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

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Appendix II. Archaeobotany of Brandwijk-Kerkhof, the Netherlands

II.1 Introduction

The site Brandwijk-Kerkhof, was partially excavated in 1991 by the Institute of Prehistory Leiden (now the Faculty of Archaeology) under the direction of A.L. van Gijn and M. Verbruggen, in the context of an investigation of the Neolithic occupation at Late Glacial inland dunes. Brandwijk-Kerkhof is a small dune (0.5 m -NAP) in the Dutch Rhine/Meuse river area, located in the central river area (coordinates 114.163/433.735, see fig. II.1). The site, its cultural setting, geology and the general development of the regional landcape are presented in Out (2008a). It can be added that open water was present south of the dune during all phases and that in addition to the large dune Brandwijk-Donk, a third smaller dune is present in the near surroundings of Brandwijk-Kerkhof. The excavation trench (3 x 15 metres, down to 6.5 m -NAP) was situated on the southern slope of the dune where occupation was concentrated. Several refuse layers (fossil anthropogenic horizons) were distinguished in the excavation trench (see table II.1 and fig. II.2). Layers 50 and 60 are the most important in extent and archaeological remains, while the other layers are of minor importance.[17] In the text below, the abbreviation L will be used to indicate a layer. The site was occupied periodically from *c.* 4600 to 3550 BC. The age of the dated layers is shown in table II.2 (see also fig.2.5). The dates are reconstructed by conventional ^{14}C dating and by interpolation of ground water levels of other sites in the region (see Verbruggen 1992).

Swifterbant pottery was found in all layers at the site. The flint assemblage indicated contact with southern regions. Layer 30 contained a sherd with characteristics of pottery of the Blicquy group; sherds similar to Blicquy pottery were also found at Hardinxveld-Giessendam De Bruin (Raemaekers 1999, 2001, 142-147). Fragments of flint axes in the base and top of L50 furthermore indicate incorporation of the Michelsberg material culture. There were no structures recognised except for a series of pointed posts, dating to L50 or later. The bone assemblage was dominated by bones of beaver, otter, deer and wild boar. Bones of domestic animals (one bone of goat/sheep and one bone of possibly domestic pig) were present from the initial occupation (L30) onwards but only formed a minority of the assemblage. It is only during the upper part of L50 that bones of cattle are present and bones of pig/wild boar can be identified as domestic pig bone with certainty (this may be related to the scarcity of material in the lower part of L50). Preliminary results indicate that the site was used as a temporary hunting/fishing camp. There are indications of summer and winter occupation, while year round occupation is not excluded (Van Gijn and Verbruggen 1992; Raemaekers 1999).

layer	sediment
80	peaty clay
70	very clayey peat; find layer
60	amorphous black peat; find layer
56	peat with flat positioned fragments of wood; possible find layer
55	amorphous peat
50	sandy peat; find layer
45	peat layer in layer 40 characterised by small lenses of sand; find layer
40	peat
30	sandy peat; find layer
20	slightly clayey peat
15	top of the dune
10	clean dune sand

Table II.1 Brandwijk-Kerkhof, stratigraphy (based on Verbruggen in prep.).

