeeren 2001, 447). The interpretation of the planks at Polderweg is based on four arguments, and one of the arguments is that the three species are regularly used to make dugout canoes. These data can therefore not be used to support the selective use of wood for dugout canoes, but the data do not reject this either.

The site report of Schipluiden pays detailed attention to small rectangular split pieces with a maximal length of 20 cm, interpreted as the probable waste of wood working. A similar piece was interestingly found at Wateringen 4 (Raemaekers *et al.* 1997), and this piece was carefully worked over the whole surface. The pieces from Schipluiden could therefore theorethically also represent semi-finished products of the same type (Louwe Kooijmans and Kooistra 2006, 240). This potential new artefact could be related to the types of houses in the coastal region, or with a specific activity that was performed in the coastal region.

There are nine objects that were initially identified as beams at the sites studied, but the use of the definition of planks and beam has resulted in the distinction of 19 beams in total (see table 8.12). Taxa that were used to make beams are mainly *Quercus* sp., *Fraxinus excelsior* and *Alnus* sp. (in order of importance).

Figure 8.6 Bergschenhoek, a platform of planks (National Museum of Antiquities, see also appendix V).

Table 8.10 (next two pages) The sites studied and comparable Late Neolithic sites, wood identifications of rectangular split pieces that are interpreted as planks.

| site | culture/group | taxon | N | dimensions (cm) | interpretation |
|---|---|---|---|---|---|
| *Sites studied* | | | | | |
| Bergschenhoek | Swifterbant | Alnus glutinosa | 1 | 13 x 3.2 | plank |
| | | Alnus glutinosa | 1 | 6 x 2.6 | plank |
| | | Alnus glutinosa | 1 | 7.5 x 2 | plank |
| | | Alnus glutinosa | 1 | 8 x 2 | plank |
| | | Alnus glutinosa | 1 | 8.5 x 2.2 | plank |
| | | Alnus glutinosa | 1 | 12 x 1.8 | |
| De Bruin | Late Mesolithic/ | Alnus glutinosa | 1 | 21 x 16 x 2 | canoe? |
| | Swifterbant | Alnus glutinosa | 1 | 65 x 9 x 1.5 | plank |
| | | Alnus glutinosa | 1 | 8 x 2.5 x 1 | plank? |
| | | Alnus glutinosa | 1 | 12 x 5.5 x 0.5 | plank? |
| | | Alnus glutinosa | 1 | 19 x 4 x 1.5 | plank? |
| | | Alnus glutinosa | 1 | 10 x 4 x 1 | plank? |
| | | Alnus glutinosa | 1 | 10 x 7 x 1 | plank? |
| | | Alnus glutinosa | 1 | 10 x 5 x 1 | plank? |
| | | Alnus glutinosa | 1 | 38 x 8 x 1.5 | plank? |
| | | Alnus glutinosa | 1 | 18 x 5 x 1 | plank? |
| | | Alnus glutinosa | 1 | > 70 x 9 x 3 | plank? |
| | | Alnus glutinosa | 1 | 12 x 6 x 1 | plank? |
| | | Alnus glutinosa | 1 | 11 x 6.5 x 1 | plank? |
| | | Alnus glutinosa | 1 | > 25 x 1-6 x 4 | plank? |
| | | Alnus glutinosa | 1 | > 25 x 5 x 2 | plank? |
| | | Alnus glutinosa | 1 | > 30 x > 14 x 3 | plank? |
| | | Alnus glutinosa | 1 | > 65 x 9 x 1.5 | plank? |
| | | Alnus glutinosa | 1 | > 30 x 7 x 1 | plank? |
| | | Alnus glutinosa | 1 | > 25 x > 10 x 1 | plank? |
| | | Alnus glutinosa | 1 | > 33 x 7 x 2 | plank? |
| | | Cornus sanguinea | 1 | 15 x 4.5 x 1.5 | plank? |
| | | Fraxinus excelsior | 1 | 19 x 5 x 2 | plank? |
| | | Fraxinus excelsior | 1 | 3.5 x 2 x 0.5 | plank? |
| | | Fraxinus excelsior | 1 | > 40 x > 6.5 x 0.9 | plank?/waste |
| | | Fraxinus excelsior | 1 | > 26 x > 9 x > 1.5 | plank? |
| | | Fraxinus excelsior | 1 | > 50 x 5-8 x 2 | plank?/waste |
| | | Fraxinus excelsior | 1 | > 20 x 57 x 1 | plank?/waste |
| | | Fraxinus excelsior | 1 | > 50 x 9 x 2 | plank? |
| | | Quercus sp. | 1 | 50 x 17 x 4 | canoe? |
| | | Quercus sp. | 1 | > 53 x 2-8 x 1-1.5 | canoe? |
| | | Quercus sp. | 1 | 10 x 4.5 x 1.5 | plank? |

| site | culture/group | taxon | N | dimensions (cm) | interpretation |
|---|---|---|---|---|---|
| De Bruin (cont.) | | Quercus sp. | 1 | 50 x 17 x 4 | plank? |
| | | Quercus sp. | 1 | > 54 x > 16 x 2 | plank? |
| | | Quercus sp. | 1 | > 17 x > 5 x 2 | plank? |
| | | Tilia sp. | 1 | 80 x 23 x 1 | canoe? |
| | | Tilia sp. | 1 | 48 x 8 x 1.5 | canoe |
| | | Tilia sp. | 1 | 50 x 17 x 3 | plank?/waste |
| | | Tilia sp. | 1 | > 64 x 12 x 3 | plank? |
| Polderweg | Late Mesolithic/ Swifterbant | Alnus glutinosa | 1 | 32 x 7.5 x 1.5 | plank |
| | | Alnus glutinosa | 1 | 38 x 1-7.5 x 1 | plank |
| | | Alnus glutinosa | 1 | 25 x 5 x 0.8 | plank |
| | | Alnus glutinosa | 1 | 45 x 5 x 2 | plank |
| | | Alnus glutinosa | 1 | 67.5 x 5-6.5 x 0.5-1.2 | canoe? |
| | | Alnus glutinosa | 1 | 82 x 7.5 x 2.4 | canoe? |
| | | Alnus glutinosa | 1 | 60 x 6 x 1.4-2 | canoe? |
| | | Alnus glutinosa | 1 | 70 x 12.2 x 1.2 | canoe? |
| | | Alnus glutinosa | 1 | 20 x 4.4-5.5 x 0.9-1.3 | plank |
| | | Alnus glutinosa | 1 | 76 x 5-13 x 2 | canoe? |
| | | Alnus glutinosa | 1 | 27 x 6.5 x 0.5-2.2 | plank |
| | | Alnus glutinosa | 1 | 74.3 x 11.4 x 3.1 | canoe? |
| | | Quercus sp. | 1 | ? | plank |
| | | Salix sp. | 1 | 41 x 6 x 2 | plank |
| | | Tilia sp. | 1 | 40 x 30 x 1-2 | plank |
| | | Tilia sp. | 1 | ? x 23 x 1.5 | plank |
| Wateringen 4 | Hazendonk | Acer campestre | 1 | 12 x 6.5-8 x 1.5 | ? |
| Schipluiden | Hazendonk | Alnus sp. | 1 | 81 x 10 x 4 | plank |
| | | Alnus sp. | 1 | 88 x 10 x 4 | plank |
| | | Alnus sp. | 1 | 105 x 10 x 4 | plank |
| | | Alnus sp. | 1 | 11 x 3 x 1.1 | split piece |
| | | Alnus sp. | 1 | 11.5 x 4 x 1.1 | split piece |
| | | Alnus sp. | 1 | 18 x 7 x 2.5 | split piece |
| | | Alnus sp. | 1 | 49 x 19 x 4 | plank |
| | | Pomoideae | 1 | 31 x 15 x 5 | waste? |
| | | Pomoideae | 1 | 16 x 8 x 3 | waste? |
| | | Pomoideae | 1 | 17 x 11 x 3 | waste? |
| | | Salix sp. | 1 | 17 x 4.5 x 1.4 | split piece |
| Ypenburg | Hazendonk | Alnus glutinosa | 1 | > 36 x 13 x 5 | plank |
| *Late Neolithic* | | | | | |
| Hazendonk | Vlaardingen | Alnus glutinosa | 1 | | |

| taxon | N | % |
|---|---|---|
| Alnus glutinosa | 47 | 64 |
| Fraxinus excelsior | 7 | 9 |
| Quercus sp. | 7 | 9 |
| Tilia sp. | 6 | 8 |
| Pomoideae | 3 | 4 |
| Acer campestre | 1 | 1 |
| Cornus sanguinea | 1 | 1 |
| Salix sp. | 2 | 3 |
| total | 74 | |

| taxon | N | % |
|---|---|---|
| Quercus sp. | 8 | 42 |
| Fraxinus excelsior | 6 | 32 |
| Alnus sp. | 4 | 21 |
| Pomoideae | 1 | 5 |
| | | |
| | | |
| | | |
| | | |
| total | 19 | |

Table 8.11 left and table 8.13 right: the sites studied, summary table of the wood identifications of rectangular split pieces interpreted as planks and as beams, respectively.

| site | culture/group | taxon | N | dimensions (cm) | interpretation |
|---|---|---|---|---|---|
| *Sites studied* | | | | | |
| Bergschenhoek | Swifterbant | Alnus sp. | 1 | | small beam |
| | | Alnus sp. | 1 | | small beam |
| De Bruin | Late Mesolithic/ | Quercus sp. | 1 | 16 x 3-5 x 3 | plank? |
| | Swifterbant | Alnus glutinosa | 1 | 12 x 3.5 x 2 | plank? |
| | | Alnus glutinosa | 1 | > 27 x 5 x 3 | plank? |
| | | Fraxinus excelsior | 1 | 19 x 7 x 3.5 | beam |
| | | Fraxinus excelsior | 1 | 14 x 6 x 3.5 | beam |
| | | Fraxinus excelsior | 1 | 8 x 3 x 2 | beam |
| | | Fraxinus excelsior | 1 | > 18 x 10 x 2.5 | beam? |
| | | Fraxinus excelsior | 1 | 15 x 4 x 4 | beam? |
| | | Quercus sp. | 1 | 13 x 3 x 2 | plank? |
| Polderweg | Late Mesolithic/ | Quercus sp. | 1 | 63 x 10 x 9 | beam |
| | Swifterbant | Quercus sp. | 1 | ? | beam |
| Schipluiden | Hazendonk | Pomoideae | 1 | 17 x 6.5 x 4 | split piece |
| Ypenburg | Hazendonk | Fraxinus excelsior | 1 | 192 x 20 x 10 | beam |
| Hoge Vaart | Late Mesolithic/ | Quercus sp. | 1 | 22.9 x 5 x 3.5 | beam? |
| | Swifterbant | Quercus sp. | 1 | 35.9 x 5.5 x 3.8 | beam? |
| | | Quercus sp. | 1 | 20.9 x 8.5 x 8.5 | beam |
| | | Quercus sp. | 1 | | |

Table 8.12 The sites studied, wood identifications of rectangular split pieces interpreted as beams.
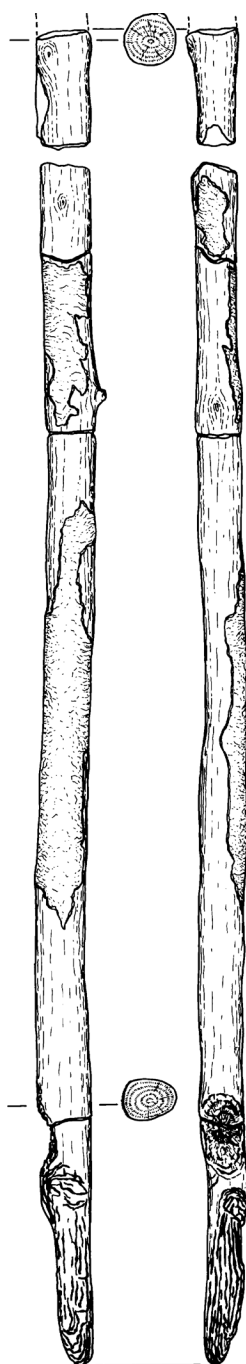
Although the number of beams is too small for a definitive conclusion, this indicates wood selection because *Quercus* sp. has strong wood while *Fraxinus excelsior* has relatively elastic wood, and because both taxa are very suitable for beams used in constructions. Beams are relatively scarce compared with planks. This could suggest that beams were not commonly used in constructions, which can partly be related to the scarcity of recovered house structures and possibly partly with the age of the sites studied, or that beams did not remain preserved since they were usually used above the ground water level. At Hoge Vaart four trunks of *Quercus* sp. without branches were found lying parallel at a distance of 1.2 metres to each other, in combination with a flint hoard (Hamburg *et al.* 2001, 32). These may have functioned as beams as well.

### 8.4.2.7 *Pointed roundwood other than posts*

Figure 8.7 shows an example of pointed roundwood other than posts. Tables 8.14 and 8.15 (at the end of this chapter) show artefacts that can be classified as pointed roundwood and that are not recognised as posts[6] from the sites studied and Late Neolithic sites, with the interpretation of the function of the objects as given in the publications. Relevant artefacts are known from four of the sites studied. The interpretations of the objects vary, and definitions of the interpretation are given only occasionaly. The category of pointed roundwood includes 40 objects made of 13 taxa (with *Fraxinus excelsior* as dominant species), which does not support the selective use of wood. This can however be related to the large diversity of artefacts that are represented by the objects, as suggested by the variation in minimal length (50-95 cm) and diameter (0.5-11 cm). The pointed roundwood dating to the Late Neolithic confirms the large variety of taxa. Comparison of the definitions and interpretations indicate that we still lack understanding of the functions of most pointed roundwood other than posts and that it is difficult to apply objective definitions.



Figure 8.7 Hardinxveld-Giessendam Polderweg, pointed roundwood (Louwe Kooijmans, Vermeeren and Van Waveren 2001).

---

6   The pointed wood of Swifterbant-S3 is all included in the category of posts since the data do not distinguish between posts and pointed roundwood (Casparie *et al.* 1977). At Schipluiden, there is a category of worked roundwood that could possibly contain pointed roundwood. This category is not included here because the publication does not discuss whether the artefacts are pointed, and since part of the objects is interpreted as woodworking waste (Louwe Kooijmans and Kooistra 2006).

A category of pointed roundwood that is remarkably scarce in the interpretations are arrow shafts, since identifications are only known from the Hazendonk where *Corylus avellana* and *Salix* sp. were used. Arrow shafts have also been found at Bergschenhoek, but wood identifications of these finds are not available. Using the criteria that arrow shafts have a diameter of 0.5-1 mm (see Mertens 2000, 12 and references there), the list of pointed roundwood includes only one other possible fragment of an arrow shaft[7], supporting that arrow shafts may indeed be absent from the excavated wood finds. The presence of bows and arrow points made of flint, however, demonstrate that arrows must have been used at the studied sites.

Drenth and Brinkkemper (2001) suggested that wood of *Viburnum opulus* is most suitable for the manufacture of arrow shafts, as supported by two prehistoric finds from the province of Drenthe and a study by Beckhoff. Finds of Mesolithic arrow shafts from Germany and Denmark were made of *Pinus* sp., *Corylus avellana* and *Viburnum* sp., and additionally of *Betula* sp., *Alnus* sp. and *Fraxinus excelsior (*Mertens 2000, 17, based on Beckhoff). Coles *et al.* (1978, 10) report the use of *Alnus* sp., *Corylus* sp., *Fraxinus excelsior* and *Viburnum* sp. Because of the reported variety, future finds of arrow shafts at Mesolithic and Neolithic wetland sites are not expected to be made predominantly from a single taxon.

*8.4.2.8 Posts*
Tables 8.16 and 8.17 (at the end of the chapter) show the wood identifications of posts from the sites studied (N = 593 +7?) and Late Neolithic sites (N = 804; see figures 3.4 and 3.5 for examples). The data set of posts from sites studied comprises 14 taxa, which does not directly support selective use. The large variation may however be related to differential use of taxa for different structures (see paragraphs below). *Alnus* sp. is strongly dominant (59%), while the percentage of other taxa remains below 10%, *Prunus* sp. and *Corylus avellana* being the most frequently found. The variety of taxa and the correspondence with the identifications of unworked wood and charcoal suggest that availability is an important factor influencing which taxa were used for posts. Most taxa represent trees or shrubs with a diameter that is suitable for posts. Taxa with a usually very small diameter are only present in small numbers or absent (*Cornus sanguinea*, *Euonymus europaeus* and *Viburnum opulus*). Therefore, this pattern may indicate diameter selection. On the other hand, their scarcity may partially represent availability since these taxa were possibly not all plentifully available.

The importance of *Alnus* sp. in the assemblage of posts may be explained by its importance in the natural vegetation, by relatively good preservation of wood from *Alnus* sp. under water (Buis 1995, 167; Casparie *et al.* 1995, 39; Louwe Kooijmans, Hänninen and Vermeeren 2001, 472) and/or by selective use. The dominance of *Alnus* sp. for posts corresponds with the dominance of *Alnus* sp. in the assemblage of planks (see above) and is in contrast to the dominance of *Quercus* sp. and *Fraxinus excelsior* for beams. The data set of Late Neolithic sites (N = 5) consists of nine taxa. *Alnus* sp. is again dominant (44%), but now *Fraxinus excelsior* and *Betula* sp. reach values of *c.* 15%. The shift in the second important taxa may be related to the increasing water table, resulting in decreased availability of taxa of dry terrain such as *C. avellana* and increased availability of *Betula* sp., and the absence of data from sites in the coastal region resulting in the absence of posts of *Prunus* sp. and *Juniperus communis*.

The function of posts of structures has been interpreted for several sites as houses, fish weirs and fences/palisades. The wood identifications of posts of each type of construction are studied separately in order to investigate whether specific taxa were used for specific structures. Data of all periods (Late Mesolithic unto Late Neolithic until *c.* 3000 BC) are combined.

---

7   Hardinxveld-Giessendam De Bruin, *Alnus glutinosa*, diameter 1 cm, find number 4305.

Tables 8.18 and 8.19 (at the end of the chapter) show the taxa used for posts for fish weirs[8] from Jardinga, Hoge Vaart and Emmeloord (N = 638), corresponding with the Late Mesolithic and complete Neolithic. At least ten species were used. *Alnus* sp. strongly dominates (70%), followed by *Betula* sp. (19%). Comparison with the results of the total number of posts shows that *Betula* sp. may have been selected for posts of fish weirs. However, most *Betula* posts were part of the fish weirs of the late Neolithic occupation phase at Emmeloord. This implies that the natural vegetation may play a role as well, since relatively eutrophic wetland vegetation with *Alnus* sp. was gradually replaced by relatively oligotrophic wetland vegetation characterised by *Betula* sp. in the Vecht region during the Late Neolithic. New data from Early and Middle Neolithic fish weirs will enable further interpretation. Posts from similar structures from Mesolithic sites in Denmark and Germany were made from *Betula* sp., *Corylus avellana*, *Salix* sp. and *Tilia* sp., supporting the absence of clear evidence of selective use (Mertens 2000, 31).

Tables 8.20 and 8.21 (at the end of the chapter) show the taxa used for posts for structures interpreted as houses from Wateringen 4 and Vlaardingen (N = 266). For Vlaardingen, it is not known precisely how many posts formed part of the recognised houses. The data set consists of five taxa. This may be indicative of selective use because it is a relatively small number of taxa, but the small number of houses and sites may play a role as well. The range of taxa indicates that both availability and selective use play a role. At both sites there are some indications of the selective use of taxa for different parts of houses. At Wateringen 4, *Alnus* sp. was used for the inner posts of the house, while *Juniperus communis* was used for the outer posts (Raemaekers *et al.* 1997). At Vlaardingen, *Fraxinus excelsior* and *Quercus* sp. were used for inner posts of a presumed house, while *Alnus* sp. and *Fraxinus excelsior* were used for outer posts of this house and *Alnus* sp. for the outer posts of another possible house (Van Beek 1990, 133, 146). It can be concluded that the choice of wood for house posts is different at each site.

Tables 8.22 and 8.23 (at the end of the chapter) show the taxa used for posts for fences and palisades at Schokkerhaven-E170, Schipluiden, Brandwijk-Kerkhof and the Hazendonk (N = 121). The two fences at E170 and Schipluiden both consisted of a double row of posts. The palisades may possibly have functioned as fences as well but their precise function remains unclear. *Alnus* sp. and *Prunus* sp. (probably *Prunus spinosa*; see chapter 7) are dominant in the assemblage of posts from fences and palisades, but the large variety of taxa does not support strongly the selective use of wood. Both at E170 and the Hazendonk those posts that are recognised as part of the fences belong to a single taxon only, but at each site another taxon was selected (*Quercus* sp. and *Alnus* sp. respectively). At Schipluiden six taxa were used for fences dating to different phases; it concerns mainly *Alnus* sp., *Juniperus communis* and *Prunus* sp. All fences of individual phases are made of posts of different taxa. The broad range of taxa does reject selective use and the reconstruction of the natural vegetation indeed suggests that the relevant taxa were well represented near Schipluiden. For one of the fences people favoured posts of *Prunus* sp. The use of a single particular taxon for a fence at Schipluiden corresponds with the consistent use of a single taxon within single structures at E170 and the Hazendonk. The large number of posts of *Prunus* sp. from this single fence explains the high importance of *Prunus* sp. in the total data set of posts as presented above.

Tables 8.24 and 8.25 (at the end of the chapter) show the taxa used for posts for which the function is not known from 13 sites (N = 648). At the sites studied (N = 10), 168 (+5?) posts made of 11 taxa have been identified. The dominant taxon is *Alnus glutinosa* (39%), while *Corylus avellana* and *Fraxinus excelsior* reach percentages higher than 10%. *Salix* sp. and *Tilia* sp. seem to be underrepresented in view of their availability in the natural vegetation in regions other than the coastal region. Therefore, the scarcity of these taxa in the group of posts with an unknown function may be related to the avoidance of these taxa with soft wood or with

---

8   Fish weirs as mentioned in this study represent fences that are used to guide fish into a fish trap, and not fences that are present over the complete width of a channel.

poor preservation of such wood. Compared with the complete set of posts, the data of posts with an unknown function from the sites studied indicate a less important role of *Alnus* sp. and more frequent use of *Corylus avellana*, *Fraxinus excelsior* and *Quercus* sp. At Late Neolithic sites (N = 5), 480 posts made of eight taxa have been identified. Dominant taxa are *Alnus glutinosa* (36%), *Fraxinus excelsior* and *Acer campestre*. The last species is frequently found at Vlaardingen and Hekelingen III. Compared with the complete set of posts, the data of posts with an unknown function from the Late Neolithic indicate a slightly less important role of *Alnus* sp. and *Fraxinus* sp., a much less important role for *Betula* sp. (that was mainly used for fish weirs), and a much more important role for *Acer campestre*.

Summarising, the evidence of selective use of wood for posts is restricted. The selective use of single taxa for posts is supported for single sites and single structures, such as fences, parts of houses and to a lesser degree fish weirs. Selective use is however not supported by corresponding selection at various sites. In addition, the selection of taxa at single sites can be related to the common presence of such a taxon in the natural vegetation in certain cases and may be explained by availability after all. For example, *Juniperus communis* and *Prunus* sp., selected for a house and fences in the coastal region only, were plentiful in that region and scarce in other regions. *Betula* sp., frequently used for the Bell Beaker fish weirs at Emmeloord, may have been common due to the high water table in the Late Neolithic.