17 Of the minor find layers, layer 45 did not contain any sherds in contrast to layers 30 and 70.

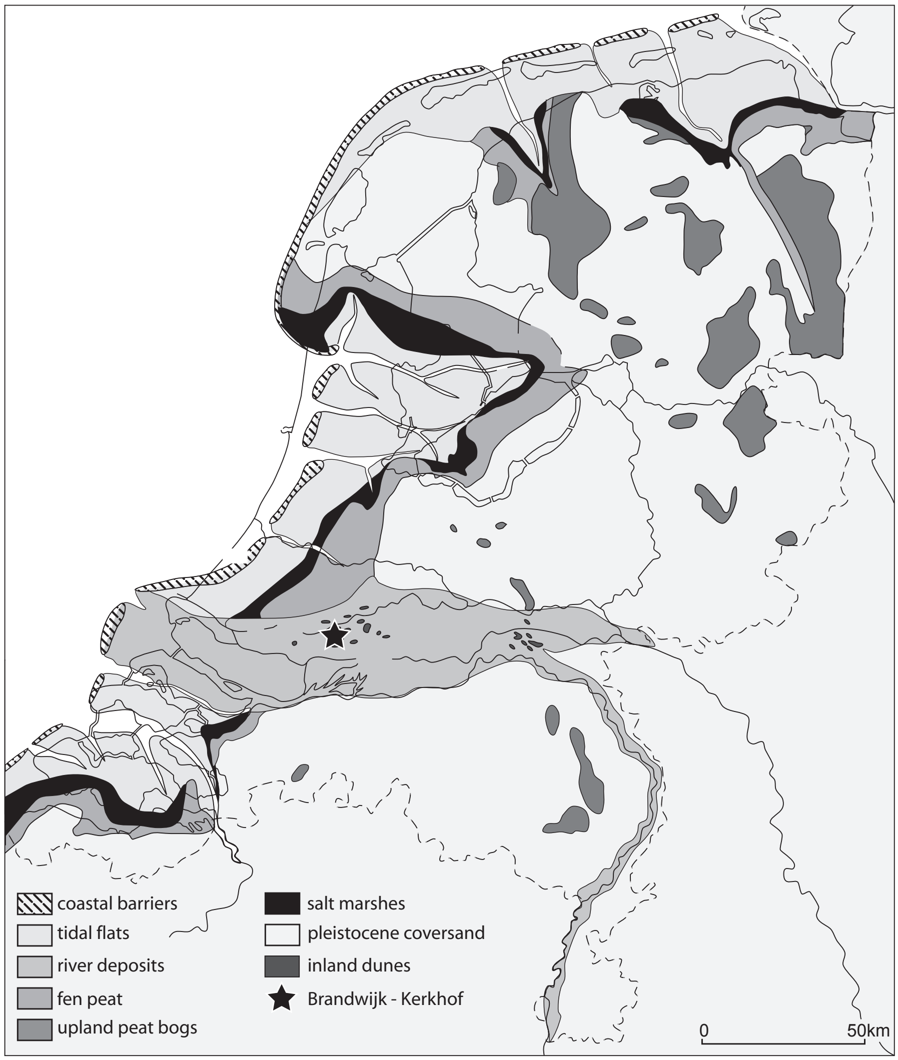


Figure II.1 Brandwijk-Kerkhof, the Netherlands, location plotted on a palaeogeographical map (*c.* 4200 BC, NITG)

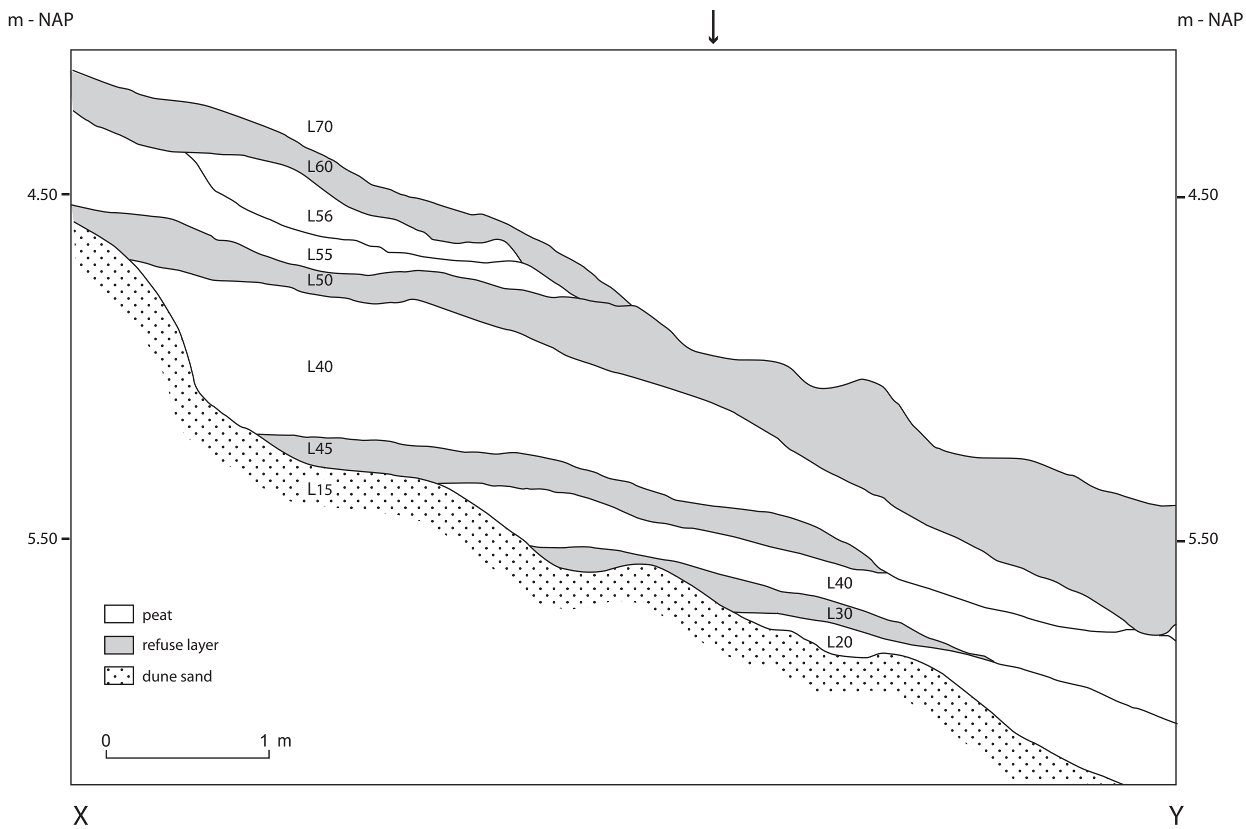


Figure II.2 Brandwijk-Kerkhof, eastern section of the excavation trench, the layers (L) (based on Verbruggen in prep.). The letters X and Y correspond with figure II.3. The vertical scale is by estimation. The arrow indicates the expected location of the sample boxes of L45 and L50.

layer	age (yrs cal BC)	surface (m^2)	attachment point (m -NAP)
70	3760-3630		3.45
60	3940-3820	1600	4.00
50 top	4030-3940	1500	
50 base	4220-4100	1500	4.60
45	4470-4370		5.30
30	4610-4550	200	5.75

Table II.2 Brandwijk-Kerkhof, the age, extent and attachment point of the refuse layers (Verbruggen in prep.). The dates are reconstructed by conventional 14C dating and by interpolation of ground water levels of other sites in the region (see Verbruggen 1992). The attachment point is the height where the peat is attached to the sand of the dune, influenced by the ground water table.

See Van Gijn and Verbruggen (1992), Out (2008a) and Raemaekers (1999) for more information.[18] Please note that the final site report is forthcoming and that all non-archaeobotanical data represent preliminary results and interpretations.

In order to study the developed stage of neolithisation at Brandwijk-Kerkhof, data on botanical remains will be presented here. Questions considered here are:

- What did the natural vegetation look like?
- What was the influence of occupation on the vegetation?
- Did people use plants that grew in the near surroundings as a food source and if so, which plants did they use?
- Which crop plants were present?
- Do the botanical remains give information on seasonality or site function?