### 8.4.3    Import of wood

Wood import to sites is occasionally suggested in site reports. This import is not always precisely defined. In this study, wood import refers to the collection of wood outside the exploitation area of the site where people collected the main part of their (plant) resources during occupation at the site. The import of wood implies the selective use of wood, since taxa that were present in the natural vegetation of the exploitation area of a site apparently were not suitable. There is however a risk that the import of wood is recognised in the case of wooden artefacts for which researchers expect wood selection. Comparison of the presence of taxa for each region in the assemblages of worked wood on the one hand and unworked wood, charcoal and macroremains on the other hand (chapter 7 and 9) allows investigation into the indications of import on a regional level and to discuss the evidence of individual sites.

Discussion at site level suggests the import of *Euonymus europaeus* and *Acer campestre* at Hardinxveld-Giessendam De Bruin and Polderweg (Bakels and Van Beurden 2001; Bakels *et al.* 2001), the possible import of *Euonymus europaeus* at the Hazendonk and Brandwijk-Kerkhof, and import of *Acer campestre* and *Taxus baccata* at Schipluiden (Kooistra 2006b, 369, 370). The presence of *Euonymus europaeus* in the river area remains unclear; it was at least scarce. *Acer campestre* was probably present in the river area since macroremains and unworked wood have been found at the Hazendonk (appendix III), but the species may have been scarce as well. The data on the import of taxa at Schipluiden are in contrast to the data from Ypenburg (see chapter 3). All taxa may have been absent on the dune of Schipluiden indeed, but were not necessarily absent in the region. The differences between the conclusions for Schipluiden and Ypenburg suggest that the occupants of both sites had a different exploitation area for unknown reasons despite the distance of only 4 km between the sites (assuming that the results from the excavation at Schipluiden are representative) (*cf.* Kooistra and Hänninen 2008).

Comparison of the data on worked and unworked wood from Hoge Vaart theoretically suggests import of five taxa, as these are present in the worked wood but not in the unworked wood. This possibility of import is not discussed in the site report, and such a scenario is indeed not likely since it concerns taxa that could well have been present in the exploitation area. The variety of taxa (N = 8) in the unworked wood identifications is relatively small, and comparison with the data on pollen and macroremains suggests that this is related to limited representativity of the unworked wood. It is however not possible to make final conclusions without data from other sites in the same region.

8.4.4    Conclusion on the selective use of wood for artefacts

Comparison of the wood taxa used for the most common artefacts found at Late Mesolithic and Early, Middle and Late Neolithic Dutch wetland sites provides clear indications of the selective use of taxa for fish traps, paddles and bows. The total number of finds of these artefacts is however limited. The choice of wood for other artefacts seems to be strongly influenced by the availability of taxa. There are moderate indications of the selective use of wood for hafts and beams, and no clear indications of the selective use of wood for planks and pointed roundwood. The choice of wood for posts seems to have been based on a combination of availability and selection. For many artefacts, the role of selective preservation of certain taxa, resulting in the selection of taxa during prehistory or to the apparent absence of taxa during excavation, may influence the results in a way that can hardly be detected. Specific deposition processes of specific artefacts or specific taxa at off-site locations that remain unexcavated may lead to underrepresentation of data on possible selective use as well. The restricted evidence of large-scale selective use of wood at the Late Mesolithic and Early and Middle Neolithic Dutch wetland sites corresponds with mainly wood data and some charcoal data from eight sites in the western part of the Netherlands dating to the Iron Age, Roman Period and Middle Ages, that indicate that primarily "locally available wood was used" for various purposes (Groenman-van Waateringe 1988, 150).

The presented data indicate that there are some regional differences in wood selection. Firstly, the data on fish traps, posts from fish traps and paddles indicate that people in the Vecht region used other taxa for specific artefacts than in the other regions. Chapter 7 discusses that the natural vegetation in this region may have been different from the natural vegetation in more southern regions. This regional variation in the vegetation is a probable explanation for the differential use of wood in the Late Neolithic. Differential cultural preferences may alternatively have played a role as well, which is supported by archaeological indications of a slight cultural division between the river area and the coastal region on the one hand and the Vecht region on the other hand (see chapter 1). Secondly, the people in the coastal region used specific taxa for posts (*Juniperus communis* in the Middle Neolithic and *Acer campestre* in the Late Neolithic). The use of *Juniperus communis* can probably be related to the presence of the species in the natural vegetation, although a symbolic meaning cannot be ruled out (see paragraph 8.5). The explanation for the use of *Acer campestre* at western sites of the Vlaardingen group may be related to the common presence in the natural vegetation (supported by finds of macroremains of the species at Hekelingen III; Bakels 1988), and to scarce presence of this species in other regions.

One of the aspects of neolithisation is that technology may have changed due to cultural changes and technological changes in the tool kit, which may have resulted in changes in wood selection. Therefore, the character and influence of the neolithisation process can be studied by analysis of the changes of wood selection. Comparison of taxa used for dugout canoes shows changes that may be related to the neolithisation process, since the change from *Alnus* sp. and *Tilia* sp. towards *Quercus* sp. can be interpreted as an indication that people ameliorated their woodworking skills, since *Quercus* sp. is considered more difficult to work than the softer alder and lime wood. The wood selected for the manufacture of bows also changed during the Neolithic, but this is presumably related to changes in the natural vegetation instead of technological changes. Selective use of wood has also been concluded for fish traps and paddles, but these do not show changes in taxon that can be related to the neolithisation process. Only the Late Neolithic fish traps from Emmeloord show a relatively large variety of taxa. This variety may be related to technological changes, but also with cultural preferences or with the large number of identifications from Emmeloord (*cf.* Out 2008b). For hafts, planks and beams there are no indications that the neolithisation process resulted in a shift in selected wood, while it is not possible to make conclusions for changes in the wood chosen for pointed roundwood and posts due to the low number of finds from more than one site dating to the Late Mesolithic. The wood assemblages from posts from Late Neolithic sites are sometimes dominated by specific species, which may be related to cultural changes that are possibly related to the ongoing neolithisation process, but which can also be explained by changes or differences

in the natural vegetation. It can therefore be concluded that the neolithisation process probably had little influence on selective use of wood for artefacts.

## 8.5    WOOD IN RELATION TO IDEOLOGY

The wood artefacts present minor indications of a possible symbolic role of wood. A first example is a Mesolithic wooden artefact in the shape of a human's head (and possibly part of the body) from a location near Willemstad, made of *Quercus* sp. and measuring *c.* 12.5 x 5.3 x 2.4 cm (Van Es and Casparie 1968). The artefact was found next to the roots of an oak tree. A function of the artefact in relation to ownership is possible, but other functions are also possible. Further and more precise archaeological context data of the find are however not available, and there are some doubts whether the wood was indeed carved in prehistory (*e.g.* Lanting and Van der Plicht 2000, 96).

A second example is the suggested symbolic meaning of *Juniperus communis* that was selected for the outer posts of the house at Wateringen 4 (Hänninen and Vermeeren 1995; Raemaekers *et al.* 1997). The fact that *J. communis* is an evergreen tree may play a role in the meaning of the tree. However, the finds and related contexts of *J. communis* at later excavations in the coastal region do not explicitly support a symbolic role of the tree.

A third example of the symbolic use of wood concerns the wood finds in the pits at De Bruin interpreted as deposition pits with a possible symbolic role (Bakels *et al.* 2001; Louwe Kooijmans and Nokkert 2001, 95). Some of these pits contained pottery, bone, antler, and nearby the remains were located of domestic animals that represent the earliest known finds of domestic animal bones in the Swifterbant culture, if not in all Neolithic cultures north of the loess zone (see appendix I). Some other pits comprised a piece of wood of *Ulmus* sp. (not a post), two sticks of *Fraxinus excelsior* and a stick of made of a root of *Euonymus europaeus*, all with a similar length of *c.* 25 cm and without working traces. *E. europaeus* was not attested in the other botanical finds of the site. The specific deposition pits as well as the presence of the unusual domestic animal bones suggest that the wood has a specific, possibly ideological function, although the precise meaning of the finds remains unclear.

## 8.6    ARTEFACTS MADE OF PLANT MATERIAL OTHER THAN WOOD

This paragraph shortly discusses finds of artefacts made of plant material other than wood with a known function. Remains of rope and knots of bark and fibre have been found at Hardinxveld-Giessendam Polderweg, Brandwijk-Kerkhof, Bergschenhoek, Hoge Vaart and Ypenburg (appendices II and V; Hamburg *et al.* 2001;Kooistra 2008b; Louwe Kooijmans, Vermeeren and Van Waveren 2001; Van Rijn and Kooistra 2001[9]). The identified rope was made of bark of *Acer campestre*, *Ulmus* sp., (*cf.*) *Tilia* sp., *Betula* sp. and *cf. Sorbus* sp. *(cf. Sorbus aucuparia)*, and of an unknown herb-like plant. Rope was probably applied to a variety of purposes.

In addition to rope, some scarce examples of textile-like products are known from the sites studied. At the Mesolithic site Hoge Vaart impressions of mats have been found, probably made of *Phragmites australis* (Hamburg *et al.* 2001). These mats seem to be comparable with mats found at the Swiss Neolithic site Arbon Bleiche 3, although those mats were made primarily of *Tilia* bark instead of *Phragmites australis* (Leuzinger 2002, 126-134). At Schipluiden, textile fragments made of bark were found, possibly of *Salix* sp. (Kooistra 2006a).

---

9   A drawing of rope found at Bergschenhoek is present in the archive of the National Museum of Antiquities.

Bark could also be used to make artefacts other than rope. A Dutch Late Neolithic example is known from Vlaardingen where the finds included a small box of bark of *Betula* sp. (Van Beek 1990, 102).[10] The use of bark of *Betula* sp. is known from many other prehistoric sites in Europe (*e.g.* Bokelmann 1986; Clark 1954, 17). Another type of vegetative artefact found at Schipluiden was a lump of birch tar (*Betula* sp.), mixed with bees wax and fats or plant oil (Van Gijn and Boon 2006). Tar (no further identification) has also been found at Hoge Vaart (phase 3; Peeters 2007, 186). The use of tar is known from various other sites in prehistoric Europe including the Palaeolithic (Mazza *et al.* 2006).

## 8.7    Charcoal: selective use of fuel

### 8.7.1    Selection of taxa

It has been assumed in chapter 7 that the charcoal from the studied sites in the first place represents the natural vegetation since people primarily use those species that are available and that can be gathered most easily, based on the principle of least effort (Shackleton and Prins 1992). The assumption that people collected fuel randomly from the natural vegetation is however simplistic since it does not take into account human selection or differential preservation and possible sampling problems (Kreuz 1988; Shackleton and Prins 1992). Selective use of wood as fuel can for example be related to the burning quality of a taxon and the function of a hearth (Kreuz 1988), avoidance of taxa that were used for other purposes (Dufraisse 2008) and socio-religious reasons (Newman *et al.* 2007). Selective use of wood for fuel could have had considerable consequences for the vegetation and aspects of plant subsistence other than fuel collection. This paragraph therefore investigates whether the charcoal identifications provide information on the character and strength of anthropogenic influence resulting from the selection of wood (taxa) for fuel.[11]

Charcoal data from all sites are compared with each other, based on the similarity between the sites concerning age, culture and geographical location.[12] Investigation of the selective use of fuel should preferably be based only on data that are collected from specific contexts, such as hearths, that provide precise information on fuel selection and do not contain the charcoal of wood that was used in other ways, for example resulting from accidental fires (Dufraisse 2008). The number of presumed hearths from the wetland sites studied is however too small to give representative results. Therefore, all available data, primarily derived from refuse layers, are included in the analysis. The research methods of the various sites are not precisely similar, while the number of identifications is not always representative (see also the original sources). The absence of finds of certain taxa at certain sites in the investigated material can therefore not be used as evidence of absence in the charcoal assemblages. It can nevertheless be expected that the data are of sufficient quality to analyse and compare with each other. The charcoal identifications are also discussed in chapter 7 (see tables 7.3, 7.4 and 7.5).