The investigations included the analysis of pollen, macrofossils and wood and charcoal remains. The results of the analysis of pollen and macroremains of four cores taken at the northern side of the dune have been published separately, together with preliminary results on the crop plants of the excavation trench and a discussion on local crop cultivation (Out 2008a; see also paragraph II.4 for a short summary of the results of the cores). Here the complete data on macroremains, wood and charcoal collected in the excavation trench will be presented. The questions of both publications are roughly the same, but the emphasis here is put on the new results. The results on wood and charcoal analysis were published in Hänninen and Vermeeren (1998).

II.2 Materials and methods

The macroremains samples were selected in five ways. The layers investigated are the layers 30, 45, 50 and 60. Firstly, macroremains samples were collected from the pollen cores; these results are already published and are not discussed here. Secondly, two sample boxes were collected from the eastern section of the excavation trench; their precise location is unfortunately unknown. Layer 45 (archaeological importance unclear) was sampled with a box of 20 x 10 x 15 cm next to the sample box of layer 50. Layer 50 was sampled with a box of 50 x 10 x 15 cm at the eastern section of the excavation pit. The top and bottom of this box also contained small quantities of sediment from the layers 40 and 70.[19] From the boxes samples with a volume of 0.15 litres (1 x 10 x 15 cm) were selected. For L45, 15 samples were selected (interval 1 cm). For L50, 11 samples were selected (interval *c.* 5 cm). The sediment of both boxes consisted mainly of peaty sediment mixed with sand, but the middle part of the box containing layer 50 contained minor quantities of clay while the upper part consisted of clay completely. The results of the sample box of layer 50 are partly based on multiplications since only fractions were counted of the residue from the fine mesh widths. Thirdly, lab samples were collected during the excavation from the layers L30, L50 and L60. These samples have a volume of 1 litre and were sieved on several mesh widths of which the finest was 0.25 mm. The presented results of these samples are partly based on multiplications of true numbers since only fractions were counted of the residues from the fine mesh widths. Fourthly, botanical remains from the layers L30, L50 and L60 were collected from the sieves that were used to sort material during the excavation (mesh width 1.5 mm). The fifth category of macroremains samples consists of finds that were picked by hand from layer L30, L50 and L60 during the excavation. Figure II.3 shows the excavation trench and the numbers of the excavated squares, corresponding with the sample numbers. Samples of layer 50 are not assigned to either the base or top of layer 50 since these sublayers were distinguished only after excavation.

18 More information is also to be published in Verbruggen (in prep.).

19 The assignment of samples to layers is based on a drawing by W.J. Kuijper.

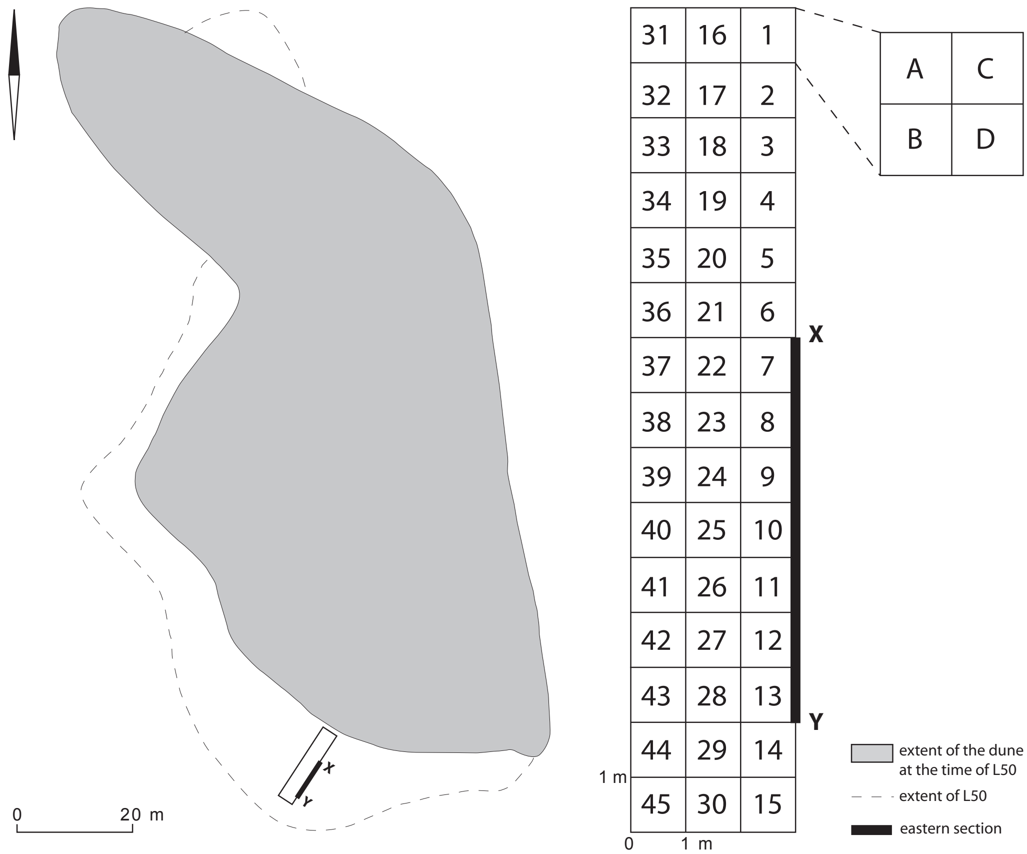


Figure II.3 Brandwijk-Kerkhof, location of the excavation trench and the plan of the excavation (based on Raemaekers 1999 and Verbruggen in prep.). The numbers in the figure represent square numbers that correspond with the sample numbers.