A first possible selection mechanism is the selection of taxa for fuel because of their burning qualities. *Quercus* sp., *Fraxinus excelsior* and Pomoideae are known for their good burning qualities, and dominance of these taxa is interestingly also known from other Neolithic charcoal assemblages (*e.g.* Castelletti and Stäuble 1997; Kreuz 1988, 2008). *Quercus* sp. and *Fraxinus excelsior* were indeed found in the charcoal assemblages of many sites (see table 7.3). *Quercus* sp., *Fraxinus excelsior* and Pomoideae furthermore belonged to the four most important taxa at all 11 sites when considering the number of identifications, and at ten sites when considering the weight of the charcoal. This pattern may indicate selective use of the taxa because of their qualities as fuel, but it may also represent the availability of taxa in the natural vegetation. Indeed, charcoal of *Alnus* sp. was

---

10 There are various interpretations of this presumed box.

11 A paper on this subject based on quantitive data from the studied sites by the author is in press.

12 Unidentified remains are not taken into account.

found at most sites, and was the most dominant taxon at most sites both in view of the frequency and the weight, which indicates that the availability of wood is the first criterion during fuel gathering (as has been presumed in chapter 7). The data from the coastal region furthermore show that *Quercus* sp. and *Fraxinus excelsior* were not used when they were not frequently present in the natural vegetation, while data from other regions show that the use of Pomoideae was restricted when this taxon was not commonly available. In conclusion, the use of taxa fur fuel was probably primarily based on the availability and presumably additionally also on selective use because of the burning qualities of wood.[13]

Opposite to the taxa earlier mentioned, wood of *Tilia* sp. is not suitable at all for fuel (Kreuz 1988). *Tilia* sp. was the dominant species at dryland patches in the river area and in the Eem region that were out of reach of the groundwater table (not submerged), as indicated by pollen and macroremains identifications. *Tilia* sp. may have been similarly dominant in the Vecht region as well. The use of wood for fuel based on availability should therefore have resulted in common use of *Tilia* sp. for fuel in these regions. Charcoal of *Tilia* sp. is however very scarce; it has been found at three sites only and is never one of the dominant taxa at single sites. Scarcity of *Tilia* charcoal is also recognised at other sites in Europe (*e.g.* Castelletti and Stäuble 1997; Kreuz 1995; Vanmontfort 2004, 325). Absence in the charcoal identifications of the studied sites could be related to complete burning and a high degree of fragmentation. Other taxa with relatively soft wood (*e.g. Ulmus* sp. and *Salix* sp.) are however not as poorly represented as *Tilia* sp. Moreover, *Tilia* sp. is also scarce in the unworked and worked wood identifications. Absence in the waterlogged wood identifications could possibly be related to characteristics of the wood resulting in poor preservation (*cf.* Schmölke *et al.* 2006, 431), or avoidance for other purposes (see next paragraph). These mechanisms could possibly also explain the scarcity in the charcoal identifications. In conclusion, scarcity of *Tilia* sp. charcoal supports the selection of fuel because of burning qualities, but scarcity of the taxon in the waterlogged wood identifications indicates that other factors may play a role as well and that the selective use of fuel is not demonstrated.

A second selection mechanism that could possibly have been applied to fuel is the avoidance of taxa intended for other purposes, such as the construction of buildings, fodder, collection of bark (see paragraph above), collection of seeds and fruits, or because of a ritual of symbolic meaning. Analysis of the identifications of various artefacts gives indications of the use of *Alnus* sp., *Fraxinus excelsior*, *Quercus* sp. and *Tilia* sp. for planks, beams and posts. Avoidance of taxa that were used for construction must therefore be rejected since the taxa that were frequently used for construction (as indicated by the available data set) are also the taxa that were most commonly used for fuel (except for *Tilia* sp.).

Taxa could have been avoided as fuel in order to maximise the production of leaf-fodder. The pollen diagrams do not give explicit evidence in favour of the application of leaf-foddering (see paragraph 8.3.2), although leaf-foddering cannot be totally excluded either. A variety of deciduous tree taxa are known for their suitability as leaf-fodder. The excavation of the Neolithic site Weier in Switzerland shows the predominant use of *Fraxinus excelsior*, *Tilia* sp., *Salix* sp. and *Alnus* sp. as leaf-fodder (Rasmussen 1989, 57). The frequent use of *Fraxinus excelsior* and *Alnus* sp. for fuel does not demonstrate the avoidance of taxa that are suitable for leaf-foddering. The scarcity of *Tilia* sp. in the charcoal identifications could possibly be related to leaf-foddering (this is however not supported by evidence).

Selective avoidance of fruit-bearing trees can be investigated by comparison of the evidence of the consumption of seeds and fruits and the importance of the relevant taxa in the charcoal identifications. There is considerable evidence of the consumption of seeds and fruits of *Corylus avellana*, *Malus sylvestris*, *Prunus spinosa*, *Crataegus monogyna*, and moderate indications of the use of seeds and fruits of *Cornus sanguinea*, *Quercus* sp., *Rosa* sp. and *Rubus* species (see chapter 9). Charcoal of *Cornus sanguinea*, *Corylus avellana*,

---

13 The paper in press adds some indications of selective use of fuel, which can be related to the burning qualities of the taxa, and indications of avoidance of wood for fuel.

Pomoideae (including *Crataegus* sp. and *Malus* sp.), *Prunus* sp. and *Quercus* sp. has nevertheless been found at a considerable number of the studied sites (see table 7.3), indicating that they were not primarily avoided. *Corylus avellana*, Pomoideae and *Prunus* sp. were furthermore one of the three dominant taxa in the charcoal identifications at a number of sites. Charcoal of *Rubus* sp. and *Rosa* sp. has not been identified at any of the sites studied. This may be related to the avoidance of the taxa because of the edible fruits, possibly to the presence of thorns on the branches, and presumably to the small diameter of the woody parts of these taxa which makes them rather unsuitable for use as fuel (except to light the fire). Overall, the results do not demonstrate the avoidance of taxa for the collection of seeds and fruits. It can therefore be concluded that there are no explicit indications that the avoidance of taxa that were intended for other purposes played a major role in charcoal selection. Avoidance on a small scale of specific trees or at individual sites can of course not be ruled out.

A third selection mechanism that could possibly have been applied to fuel is the selection of wood based on the diameter. Dufraisse (2008) showed the selective use of wood with a diameter smaller than 10-15 cm at a Late Neolithic lakeshore site in the Jura, France, and suggested that this is related to optimal use of fuel in the context of domestic fires. The results of Dufraisse are based on a specific method that is not commonly practised in the Netherlands yet. Therefore, the selective use of wood with a specific diameter for fuel at the Dutch wetland sites cannot be tested in a similar way.

Selective use has sometimes been suggested based on the dominance of single species in the charcoal identifications of individual closed contexts. Such assemblages could indeed be the results of the selective use of wood for specific purposes or contexts. Absence of selection, *i.e.* collection of fuel based on availability, can however result in the dominance of single taxa in single contexts as well. The dominance of a single taxon then would represent a single random occasion of fuel collection, while another gathering event would result in the dominance of another taxon. Therefore, selective use based on identifications from single contexts can only be demonstrated with certainty if the dominance of this taxon cannot be explained by the dominance of the taxon in the natural vegetation (alone). The next section discusses the indications of selective use that have been derived from individual contexts.

Dominance of charcoal from *Alnus* sp. in contexts at Bergschenhoek, and Pomoideae, *Prunus* sp. and *Alnus* sp. at Schipluiden can in the first place be related to the dominance of these taxa in the natural vegetation (Kooistra 2006b). At Sion, one of the two investigated charcoal samples was dominated by *Alnus* sp. (Rieffe *et al.* 2006). This could possibly indicate the selective use of *Alnus* sp. since the taxon was scarce in the pollen and macroremains assemblage, but the archaeobotanical data set of the site is not large enough to make a firm conclusion. At Polderweg, selective use is suggested for hearths dominated by *Corylus avellana* (62%) and *Euonymus europaeus* (26%). Selection of *Corylus avellana* is difficult to assess since this species was commonly present in the natural vegetation. *Euonymus europaeus* was however not common at all and the selection of *Euonymus europaeus* may indeed have been applied. Other examples of the selective use of *Euonymus europaeus* as fuel are not known. At Hoge Vaart, the dominance of *Quercus* charcoal is partly related to the dominance of this taxon in the natural vegetation, but the dominance is stronger than expected when comparing the charcoal assemblage with the variety of taxa in the pollen and macroremains assemblages (Van Rijn and Kooistra 2001). Surface hearths at Doel corresponding with the Swifterbant culture (number of hearths = 22) were rich in charcoal of *Quercus* sp. and *Alnus* sp., which corresponds with the dominance of these taxa in the natural vegetation according to the investigators. Earlier Mesolithic hearths pits (c. 6800-6400 BC) were rich in *Quercus* sp., which is interpreted as the selection of *Quercus* sp. for fuel (Bastiaens *et al.* 2005). At Wateringen 4, the use of only Pomoideae in a hearth can be related to selective use, since it corresponds with the good qualities of wood of Pomoideae for calm fires and is supported by the scarcity of Pomoideae in the remaining charcoal and in the assemblage of waterlogged wood at Wateringen 4 (Raemaekers *et al.* 1997). At Ypenburg two samples contained charcoal of a single taxon only, *Salix* sp. and *cf.* Pomoideae. These samples could possibly represent unrecognised hearths. A concentration of charcoal of

Pomoideae was also found at Schipluiden (Kooistra 2006, 366). This repetitive selective use of Pomoideae for fuel at sites in the coastal region supports selective use. In conclusion, single contexts from single sites present indications of selection, but the number of contexts is very limited and selection is not always demonstrated. Repetitive use of a specific taxon that points to fuel selection at the studied sites and during the studied period is only observed for wood of Pomoideae.

Analysis of indications of the selection of taxa for fuel shows that there is no reason to reject the assumption that charcoal primarily represents the natural vegetation from the exploitation areas from the sites studied. Selective use may additionally have been applied since taxa with good combustion qualities are rather important in the charcoal identifications (*Quercus* sp., *Fraxinus excelsior* and Pomoideae). These taxa were however also rather common in the natural vegetation, although this varied between the regions. Analysis of individual contexts supports that the selective use of fuel may have occurred, but that it did not play a major role. There are no indications of the avoidance of taxa used for construction and the collection of food plants and fodder, although the underrepresentation of *Tilia* sp. remains unexplained. The importance of availability and the additional role of selective use of wood have also been shown in charcoal studies from some other Mesolithic and Neolithic sites in Europe (Dufraisse 2008; Kreuz 2008; Verlinde and Newell 2006).

8.7.2    CHARCOAL COLLECTION STRATEGIES

The quality of charcoal provides information on human impact since it reveals information on collection strategies, which may also point to fuel selection processes. It is frequently possible to distinguish whether the burned wood was moist or dry and whether it was affected by fungi and insects. The use of moist wood could for example indicate the clearance of living trees instead of the collection of brushwood (dead wood). This could be confirmed by the scarcity of wood affected by fungi and insects, since it is expected that living wood is less affected by fungi and insects than dead wood. Caution is needed with this interpretation since a humid climate could keep dead wood moist despite being dead, resulting in similar burning effects as in fresh wood. The characteristics of the wood resulting in the evidence of burning in a moist state moreover differ between taxa. The susceptibility of trees for fungi furthermore differs between taxa as well, and depends on various conditions such as abiotic factors as well as the period of exposure of dead wood to fungi.