W.J. Kuijper and D. Paetzold analysed most of the macroremains in 1991, while W.J. Kuijper and W.A. Out identified the macroremains of some samples of layer 45 in 2006. The diagrams show absolute numbers of macroremains.[20] The plant taxa are separated into ecological groups, based on combinations of modern plant community classes (Schaminée *et al.* 1995-1999) and on the interpretation of the vegetation. Table II.3 shows the ecological groups that are distinguished. This classification is meant only as a method to analyse changes in the vegetation, since the distinction between some groups is not sharp and since some taxa are characteristic of more than one plant community. Prehistoric plant communities may furthermore possibly have differed from modern plant communities and modern ecology can only function as a comparison.

Wood and charcoal were collected by hand during excavation and from sieve residues samples (mesh width 2 mm). The investigated charcoal represents two samples of the layers 30, 50 and 60 that were all collected in different squares. D. Paetzold, C.E. Vermeeren and K. Hänninen identified the wood remains, while K. Hänninen identified the charcoal remains. In 2004 C.E. Vermeeren identified a knot of plant material with help of Schweingruber (1978).

20 *Epilobium hirsutum*-type represents *E. hirsutum*, *E. montanum*, *E. parviflorum*, *E. obscurum*, *E. roseum* and *E. tetragonum*. *Galeopsis bifida*-type represents *G. bifida*, *G. speciosa* and *G. tetrahit*. *Juncus effusus*-type represents 14 different species (Körber-Grohne 1964). *Ranunculus aquatilis*-type represents *Ranunculus* subgenus *Batrachium*. *Ranunculus repens*-type represents *R. acris/lingua/repens* but it probably refers to *R. repens* here. *Veronica beccabunga*-type refers to *V. anagallis-aquatica*, *V. beccabunga* and *V. catenata*.

ecological groups
1) Taxa of woodland and woodland edges of dry terrain.
2) Dryland ruderals and taxa that indicate recent disturbance of dry to slightly moist sediment.
3) Crop plants.
4) Wetland trees and shrubs.
5) Wetland herbs and spore plants of marsh and forb vegetation.
6) Wetland pioneers and wetland herbs that indicate disturbance.
7) Taxa indicative of open water.
8) Taxa that are not associated with specific ecologic conditions.
9) Varia, including archaeological remains, macroscopic plant remains such as bark, leaves and moss, animal remains and sand.

Table II.3 Brandwijk-Kerkhof, ecological groups used for the classification of macroremains.

II.3 Results

II.3.1 Macroremains analysis

II.3.1.1 Layer 30 (4610-4550 BC)

Table II.4 shows the results of eight samples collected from layer 30. Figure II.4 shows the number of macroremains and taxa of the lab sample for each ecological group. The macroremains of layer 30 were collected in only three adjacent excavation squares, since the refuse layer was only present in a few squares. The small number of samples and the relatively large number of handpicked samples restrict the representativity of the results. The assemblage consists of waterlogged and carbonised taxa (carbonised remains are further discussed below). Crop plants are absent in this layer, despite the presence of pottery and a few bones of domestic animals. All other ecological groups are represented by some taxa. Most plant species indicate moderate to very eutrophic conditions. Macroremains of trees, shrubs and herbs of woodland and woodland edges of dry terrain (group 1) are well represented, especially *Cornus sanguinea*, *Corylus avellana* and *Crataegus monogyna* that are probably overrepresented due to handpicked sampling. The sieve residue samples indicate that alder vegetation, marsh vegetation and open water were present nearby. The scarce taxa from groups 2 and 6, like *Chenopodium album* and *Persicaria* species, are characteristic of disturbance of the vegetation, probably due to anthropogenic influence.

sample	12	26 C	26 D	27 D	12	26D	27D	26D
sample type	hp	hp	hp	hp	sieve	sieve	sieve	lab
mesh width	-	-	-	-	1.5	1.5	1.5	0.25
volume (litre)	?	?	?	?	?	?	?	1
taxon								
Group 1								
Quercus sp.	-	-	-	-	-	-	-	-
Quercus sp., buds	5 cf.	-	-	10	+	-	-	-
Quercus sp., cupulae	4	-	-	6	1	-	-	-
Quercus sp., juvenile fruits and cupulae	7	-	-	4	-	-	-	-
Tilia platyphyllos	2	-	-	-	-	-	-	-
Tilia sp.	-	-	-	-	++	2	4	-
Malus sylvestris	-	-	-	-	1	-	-	-
Viburnum opulus	-	-	-	1	-	-	-	-
Cornus sanguinea	29	2	14	11	+	1	1	20
Corylus avellana	12	1	9	15	6, 2 c	1 c	2 c	2, 1 c
Crataegus monogyna	14	-	2	3	-	-	-	-
Glechoma hederacea	-	-	-	-	-	-	-	1
Alliaria petiolata	-	-	-	-	-	1	-	-
Chelidonium majus	-	-	-	-	3	-	-	-
Urtica dioica	-	-	-	-	++	-	+	++
Galium aparine	-	-	-	-	1 c	1 c	-	-
Group 2								
Atriplex patula/prostrata	-	-	-	-	-	-	1	-
Chenopodium album	-	-	-	-	8	6	-	-
Persicaria lapathifolia	-	-	-	-	2	3 cf.	-	-
Group 4								
Alnus glutinosa	-	-	-	-	+, 1 c	+, 2 c	+	++
Alnus glutinosa, buds	-	-	-	-	+	-	+	-
Alnus glutinosa, male catkins	-	-	-	-	1	-	-	+
Alnus glutinosa, cones	-	-	-	-	2	-	-	1
Group 5								
Alisma sp.	-	-	-	-	1	-	-	-
Carex acutiformis	-	-	-	-	1	-	1	-
Cladium mariscus	-	-	-	-	1	-	-	-
Schoenoplectus lacustris/ tabernaemontani	-	-	-	-	14, 2 c	4, 2 c	6	-