Information on the quality of the wood used as fuel is available from the sites Polderweg, De Bruin, Brandwijk-Kerkhof, Hoge Vaart, Schipluiden, Ypenburg and Doel. The importance of the observed characteristics is sometimes quantified or discussed for separate species, but is sometimes only mentioned in very general terms without any quantification.

The use of brushwood (old wood affected by fungi and/or insects) has been reported for Polderweg, De Bruin, Brandwijk-Kerkhof, Hoge Vaart, Schipluiden, Ypenburg and Doel, *i.e.* all sites for which data are available. The common use of brushwood indicates that people did not simply fell trees in order to collect fuel resources but that they efficiently used many of the wood resources that were available in the exploitation area. The use of brushwood corresponds with the limited indications of deforestation from pollen diagrams and with the indications that the availability of taxa in the natural vegetation was the main factor influencing the choice of wood for fuel. The use of moist wood has been reported for Polderweg, De Bruin, Ypenburg, Schipluiden and Doel, *i.e.* at only some of the sites.[14] The fact that moist wood was not used at all sites for which data on the wood quality are available indicates that people sometimes avoided moist wood (freshly cut or not) by drying the wood before using it as fuel. At Hoge Vaart, Ypenburg and Schipluiden most wood appears to have been dead and dry but not severely affected by fungi yet, and probably formed good (optimal) fuel wood. At De Bruin,

---

14 Use of moist wood has been reported for *Alnus* sp., *cf. Betula* sp., *Cornus sanguinea*, *Corylus avellana*, *Fraxinus excelsior*, *Pinus* sp., Pomoideae, *Prunus* sp., *Prunus spinosa*, *Quercus* sp., *Rhamnus cathartica*, *Rhamnus frangula*, *Salix* sp., *Sorbus* sp., *Ulmus* sp. and *Viburnum opulus*.

the importance of moist wood decreased through time, which could possibly indicate reduction of clearance or increased preparation (drying and storage) of fuel wood through time.[15]

## 8.8   MANAGEMENT

The relationship and interdependence between plants and people, changing during the neolithisation process, can be characterised is various ways. Zvelebil (1994) has proposed five categories of intensity of plant use, focussing on consumption: 1) opportunistic use of plant food, leaving little traces in the archaeological record, 2) systematic and intensive plant use, visible by preservation and storage of food and specialised tool kits, 3) plant (food) management or husbandry, visible by indications of strategies of changing the landscape in order to increase control over the plants and the habitat, 4) cultivation based on systematic sowing/planting and 5) cultivation based on intentional selective purposeful breeding. These categories can be applied in a broader sense than for food plants alone. At the Dutch wetland sites, use of plants other than the obvious crop plants was probably partly opportunistic and partly systematic. These are the easiest forms of plant use and are not the subject of discussion for the sites studied. Preservation and storage are also highly likely although the evidence is limited (see chapter 9). Management and the possible cultivation of plants other than the well-known crop plants is however highly questionable for the Late Mesolithic and Early and Middle Neolithic Dutch wetland sites, and it is moreover very difficult to demonstrate. It is suggested that such processes should be visible by indications of planned strategies of changing the landscape. "Such practices would include protective plant tending, selective burning of woodland, weeding and soil modification" (Zvelebil 1994, 37-41). The analysis of human impact gives clear indications of changes in the landscape that may even possibly be the result of various strategies, but this does not demonstrate management of the vegetation with certainty. The following paragraphs investigate whether there are any indications of management and cultivation of plants other than crop plants, and how valid these indications are.

### 8.8.1   FIRE ECOLOGY

Fire ecology, *i.e.* burning of the vegetation in order to create open patches in the vegetation for non-agricultural reasons, is a method of vegetation management often suggested to be practised, especially for the Mesolithic. Evidence is mainly known from prehistoric Britain (*e.g.* Chiverell *et al.* 2004; Innes and Blackford 2003; Mellars and Dark 1998; Mighall *et al.* 2007; Simmons 1996). It has also been suggested tentatively for the Mesolithic site Zutphen in the Netherlands (Bos *et al.* 2005). It is specifically the burning of eutrophic wetland vegetation, such as alder carr and reed vegetation that is relevant, since such vegetation was commonly present around the Dutch wetland sites and since burning of this vegetation is suggested to be related to management of the natural vegetation.[16]

Various sources suggest that the burning of wetland vegetation would result in the increased presence of open patches and thus in the increased growth of wetland taxa such as reeds and sedges. Suggested goals of such developments are the increased productivity and quality of plants, including *Phragmites australis*, that could be used for thatching *etc.*, human food (*e.g.* rhizomes) and animal fodder or that could attract game (Hurcombe 2000; Law 1998; Mighall *et al.* 2007). Alternative explanations are that burning of the wetland vegetation resulted in better accessibility and visibility (Mellars and Dark 1998, 212), that people exploited the wetlands by help of fire ecology because of the wood resources (Chiverell *et al.* 2004), and that clearings

---

15 The charcoal identifications from early and late phases at De Bruin include a variety of taxa, which suggests that decreased evidence of use of moist wood cannot be related to a change in wood selection.

16 Burning of dryland vegetation (discussed in paragraph 8.3.2) is usually related to the creation of space for daily activities and arable plots.

were created for social reasons instead of economic ones (Davies *et al.* 2005). These suggestions indicate that burning of wetland vegetation could have been useful to the people at the studied sites for various reasons.

The data of the sites studied do not provide evidence of the intentional burning of wetland vegetation in contexts other than domestic fires. Layers rich in charred material including charred plant material are regularly found, but these are interpreted as refuse layers resulting from occupation (fossil anthropogenic horizons), since they are located within or next to archaeological sites and contain a variety of archaeological remains. The charred material present in these layers is assumed to originate from various domestic activities, and is assumed to be spread from activity zones after deposition due to down-wash by erosion, colluviation, *etc.* The charred material probably also partly reflects activity zones at the border of or in the wetland vegetation.

Despite the absence of indications of the intentional burning of wetland, the practice of fire as described above cannot be excluded. It can be argued that the archaeobotanical data available from the sites studied are not optimally suitable to investigate fire ecology, since most excavations and pollen cores presented in this study have mainly been selected to investigate the nearby surroundings of archaeological sites, *i.e.* the main zone of daily domestic life, while burning of wetland vegetation may have occurred at locations elsewhere that were used for this specific purpose. Especially data from off-site locations could therefore give further information on the burning of wetland vegetation. Data from the studied regions that are most suitable for the analysis of off-site burning of wetland vegetation are the data of Van der Woude (1983), whose palaeoecological study concerns several locations at 1 to 3 km distance from archaeological sites. Van der Woude does however not mention any evidence of fire ecology.

A question relevant to fire ecology at the sites studied is whether it was easily possible to set fire to the wetland vegetation. The ground water table in this kind of vegetation generally reached the surface. Development of large-scale fires is therefore expected to be unlikely during the major part of the year. However, opinions on this subject vary (*cf.* Moore 1997). According to Brown (1997, 136), "wet temperate woodland (as opposed to heathland or mixed coniferous woodland) is extremely difficult to ignite even during exceptional dry summers". Chiverell *et al.* (2004) and Innes and Blackford (2003) contrastively conclude that wetlands were cleared primarily through fire, based on their archaeobotanical data. Interestingly, Law (1998) summarises evidence from modern-day reed burning practices from various parts of the world including Great Britain, clearly demonstrating the possibility to burn reedlands. Burning of reedland is still practised in the Netherlands for commercial purposes. The possibilities of burning of alder carr remains however to be investigated.

### 8.8.2    HEDGES

Analysis of pollen diagrams has shown that human impact in the central river area resulted in the increased presence of shrubs. Shrubs were already present before occupation as part of the natural vegetation, but human impact resulted in increased importance in the vegetation. Such changes in the natural vegetation related to human impact are also known from other Late Mesolithic and Neolithic sites in Northwestern Europe (Brown 1997; Simmons 1996) and has also been proposed for the LBK (Kreuz 1988, 1992). There are several human and human-related activities that could have resulted in the increased presence of shrub vegetation, *e.g.* clearance of the vegetation to create living space, collection of wood for fuel, the avoidance of taxa for fruit harvesting and animal grazing.

Groenman-van Waateringe (1978, 138-140) has argued that shrubs of the order *Prunetalia spinosae* were part of the natural vegetation in the Netherlands during the Neolithic, commonly occurring on "fairly rich soils" as woodland edge vegetation or at locations with a natural gradient. She furthermore argued that shrub vegetation would have been favoured by Neolithic farming communities, since the shrubs could have functioned as natural hedges (mantle vegetation), with their thorns protecting fields and domestic animals from wild animals, and protecting the hedges themselves from foraging by domestic animals. The common presence of hedges would also explain the presence of shade-loving arable weeds in crop assemblages.

Groenman-van Waateringe (1978, 140) therefore hypothesised that "the inception of Neolithic farming activities will be  represented in the pollen diagrams by an increase of the *Prunetalia* species".

The evidence from several of the sites studied shows that human activity indeed resulted in the increased presence of shrub vegetation (see the beginning of this chapter), and this can indeed (partly) be caused by the processes as suggested by Groenman-van Waateringe. It can be added that the increased presence of shrubs can also be observed at non-agricultural sites, as has been suggested for Hardinxveld-Giessendam Polderweg and De Bruin and also for Hoge Vaart. It is however difficult to detect whether and in what way shrubs were influenced or managed by people. Shrubs were present as part of the natural woodland edge vegetation and secondary vegetation that was present around settlements, and there is no evidence that they were managed in any way, although it cannot be excluded either. The restricted evidence of clearance of taxa other than shrubs does indicate that if the management of shrub vegetation occurred, this did not play an important role in the development of the vegetation around the sites studied. Comparison of the identifications of unworked wood, worked wood and charcoal does not demonstrate that the relevant shrubs were strongly avoided either. Furthermore, archaeological evidence from several Dutch wetland sites dating to the Early and Middle Neolithic indicate that people used shrubs for the construction of fences (see paragraph 8.4.2.8).

The data from the coastal region (especially Ypenburg and Schipluiden, see chapter 3) are contradictive to the statement that farming activities from Neolithic people will result in the increased presence of shrubs, since human impact in this region in the Middle Neolithic resulted in a decrease in shrubs, despite the presence of domestic animals and strong indications in favour of local arable farming near the sites. The decrease in shrubs at sites Schipluiden and Ypenburg therefore indicates either that arable plots were not located on these dunes, or that plots present on the dunes were not surrounded by natural shrub hedges that were managed as such by people. When the locations of arable fields can be detected in the future, it would be relevant to test the hypothesis of Groenman-van Waateringe concerning hedges around arable plots in this region in further detail, possibly by detailed spatial analysis of pollen and macroremains.

### 8.8.3 Pollarding and coppicing

Management methods that are often suggested and presumably also demonstrated for the Mesolithic and Neolithic are pollarding and coppicing. The text below will focus on coppicing. Pollarding includes the planned repetitive cutting of branches from trees at a height of 2-3 meters in order to maximise leaf production (Rackham 2006; Rasmussen 1989). Pollarding could however probably also result in the development of branches that can be used in the same way as coppice wood. Coppicing consists of the removal of the trunks at ground level followed by repetitive cutting of branches in order to maximise twig growth, followed by planned repetitive further removal of the branches resulting in the development of a new series of branches. Coppicing can include the removal of all branches of a tree, or part of the branches. Coppicing would in the first place be done for the branches, although leaf-production has also been suggested (Rasmussen 1989, 1990). Both pollarding and coppicing enable trees to reach a higher age (Rackham 2006).