Table II.4 part 1.

sample	12	26 C	26 D	27 D	12	26D	27D	26D
Group 5 (cont.)								
Solanum dulcamara	-	-	-	-	2	1	-	-
Sparganium erectum	-	-	-	-	4, 1 c	-	1	-
Stachys palustris	-	-	-	-	1 cf.	-	-	-
Group 6								
Persicaria cf. minor	-	-	-	-	++	-	-	-
Persicaria hydropiper	-	-	-	-	+	-	-	-
Group 7								
Nymphaea alba	-	-	-	-	1	-	-	-
Potamogeton sp.	-	-	-	-	2	-	-	-
Ranunculus aquatilis-type	-	-	-	-	1	-	-	-
Trapa natans	-	-	-	-	-	-	1	-
Group 8								
Carex sp.	-	-	-	-	1	-	-	-
Fallopia sp./Persicaria sp./Polygonum sp.	-	-	-	-	4	-	1	-
Ranunculus repens-type	-	-	-	-	1	1	-	+
Rumex sp.	-	-	-	-	-	-	-	1
Galeopsis bifida-type	-	-	-	-	6	-	-	-
Stachys sp.	-	-	-	-	3	-	3	-

hp = handpicked sample
sieve = sample from sifting residue
lab = botanical sample

c = carbonised
x, yc = x macroremains of which y are carbonised
+ = few (1-10)
++ = some tens (10-49)
- = not present

Table II.4 Brandwijk-Kerkhof, layer 30, macroremains.

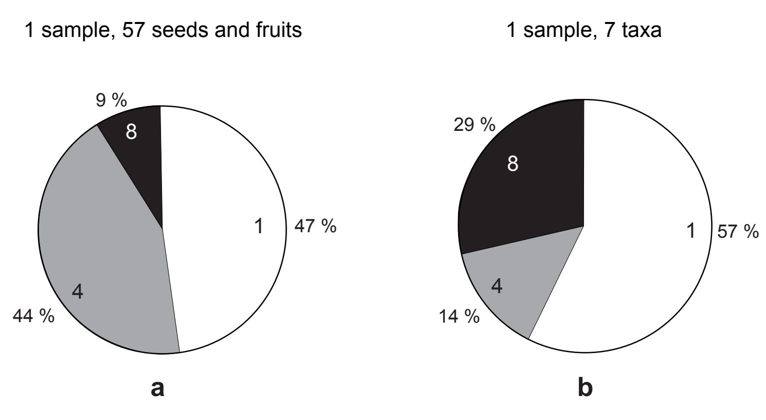


Figure II.4 Brandwijk-Kerkhof, layer 30, macroremains, lab sample, a) number of identifications and b) number of taxa, ordered by ecological group (see table II.3).

II.3.1.2 Layer 45 (4470-4370 BC)

Figure II.5 shows the macroremains diagram of layer 45. The lower part of the diagram probably shows clearance of *Alnus glutinosa* since fruits of this species are temporarily absent, and especially since *Urtica dioica* increases, combined with the presence of the wetland herbs *Galium palustre*, *Solanum dulcamara* and *Berula erecta*. The curve of sand, resulting from erosion and downwash, indicates the disturbance and open character of the southern slope with maximal values in the middle of the diagram. At this time alder carr mixed with *Cornus sanguinea* develops again, indicating that the diagram shows the rather local clearance of alder. In the upper part of the diagram the sedimentation of sand decreases, and *Moehringia trinervia* becomes an important element in the local vegetation. *M. trinervia* is a species common in woodland and shrub vegetation, preferring locations where organic material is decomposed at a high rate, for example due to changes in the water table or due to the increased presence of light (Weeda *et al.* 1985). The presence of *Tilia* sp. in the most upper samples probably demonstrates further recovery of the vegetation from human impact on the higher parts of the slope.

In comparison with layer 30, the diversity of marsh taxa (group 5) has increased, while the diversity of dryland woodland taxa has decreased. The changes in the diversity of marsh taxa and dryland woodland taxa can be related to the increasing water level. The only species found in a carbonised state is *Corylus avellana*, which may be related to restricted human impact during this occupation period and/or at the location of the sampling boxes. Crop plants were not found in this layer despite active searching in the available samples.

II.3.1.3 Layer 50 (4220-3940 BC)

The macroremains analysis of layer 50 is based on 11 sample box samples, five lab samples, and 20 samples that were handpicked or collected from sieve residues from 11 squares. The number of samples is large since this layer was rich in archaeological material, indicating intensive occupation. The results of all samples except for the box samples are shown in table II.5 (at the end of appendix II). The presentation of the results starts with a discussion of all samples together, followed by a discussion of the sample box samples and lab samples separately.

Compared to the earlier layers, the relative importance of the vegetation of woodland and woodland edges of dry terrain has decreased, while there is an increase in the diversity of taxa and number of macroremains of ruderals and disturbance indicators of both dry and moist to wet terrain (groups 2 and 6, especially *Chenopodium album*, *Solanum nigrum*, *Brassica rapa* and *Persicaria lapathifolia*). Both changes can be related to human activity and to the rise of the ground water level. The presence of remains of dryland taxa including *Tilia* sp. nevertheless indicates that at least patches of woodland remained present on the slope of the dune, and that anthropogenic influence probably did not lead to large-scale deforestation of the dune. The common presence of *Alnus* remains indicates the local presence of alder vegetation at the southern slope of the dune. *Alnus glutinosa*, taxa of forb and marsh vegetation (group 5) and indicators of open water have increased compared with the previous layers, which points to an increase in the ground water level. This must have led to gradual submerging of the dune and a shift of plant communities along the slope of the dune in an upward direction. An important difference with the previous layers is the presence of crop plants *Triticum dicoccon*, *Hordeum vulgare* var. *nudum* and *Papaver somniferum* ssp. *setigerum*, further discussed below.

Layer 50 provides extensive information on the marsh vegetation and water plants. Most marsh taxa point to stagnant to slowly running water of *c.* 50 cm depth, although a few species like *Apium nodiflorum* and *Berula erecta* tolerate quickly running water. The group of taxa that indicate open water includes both floating and submerged species, as well as rooting and non-rooting species. *Nymphaea alba* and *Nuphar lutea* point to a water depth of 1 to 2 metres. Other species, like *Ceratophyllum demersum* (pollen) and *Zachinellia palustris*, prefer water with a limited depth that warms in summer.

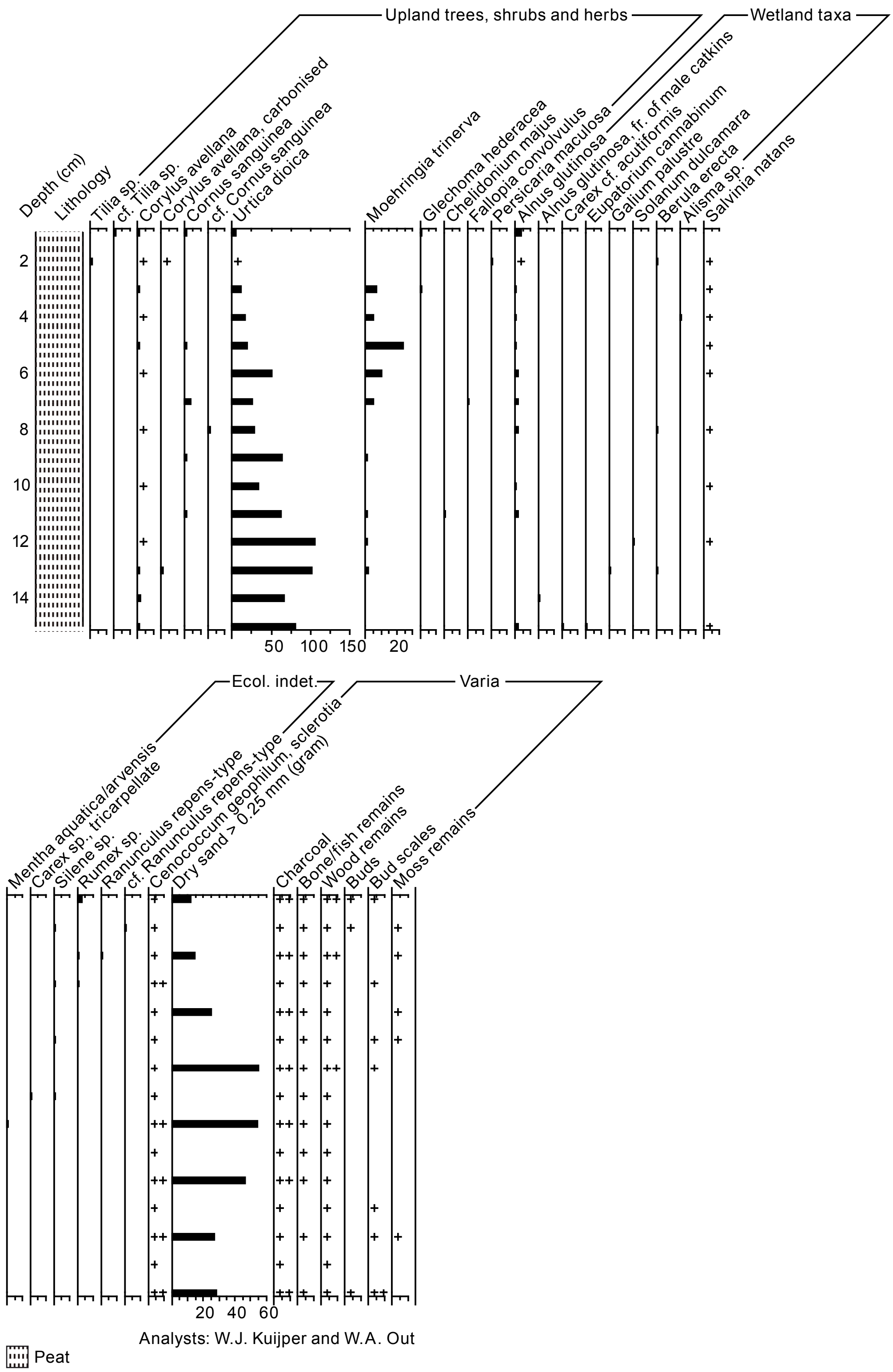


Figure II.5 Brandwijk-Kerkhof, eastern section of the excavation trench, layer 45, macroremains diagram, + = few (1-10), ++ = some tens (10-49).

The group of water plants contains thermophilous species, including *Trapa natans* and *Najas minor*. *T. natans* needs a temperature of 20 °C for flowering and 12-15 °C for germination of the fruits (Karg 2006). The remains of *T. natans* include bristles of spines. These fine bristles usually do not remain preserved after transport or collection, and their presence therefore indicates that *T. natans* grew in the extra-local vegetation. *T. natans* is no longer present in The Netherlands while *Najas minor* is very rare. The marsh taxa *Elatine triandra* and *Elatine hydropiper* were probably favoured by high summer temperatures as well (Brinkkemper *et al.* 2008).