A first management aspect of both pollarding and coppicing is the deliberate repetitive removal of branches. This aspect is most commonly discussed in relevant literature on the Mesolithic and Neolithic. A second management aspect could be relocation of trunks or stools to concentrate a group of coppice trees and reduce the effort to gather the branches. This aspect is seldom discussed since evidence of the relocation of trees can hardly be gathered for prehistory. A third form of management could be the protection of the managed wood from wild and domestic animals. This aspect is hardly discussed in relation to Mesolithic and Neolithic either. Rowley-Conwy (2004, 96) stated that coppicing needs fencing and patrolling, thus implying sedentism. This need for protection and sedentism can however be questioned. On the one hand coppice trees clearly need management for optimal growth and the absence of people will indeed result in damage caused by wild animals. On the other hand, a large part of the coppice trees left after the previous visit will still be useful

and/or can be turned into a useful coppice tree again with less effort than would be required for a tree that was not coppiced before. Seasonal visits to sites are not in contrast to coppicing techniques, especially when it concerns winter visits, since this is the season when the risk that wild animals forage on twigs is maximal (because of the scarcity of animal fodder). Pollarded trees would barely suffer from animal foraging and could thus be left unguarded, although people could have difficulties with reaching the branches as well.

Pollarding and coppicing has in the first place regularly been suggested to be practised in relation to leaf-foddering or to explain changes in pollen diagrams (*e.g.* Kalis and Meurers-Balke 1998; references in Rasmussen 1989, 51; Troels-Smith 1954). Some authors suggested that coppicing will lead to increased pollen production of *Tilia* sp., *Fraxinus excelsior, Corylus avellana* and decreased flowering of *Ulmus* sp. and *Betula* sp. (Bakker 2003, 267; Groenman-van Waateringe 1992). Rasmussen (1990) however states that the reaction of trees concerning pollen production depends on the age of the tree, the coppice interval, the precise method and the surrounding vegetation, indicating that there is no uniform single reaction for a single taxon. This implies that there is no straightforward method to detect coppicing and pollarding in pollen diagrams (Rasmussen 1990; Waller and Schofield 2006, 382). Although there is archaeobotanical evidence of leaf-foddering and although this practice is also known from historical times in various parts of Europe, it can be questioned whether leaf-foddering was practised in all parts of Europe, and especially whether it was practised at the Dutch wetlands (see paragraph 8.3.2 and below). Coppicing has secondly be concluded based on evidence from wooden artefacts made of branches from coppiced trees, such as fish traps, wattle work and trackways. Such artefacts can give evidence of coppicing when they are made out of several branches that show a similarity in age (*e.g.* Christensen 1997; McQuade and O'Donnell 2007; Mertens 2000, 44; Morgan 1988). Recognition of coppiced wood in this way is further discussed below.

A coppice practice consisting of the collection of all branches of a stool would theoretically result in the availability of a group of branches with a similar age, and with diameters that show variation (the variation in diameter is confirmed by experimental work, pers. comm. Vermeeren 2008). Coppicing of several trees could therefore primarily be recognised when the coppice interval of a group of trees and branches was the same. Coppicing will however be more difficult to recognise if branches from different trees are not collected with the same interval, since this would not result in a single peak in the age distribution (*cf.* Rasmussen 1989, 61). Coppicing can secondly be recognised when various branches show narrow annual rings with a certain interval. These narrow annual rings are then assumed to represent coppice events that only affected other branches of the tree from which the investigated branch was collected. Importantly, coppicing that includes only some of the branches during some of the coppice events will result in an age distribution that may be difficult to relate to coppicing since it will result in a spread age distribution (*cf.* Morgan 1988), unless the width or annual rings is (can be) studied. Repetitive coppicing can furthermore result in the continuous formation of narrow annual rings which may make it difficult to recognise separate coppice events after the start of coppicing (*cf.* Rasmussen 1990, 90), and to distinguish coppicing practices from increasingly poor environmental conditions. Coppicing can thirdly be recognised by characteristics of the branches, such as the presence of a heel at the base of the branches, the length and the straightness of the shoots, the presence of scars of died-back side-shoots, and the presence of kinks of topped growth (Coles 1987).

Characteristics of wood in an assemblage that results from coppicing can be very similar to characteristics of a wood assemblage that was not produced by coppicing as defined above. Cleared trees of various taxa will form new shoots, and collection of these shoots after several years would result in a wood assemblage similar to one resulting from coppicing, despite the possible absence of a planned strategy and possible absence of repetitive collection of branches (*cf.* Morgan 1988). Random collection of branches from the trees present in the natural vegetation without a planned strategy would possibly resemble coppicing as well, since random collection of wood near sites could also result in development of branches with a similar age at

single trees or in groups of trees (*cf.* Mertens 2000). This would especially be the case if the same branches are selected repetitively and in case of intermittent site occupation with a regular interval.

Another aspect that potentially weakens the evidence of coppicing is the number of branches investigated. Would 50 branches corresponding in age and slightly varying diameters give evidence of coppicing in prehistory, or could this number result from random collection of branches? This is also related to the definition of management of trees and shrubs in relation to coppicing. Is coppicing a form of a management when a single tree is coppiced, or is coppicing only true management when it concerns tens of coppice trees of a single taxon? When dealing with the archaeological evidence, it is here suggested that conclusions on coppicing can only be made when at least 75 and preferably 100 samples have been collected from a single structure (*e.g.* a single fish trap or a single trackway). Only such numbers will give results that are statistically meaningful.

The pollen diagrams of the Mesolithic and Neolithic Dutch wetland sites do not show clear evidence of pollarding and/or coppicing since it is not known how to recognise such management practices in the diagrams. Bakker (2003, 271) and Groenman-van Waateringe (1992, 20) similarly concluded that there are no indications in pollen diagrams for coppicing in the Late Neolithic in the northern Netherlands and the Neolithic and Bronze Age in the Netherlands respectively.

There are several wooden structures known from the Late Mesolithic and Early and Middle Neolithic Dutch wetland site that have led to discussion on coppicing. It concerns investigations on wood from fish weirs and fish traps from Bergschenhoek, Hoge Vaart and Emmeloord.

Wood analysis of several fish traps at the Early Neolithic site Bergschenhoek gives strong indications of the coppicing of shrubs of *Cornus sanguinea* (dogwood), which are the best indications of coppicing from all sites studied (see appendix V, based on work by Casparie and Stuijts). The data set strongly supports coppicing because of the large number of twigs with a similar age, the large length of the twigs, the small diameter and the finds of deformed stumps of trees. The data set is furthermore very representative because of the large number of identifications (hundreds) and age observations (thousands).

At Hoge Vaart, three fish weirs and three fish traps that were part of the weirs were investigated for indications of coppicing of *Alnus* sp. and *Salix* sp. In the assemblage of posts from the weirs, *Alnus* sp. was dominant, followed by *Acer* sp., *Betula* sp., *Corylus avellana*, *Prunus padus*-type, *Populus* sp., *Quercus* sp. and *Salix* sp. The wood from two of the weirs did not show a peak in the age distribution and therefore gave no indications of coppicing. The wood of *Alnus* sp. from one of the weirs (N = 40) gave some indications of coppicing since the age distribution had a range from 3 to 11 years with a cluster around 6, 7 and 8 years (N = *c.* 25), while the diameter range was similar to (though slightly smaller than) that of the wood of one of the weirs for which the use of coppiced trees was rejected.[17] The clustered age is interpreted as a suggestion that the *Alnus* posts were collected from woodland that had been used seven and eight years earlier for the collection of wood (Van Rijn and Kooistra 2001). The investigators did however not conclude that the wood originated from coppiced trees, and indeed the evidence is too weak when considering the number of posts with a similar age and in view of the relation between age and diameter (shown in Van Rijn and Kooistra 2001).

The fish traps found as part of the fish weirs at Hoge Vaart were made of *Salix* sp., while two twigs of *Alnus* sp. and *Quercus* sp. possibly were part of the fish traps as well. The number of identifications from the first fish traps is 37 (including 35 identifications of *Salix* sp.), the number of identifications from the two other traps was however only one and eight due to excavation conditions. All *Salix* wood remains from all fish traps were 1, 2, or 3 years old, though mainly 2 years. In addition the range of the diameters is limited (0-1 cm for fish trap 1 from which most wood identifications are available), and the annual rings had a relative large width, suggesting that the branches grew on adult stools. The branches were furthermore all collected in autumn or winter, which

---

17 The wood diameter of the fish trap that showed a clustered age was 1.5-6 cm while the wood diameter of the two other weirs was 0.8-5.5 and 0.6-8 cm.

is suggested to be the best period for the harvesting of branches for *e.g.* wattle work. All these indications result in the conclusion that the willow branches were collected from trees that were regularly used for the collection of branches and that were possibly coppiced (Van Rijn and Kooistra 2001). The conclusion is correct, and the caution concerning coppicing as well. Although the willow withies could indeed be collected from coppiced woodland, the number of investigated branches is far too small to conclude coppicing with certainty. The range of the diameter can furthermore officially not be used as an argument since at least part of the fragments of the fish traps were interpreted as such because of the small diameter (see also chapter 5).

At Emmeloord, a large number of fish traps and fish weirs dating to the late phase of the Swifterbant culture and the Bell Beaker culture was found (Bulten *et al.* 2002). Analysis of the age of the posts from the weirs, representing a variety of taxa, showed a broad range, and it was concluded that collection from coppiced woodland is improbable (Van Rijn 2002, 75). The young age and the straight shapes of the posts nevertheless suggest that the wood was possibly collected from woodlands that had been exploited before (Van Rijn 2002, 75). Age ranges from individual weirs moreover show some indications of coppicing, since the range patterns correspond with a pattern known from recent *Corylus* coppice (fig. 4 in Morgan 1988). The number of branches from single weirs is however too limited to conclude exploitation of coppice woods.

The 44 fish traps found at Emmeloord were primarily made from *Salix* sp., *Corylus avellana* and a combination of the two. Van Rijn (2002, 75) concludes that the wood from the fish traps suggests management of *Salix* sp. and *Corylus avellana*. The fish trap withies give indications of the regular exploitation of trees, since most *Corylus avellana* withies had an age of 1 year (N = 96) and additionally two year (N = 30), while most willow withies had an age of one year (N = 37), two years (N = 43) and three years (N = 17). Most branches had furthermore been collected in winter, which is the best season for collecting branches from coppiced trees (Van Rijn 2002). Coppicing could indeed be practised here, but the data do not allow a firm conclusion to be made. In the first place it must be questioned whether the combination of the data of all fish traps is valid, since it is not demonstrated that all traps are contemporaneous. The data of the Swifterbant culture and the Bell Beaker culture could have been better separated. On the other hand, coppice wood can be in use for many decades, which implies that data of various periods can be combined, and in this view the data support management. Nevertheless, the representativity of the number of counts of annual rings (N = 237) can be questioned in view of the total number of fish traps (44). The maximum number of identifications from single fish traps is 17, and this number is clearly not enough to make definitive conclusions on coppice practices either. Finally, scatter diagrams illustrating the age and diameter range of individual traps are not given. This example shows that better dating of the relevant fish traps as well as more possibilities for archaeobotanical research would have led to more valid conclusions.

In conclusion, there are indications of the management of woodland by coppicing, especially at Bergschenhoek. The evidence is only available from sites that date to the Neolithic (although domesticates were not found at Bergschenhoek). It remains unknown whether coppicing was practised in the (Late) Mesolithic since there are no structures available to investigate this. The quantity of structures from which coppiced wood can be recognised is clearly a limiting factor, both for the Mesolithic and Neolithic. If relevant structures are found, the number of identifications from single structures is a second factor restricting the validity of conclusions. Topics for future research are whether coppicing was applied on a regular scale or not, the extent of coppiced woodland and details on the intensity of management (cultivation?).