II.3.1.4 Sample box samples layer 50

The stratigraphy of the complete layer 50 is somewhat complex. In the first place layer 50 was divided into two sublayers after excavation, the base of layer and the top of layer 50. The sublayers however cannot be recognised in the macroremains diagram and will therefore not be discussed. In the second place small cracks were present in the peat of layer 50, identified by micromorphological analysis and not visible during excavation. The presence of these cracks resulted in mixture of sediment of different occupation periods that together form layer 50. The results of the analysis of the sample box of layer 50 do however not give indications of mixing of layer 50 at the location where the box was sampled since the curves are rather smooth. There are moreover no indications that the peat suffered from intensive oxidation despite the presence of cracks in the peat (pers. comm. Verbruggen 2006).

Figure II.6 shows the macroremains diagram of layer 50. The sediment in the sample box consisted of peat (50-40 cm), sandy peat (39-8 cm) with minor quantities of clay in the upper 10 cm of the peat, and clay (7-0 cm). The sample location was *c.* 4 metres away from the dry surface of the dune during the formation of layer 50. The sample box samples reflect the development of the vegetation on the dune before, during and after occupation of layer 50. The two lower samples of the diagram represent layer 40, a non-anthropogenic layer. This layer nevertheless contains charcoal, bone and pottery remains. These archaeological remains probably represent material from the start of layer 50 or the transition to layer 50. The two samples show the local presence of dry woodland terrain with *Tilia* sp., *Corylus avellana*, *Cornus sanguinea*, *Glechoma hederacea* and *Moehringia trinervia*. Marsh vegetation, including alder and herb taxa, is present as well, but the variety of taxa is restricted and water plants are scarce.

The remaining part of the diagram represents layer 50 except for the highest sample. The curve of the sand combined with high values of bone, fish and pottery remains indicate that human impact is relatively strong in the middle part of the diagram, resulting in the disturbance of the vegetation and erosion of the dune. *Tilia* sp. has disappeared, which may indicate clearance or submerging of the woodland of dry terrain at the sampling location. Some other dryland trees and shrubs appear instead: *Quercus* sp., *Malus sylvestris* and *Viburnum opulus*. The finds of these taxa probably indicate the transition of relatively closed woodland into more open shrub vegetation. It can however not be excluded that all macroremains of shrubs have been transported by people to the spot together with resources (*e.g.* fuel or food). Remains of crop plants are present from 40 cm in layer 50, but only in very small numbers per sample. Ruderals, disturbance indicators and marsh taxa show increasing values and variety. These particularly include the taxa *Urtica dioica*, *Chenopodium album*, *Persicaria lapathifolia*, *Brassica rapa*, *Veronica beccabunga*-type, *Lythrum salicaria*, *Elatine hydropiper*, *Stellaria aquatica/media* and *Alisma plantago-aquatica*. The increase in these taxa in the middle of the diagram is probably related to human impact at the sample location, while the maximum at 7 cm is probably related to a decrease in the human impact that had previously prevented maximal growth of the taxa during occupation. The plants *Capsella bursa-pastoris* and *Polygonum aviculare* that are indicative of tread are present as well, representing open patches in the dryland vegetation caused by human impact. By 17 cm the assemblage of woodland of dry terrain taxa already changes, while *Alnus glutinosa* also increases, suggesting recovery.