## 8.8.4 MANAGEMENT – MISCELLANEOUS

Many forms of human impact on the vegetation, ranging from the incidental removal of bark and branches in parts of the exploitation area that were infrequently visited to structural management of the vegetation, would have resulted in changes that could be detected by other people. This could have had severe implications for experiences of ownership, *i.e.* exclusive use rights (*cf.* Mertens 2000, 45), both of individual trees and shrubs

and of ownership of larger parts of the landscape. For example, tree carvings in historic Sweden probably functioned as notice boards and gave information on ownership, visits and people (Andersson *et al.* 2005). Marking of trees in relation to ownership is also known from the Neolithic site Hauterive-Champréveyres in Switzerland (Pillonel 2007). It can be questioned to what degree ownership was relevant in the Mesolithic and Neolithic. The indications of the management of animals (Zeiler 1997) and plants (presented above), as well as off-site animal catching devices such as fish traps nevertheless indicates that ownership probably played a role in society, since it is probable that people aimed to gain back a major part of the energy that was invested in management practices.

There is no explicit information on how people marked ownership of terrain at the Late Mesolithic and Early and Middle Neolithic Dutch wetland sites, possibly because this mainly concerns uncommon off-site data, or because such markings are difficult to recognise as such nowadays. Wood remains from the sites studied hardly contain traces of working that clearly indicate a symbolic meaning that could have had a function in relation to ownership. An exception is known from a bow from Polderweg (Louwe Kooijmans, Vermeeren and Van Waveren 2001, 384). The carving may have functioned as a symbol of ownership of the bow, but the bow was probably not used as a marker of ownership of land.

An important form of management in the Netherlands known from historical and prehistoric periods is the digging of ditches, created in order to lower the water level at the patches of terrain enclosed by ditches. Lowering the water level increases the amount of terrain suitable for habitation and agriculture, and may function as a marker of ownership. Ditches as described above that could have been made in order to improve the growing conditions of plants are not recognised at the Late Mesolithic and Neolithic sites studied, except for a single ditch at Rijswijk-A4 with an unknown function (see paragraph 3.5). The presence of pits at the coastal dunes interpreted as unlined wells assuring availability of fresh water to both people and animals nevertheless indicated that water management had already started.

| site | culture/group | taxon | N | dimensions (cm) | interpretation |
|---|---|---|---|---|---|
| *Sites studied* | | | | | |
| De Bruin | Late Mesolithic/ Swifterbant | Alnus glutinosa | 1 | l. 5, Ø 1 | |
| | | Alnus glutinosa | 1 | l. 26 | |
| | | Alnus glutinosa | 1 | l. > 13, Ø 7 | |
| | | Alnus glutinosa | 1 | l. 7, Ø 1.5-3.5 | |
| | | Cornus sanguinea | 1 | l. 28, Ø 2.5 | point? |
| | | Cornus sanguinea | 1 | l. 42, Ø 2 | point? |
| | | Cornus sanguinea | 1 | l. 34 | |
| | | Cornus sanguinea | 1 | l. 24, Ø 2 | |
| | | Corylus avellana | 1 | l. 38, Ø c. 2 | point |
| | | Corylus avellana | 1 | l. 40, Ø 3 | |
| | | Fraxinus excelsior | 1 | l. 34, Ø 2 | point |
| | | Fraxinus excelsior | 1 | l. > 173, Ø 3-4 | |
| | | Quercus sp. | 1 | l. > 12, Ø1-1.8 | ? |
| Polderweg | Late Mesolithic/ Swifterbant | Corylus avellana | 1 | l. > 76, Ø 3 | spit? |
| | | Euonymus europaeus | 1 | l. 81, Ø 2 | spit? |
| | | Fraxinus excelsior | 1 | l. 32, Ø 5.2 | point |
| | | Fraxinus excelsior | 1 | l. 20, Ø 1.8-2.0 | point |
| | | Fraxinus excelsior | 1 | l. 72, Ø 2.5 | spit? |
| | | Fraxinus excelsior | 1 | l. 25, Ø 11 | |
| | | Fraxinus excelsior | 1 | l. >95, Ø 6 | |
| | | Quercus sp. | 1 | l. 90, Ø 3-4 | |
| | | Quercus sp. | 1 | l.: > 33 | |
| | | Salix sp. | 1 | l. 33, Ø 2.5-3.5 | digging stick |
| | | Viburnum opulus | 1 | l. 36, Ø 2.4-4.0 | digging stick |
| Schipluiden | Late Mesolithic/ Swifterbant | Corylus avellana | 1 | l. 16, Ø 1.7 | spearhead |
| | | Corylus avellana | 1 | l. 20.5, Ø 1.9 | spear/javelin |
| | | Euonymus europaeus | 1 | l. 45.5, Ø 2.2 | spear/javelin |
| | | Euonymus europaeus | 1 | l. 5.5, Ø 1.5 | spear/javelin |
| | | Juniperus communis | 1 | l. 9, Ø 1.4-2.2 | spear/javelin |
| | | Lonicera periclymenum | 1 | l. 17.5, Ø 0.8-1.3 | spear/javelin |
| | | Pomoideae | 1 | l. 9, Ø 1.7 | spear/javelin |
| | | Prunus sp. | 1 | l. 35.5, Ø 2.2 | spear/javelin |

Table 8.14 part 1.

| site | culture/group | taxon | N | dimensions (cm) | interpretation |
|---|---|---|---|---|---|
| Schipluiden (cont.) | | Prunus sp. | 1 | l. 13, Ø 1.5-3 | spear/javelin |
| | | Prunus sp. | 1 | l. 9.5. Ø 2.6 | spear/javelin |
| | | Prunus sp. | 1 | l. 12.5, Ø 1.7-2.6 | ? |
| | | Rhamnus cathartica | 1 | l. 7.5, Ø 1.5 | spear/javelin |
| Ypenburg | Hazendonk | Alnus glutinosa | 1 | Ø 2 | |
| | | Fraxinus excelsior | 1 | Ø 2 | spear/javelin |
| | | Juniperus communis | 1 | Ø 1.5-2 | leister prong? |
| | | Rhamnus cathartica | 1 | l. > 20, Ø 0.5-2.5 | post? |
| *Late Neolithic* Emmeloord | Neolithic /Bronze Age | Taxus baccata | 1 | l. c. 200 | ? |
| Hazendonk | Vlaardingen | Corylus avellana | 1 | | spear |
| | | Corylus avellana | 2 | | arrow shaft(s) |
| | | Salix sp. | 2 | | spear |
| | | Salix sp. | 1 | | arrow shaft |
| | | Viburnum sp. | 2 | | spear |
| Vlaardingen | Vlaardingen | Fraxinus excelsior | 1 | l. 62.8 | |

l. = length

Ø = diameter

Table 8.14 The sites studied and comparable Late Neolithic sites, wood identifications of artefacts that can be classified as pointed roundwood (posts excluded), with the interpretation of the function of the objects as given in the original publications, part 2.

| taxon | N | % |
|---|---|---|
| Fraxinus excelsior | 8 | 20 |
| Alnus sp. | 5 | 13 |
| Corylus avellana | 5 | 13 |
| Cornus sanguinea | 4 | 10 |
| Prunus sp. | 4 | 10 |
| Euonymus europaeus | 3 | 8 |
| Quercus sp. | 3 | 8 |
| Juniperus communis | 2 | 5 |
| Rhamnus cathartica | 2 | 5 |
| Lonicera periclymenum | 1 | 3 |
| Pomoideae | 1 | 3 |
| Salix sp. | 1 | 3 |
| Viburnum opulus | 1 | 3 |
| total | 40 | |

Table 8.15 The sites studied, summary table of the wood identifications of pointed roundwood.

| site | culture/group | taxon | N | interpretation |
|---|---|---|---|---|
| *Sites studied* | | | | |
| Bergschenhoek | Swifterbant | Alnus glutinosa | 1 | |
| | | Betula sp. | 1 | |
| | | Fraxinus sp. | 1 | |
| Brandwijk-Kerkhof | Swifterbant | Alnus glutinosa | 3 + 1? | |
| | | Corylus avellana | 1 + 1? | |
| | | Fraxinus excelsior | 1 + 1? | |
| | | Quercus sp. | 4 | |
| De Bruin | Late Mesolithic/ Swifterbant | Cornus sanguinea | 1 | |
| | | Fraxinus excelsior | 2 | |
| | | Quercus sp. | 1 | |
| Polderweg | Late Mesolithic/ Swifterbant | Alnus glutinosa | 1 | |
| | | Corylus avellana | 1 | |
| Wateringen 4 | Hazendonk | Alnus glutinosa | 7 | House |
| | | Juniperus communis | 7 | House |
| | | Quercus sp. | 1 | |
| Schipluiden | Hazendonk | Alnus sp. | 19 | Fence |
| | | Euonymus europaeus | 1 | Fence |
| | | Juniperus communis | 23 | Fence |
| | | Pomoideae | 4 | Fence |
| | | Prunus sp. | 42 | Fence |
| | | Salix sp. | 2 | Fence |
| | | Alnus sp. | 1 | |
| | | Juniperus communis | 2 | |
| | | Pomoideae | 1 | |
| | | Prunus sp. | 4 | |
| Ypenburg | Hazendonk | Alnus sp. | 1 + 1? | |
| | | Fraxinus excelsior | 1 | |
| | | Quercus sp. | 1? | |
| | | Salix sp. | 1 | |
| Schokkerhaven-E170* | Swifterbant | Quercus sp. | 1 + ? | Fence |
| Emmeloord | Swifterbant | Alnus glutinosa | 31 | Fish weir |
| | | Betula sp. | 3 | Fish weir |

Table 8.16 part 1.

| site | culture/group | taxon | N | interpretation |
|---|---|---|---|---|
| *Sites studied* | | | | |
| Emmeloord (cont.) | Swifterbant | Populus sp./Salix sp. | 2 | Fish weir |
| | | Quercus sp. | 1 | Fish weir |
| | | Salix sp. | 7 | Fish weir |
| | | Ulmus sp. | 2 | Fish weir |
| J112** | Swifterbant | Alnus glutinosa | 1 | |
| Swifterbant | Swifterbant | Alnus glutinosa | 57 | |
| | | Betula sp. | 7 | |
| | | Corylus avellana | 33 | |
| | | Fraxinus excelsior | 19 | |
| | | Pomoideae | 6 | |
| | | Populus sp. | 1? | |
| | | Quercus sp. | 10 | |
| | | Salix sp. | 5 | |
| Hoge Vaart | Swifterbant | Acer campestre | 4 | Fish weir |
| | | Alnus glutinosa | 229 | Fish weir |
| | | Betula sp. | 4 | Fish weir |
| | | Corylus avellana | 8 | Fish weir |
| | | Pomoideae | 1 | Fish weir |
| | | Populus sp. | 3 | Fish weir |
| | | Prunus padus | 1 | Fish weir |
| | | Quercus sp. | 2 | Fish weir |
| | | Salix sp. | 17 | Fish weir |
| Jardinga | Late Mesolithic | Alnus sp. | 2 | Fish weir? |
| | | Corylus avellana | 1 | Fish weir? |
| | Swifterbant | Alnus sp. | 1 | |
| *Late Neolithic* | | | | |
| Emmeloord | Bell Beaker | Alnus glutinosa | 185 | Fish weir |
| | | Betula sp. | 115 | Fish weir |
| | | Corylus avellana/ Fraxinus excelsior | 3 | Fish weir |
| | | Quercus sp. | 7 | Fish weir |

Table 8.16 part 2.

| site | culture/group | taxon | N | interpretation |
|---|---|---|---|---|
| *Sites studied* | | | | |
| Emmeloord (cont.) | Bell Beaker | Salix sp. | 7 | Fish weir |
| | | Ulmus sp. | 3 | Fish weir |
| Schipluiden | Bell Beaker | Alnus glutinosa | 8 | |
| | | Salix sp. | 16 | |
| Vlaardingen | Bell Beaker | Alnus glutinosa | 1 | (House) |
| | | Corylus avellana | 4 | (House) |
| | | Fraxinus excelsior | 2 | (House) |
| Hazendonk | Vlaardingen | Alnus glutinosa | 32 | Fence |
| | | Corylus avellana | 1 | |
| | | Ulmus sp. | 2 | |
| Hekelingen III*** | Vlaardingen | Acer campestre | 13 | |
| | | Alnus glutinosa | 22 | |
| | | Corylus avellana | 13 | |
| | | Fraxinus excelsior | 27 | |
| | | Prunus sp. | 1 | |
| | | Quercus sp. | 5 | |
| | | Salix sp. | 2 | |
| Vlaardingen | Vlaardingen | Acer campestre | 64 | |
| | | Alnus glutinosa | 109 | (House) |
| | | Corylus avellana | 19 | |
| | | Fraxinus excelsior | 110 | (House) |
| | | Quercus sp. | 26 | (House) |
| | | Salix sp. | 4 | |
| | | Ulmus sp. | 3 | |

* = Hogestijn 1990

** = Hogestijn 1991

*** = unpublished data Casparie and Louwe Kooijmans 1982-1985

(House) = precise number of posts representing the house is unknown

Table 8.16 The sites studied and comparable Late Neolithic sites, wood identifications of posts, part 3.

| taxon | N | % |
|---|---|---|
| *Sites studied* | | |
| Alnus glutinosa | 352 | 59 |
| Prunus sp. | 47 | 8 |
| Corylus avellana | 44 | 7 |
| Salix sp. | 34 | 6 |
| Juniperus communis | 32 | 5 |
| Fraxinus excelsior | 24 | 4 |
| Quercus sp. | 19 | 3 |
| Betula sp. | 16 | 3 |
| Pomoideae | 12 | 2 |
| Acer campestre | 4 | 1 |
| Populus sp. | 3 | 1 |
| Populus sp./Salix sp. | 2 | 0 |
| Ulmus sp. | 2 | 0 |
| Cornus sanguinea | 1 | 0 |
| Euonymus europaeus | 1 | 0 |
| total | 593 | |
| | | |
| *Late Neolithic* | | |
| Alnus glutinosa | 357 | 44 |
| Fraxinus excelsior | 139 | 17 |
| Betula sp. | 115 | 14 |
| Acer campestre | 77 | 10 |
| Corylus avellana | 37 | 5 |
| Quercus sp. | 38 | 5 |
| Salix sp. | 29 | 4 |
| Ulmus sp. | 8 | 1 |
| Corylus avellana/Fraxinus excelsior | 3 | 0 |
| Prunus sp. | 1 | 0 |
| total | 804 | |

Table 8.17 The sites studied and comparable Late Neolithic sites, summary table of the wood identifications of posts.

| site | culture/group | taxon | N |
|---|---|---|---|
| Emmeloord | Swifterbant | Alnus glutinosa | 31 |
| | | Betula sp. | 3 |
| | | Populus sp./Salix sp. | 2 |
| | | Quercus sp. | 1 |
| | | Salix sp. | 7 |
| | | Ulmus sp. | 2 |
| Hoge Vaart | Swifterbant | Acer campestre | 4 |
| | | Alnus glutinosa | 229 |
| | | Betula sp. | 4 |
| | | Corylus avellana | 8 |
| | | Pomoideae | 1 |
| | | Populus sp. | 3 |
| | | Prunus padus-type | 1 |
| | | Quercus sp. | 2 |
| | | Salix sp. | 17 |
| Jardinga | Late Mesolithic | Alnus sp. | 2? |
| | | Corylus avellana | 1? |
| Emmeloord | Bell Beaker | Alnus glutinosa | 185 |
| | | Betula sp. | 115 |
| | | Corylus avellana/Fraxinus excelsior | 3 |
| | | Quercus sp. | 7 |
| | | Salix sp. | 7 |
| | | Ulmus sp. | 3 |

Table 8.18 Jardinga, Hoge Vaart and Emmeloord, wood identifications of posts of fish weirs.

| taxon | N | % |
|---|---|---|
| Alnus glutinosa | 447 | 70.1 |
| Betula sp. | 122 | 19.1 |
| Salix sp. | 31 | 4.9 |
| Quercus sp. | 10 | 1.6 |
| Corylus avellana | 9 | 1.4 |
| Ulmus sp. | 5 | 0.8 |
| Acer campestre | 4 | 0.6 |
| Corylus avellana/Fraxinus excelsior | 3 | 0.5 |
| Populus sp. | 3 | 0.5 |
| Populus sp./Salix sp. | 2 | 0.3 |
| Pomoideae | 1 | 0.2 |
| Prunus padus-type | 1 | 0.2 |
| total | 638 | |

Table 8.19 Jardinga, Hoge Vaart and Emmeloord, summary table of the wood identifications of posts of wish weirs.

| site | culture/group | taxon | N | interpretation |
|---|---|---|---|---|
| *Sites studied* | | | | |
| Wateringen 4 | Hazendonk | Alnus glutinosa | 7 | House |
| | | Juniperus communis | 7 | House |
| *Late Neolithic* | | | | |
| Vlaardingen | Bell Beaker | Alnus glutinosa | 1 | (House) |
| | | Corylus avellana | 4 | (House) |
| | | Fraxinus excelsior | 2 | (House) |
| Vlaardingen | Vlaardingen | Alnus glutinosa | 109 | (House) |
| | | Fraxinus excelsior | 110 | (House) |
| | | Quercus sp. | 26 | (House) |

House = the number of posts that are interpreted as part of a house

(House) = precise number of posts representing the house is unknown

Table 8.20 Wateringen 4 and Vlaardingen, wood identifications of posts of structures interpreted as houses.

| taxon | N | % |
|---|---|---|
| Alnus glutinosa | 117 | 44 |
| Fraxinus excelsior | 112 | 42 |
| Quercus sp. | 26 | 10 |
| Juniperus communis | 7 | 3 |
| Corylus avellana | 4 | 2 |
| total | 266 | |

Table 8.21 Wateringen 4 and Vlaardingen, summary table of the wood identifications of house posts, including the category House and (House).

| taxon | N | % |
|---|---|---|
| Prunus sp. | 42 | 45 |
| Juniperus communis | 23 | 24 |
| Alnus glutinosa | 20 | 21 |
| Pomoideae | 4 | 4 |
| Salix sp. | 2 | 2 |
| Corylus avellana | 1 | 1 |
| Euonymus europaeus | 1 | 1 |
| Quercus sp. | 1 | 1 |
| Quercus sp. | ? | |
| total | 94 | |

Table 8.23 The sites studied, summary table of the wood identifications of posts of fences and palisades.

| site | culture/group | taxon | N | interpretation |
|---|---|---|---|---|
| *Sites studied* | | | | |
| Brandwijk-Kerkhof | Swifterbant | Alnus sp. | 1? | Palisade |
| | | Corylus avellana | 1? | Palisade |
| | | Quercus sp. | 1? | Palisade |
| Schipluiden | Hazendonk | Alnus sp. | 19 | Fence |
| | | Euonymus europaeus | 1 | Fence |
| | | Juniperus communis | 23 | Fence |
| | | Pomoideae | 4 | Fence |
| | | Prunus sp. | 42 | Fence |
| | | Salix sp. | 2 | Fence |
| Schokkerhaven-E170 | Swifterbant | Quercus sp. | ? | Fence |
| *Late Neolithic* | | | | |
| Hazendonk | Vlaardingen | Alnus glutinosa | 27 | Palisade |

Table 8.22 The sites studied and comparable Late Neolithic sites, wood identifications of posts of fences and palisades.

| site | culture/group | taxon | N |
|---|---|---|---|
| *Sites studied* | | | |
| Polderweg | Mesolithic/Swifterbant | Corylus avellana | 1 |
| | | Alnus glutinosa | 1 |
| De Bruin | Swifterbant | Cornus sanguinea | 1 |
| | | Fraxinus excelsior | 2 |
| | | Quercus sp. | 1 |
| Brandwijk-Kerkhof | Swifterbant | Alnus glutinosa | 2+1? |
| | | Corylus avellana | 1+1? |
| | | Fraxinus excelsior | 1? |
| | | Quercus sp. | 3 |
| Bergschenhoek | Swifterbant | Alnus glutinosa | 1 |
| | | Betula sp. | 1 |
| | | Fraxinus sp. | 1 |
| | | Betula sp. | 1 |
| Swifterbant | Swifterbant | Alnus glutinosa | 57 |
| | | Betula sp. | 7 |
| | | Corylus avellana | 33 |
| | | Fraxinus excelsior | 19 |
| | | Pomoideae | 6 |
| | | Populus sp. | ? |
| | | Quercus sp. | 10 |
| | | Salix sp. | 5 |
| J112 | Swifterbant | Alnus glutinosa | 1 |
| Jardinga | Swifterbant | Alnus sp. | 1 |
| Ypenburg | Hazendonk | Alnus sp. | 1 + 1? |
| | | Fraxinus excelsior | 1 |
| | | Quercus sp. | 1? |
| | | Salix sp. | 1 |
| Wateringen 4 | Hazendonk | Quercus sp. | 1 |
| Schipluiden | Hazendonk | Juniperus communis | 2 |
| | | Prunus sp. | 4 |
| | | Pomoideae | 1 |
| | | Alnus sp. | 1 |

Table 8.24 part 1.

| site | culture/group | taxon | N |
|---|---|---|---|
| *Late Neolithic* | | | |
| Schipluiden | Bell Beaker | Alnus glutinosa | 8 |
| | | Salix sp. | 16 |
| Vlaardingen | Bell Beaker | Alnus glutinosa | 2 |
| | | Corylus avellana | 1 |
| Hazendonk | Vlaardingen | Alnus glutinosa | 32 |
| | | Corylus avellana | 1 |
| | | Ulmus sp. | 2 |
| Vlaardingen | Vlaardingen | Acer campestre | 64 |
| | | Alnus glutinosa | 109 |
| | | Corylus avellana | 19 |
| | | Fraxinus excelsior | 110 |
| | | Quercus sp. | 26 |
| | | Salix sp. | 4 |
| | | Ulmus sp. | 3 |
| Hekelingen III | Vlaardingen | Alnus glutinosa | 22 |
| | | Corylus avellana | 13 |
| | | Fraxinus excelsior | 27 |
| | | Salix sp. | 2 |
| | | Acer campestre | 13 |
| | | Quercus sp. | 5 |
| | | Prunus sp. | 1 |

Table 8.24 The sites studied and comparable Late Neolithic sites, wood identifications of posts with unknown function, including the category (House), part 2.

| taxon | N | % |
|---|---|---|
| *Sites studied* | | |
| Alnus glutinosa | 65 | 39 |
| Corylus avellana | 35 | 21 |
| Fraxinus excelsior | 24 | 14 |
| Quercus sp. | 15 | 9 |
| Betula sp. | 9 | 5 |
| Pomoideae | 7 | 4 |
| Salix sp. | 6 | 4 |
| Prunus sp. | 4 | 2 |
| Juniperus communis | 2 | 1 |
| Cornus sanguinea | 1 | 1 |
| Populus sp. | ? | |
| Total | 168 | |
| *Late Neolithic* | | |
| Alnus glutinosa | 173 | 36 |
| Fraxinus excelsior | 137 | 29 |
| Acer campestre | 77 | 16 |
| Corylus avellana | 34 | 7 |
| Quercus sp. | 31 | 6 |
| Salix sp. | 22 | 5 |
| Ulmus sp. | 5 | 1 |
| Prunus sp. | 1 | 0 |
| total | 480 | |

Table 8.25 The sites studied and comparable Late Neolithic sites, summary table of the wood identifications of posts with unknown function, possible posts not included.