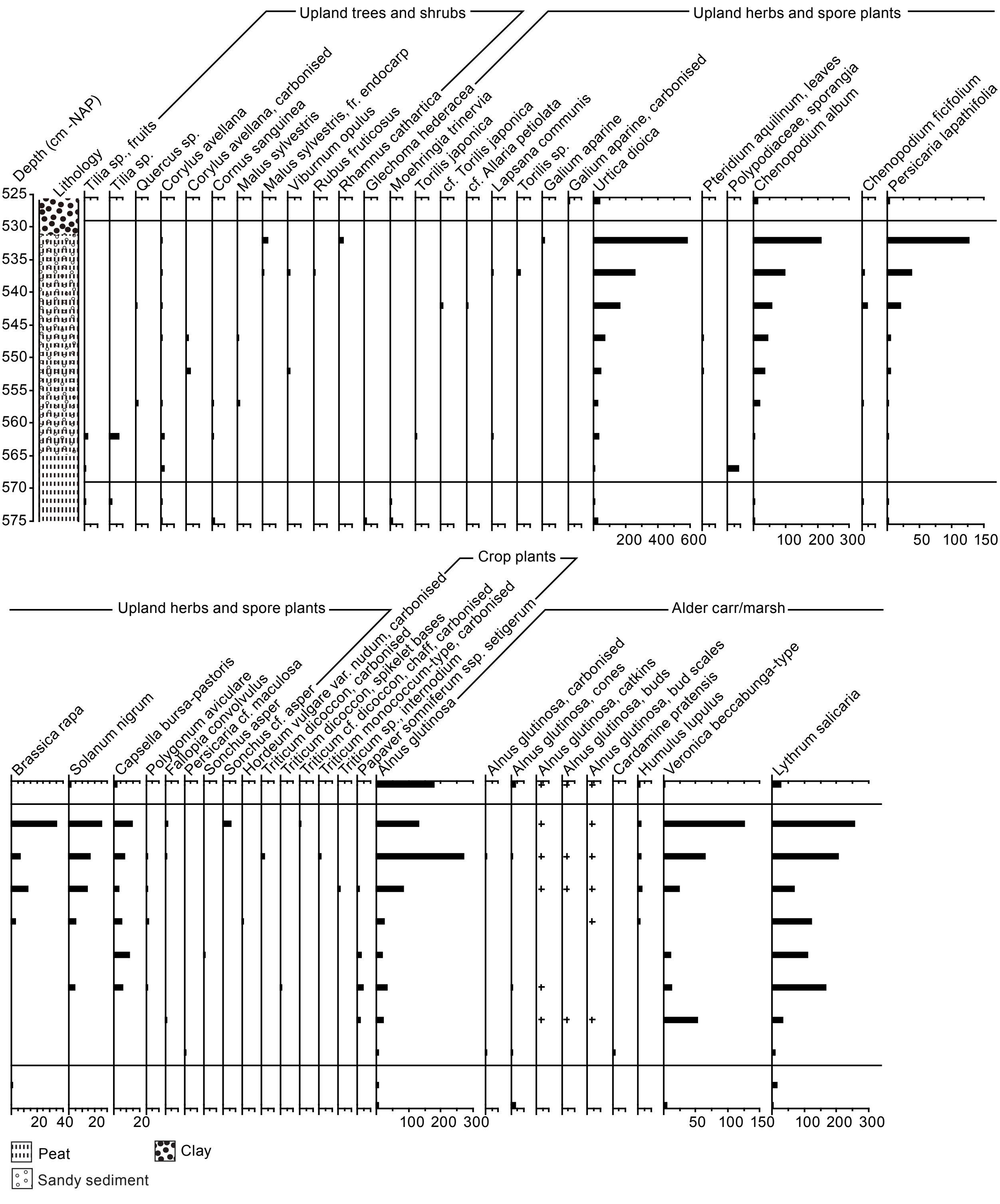


Figure II.6 part 1.

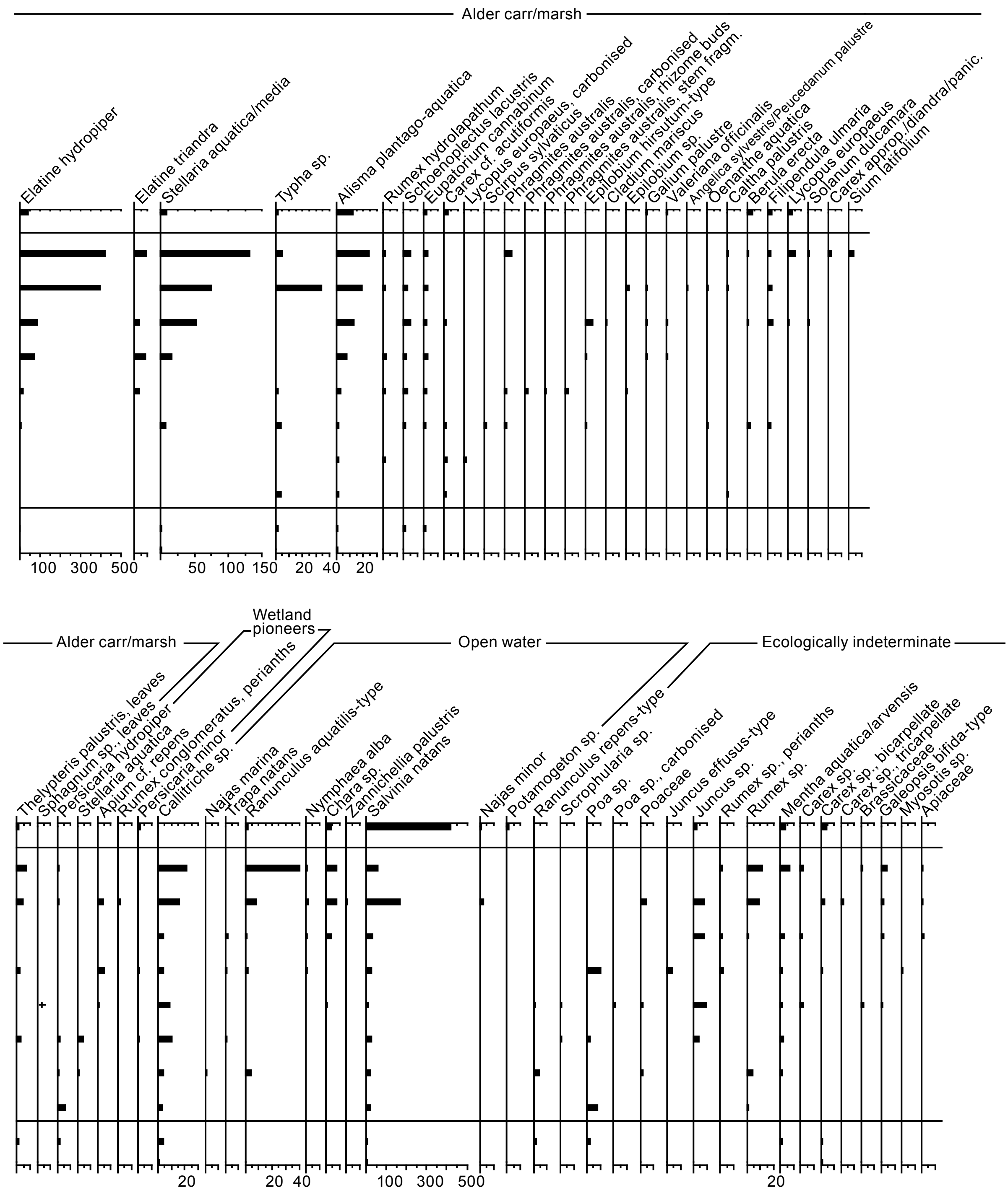


Figure II.6 part 2.

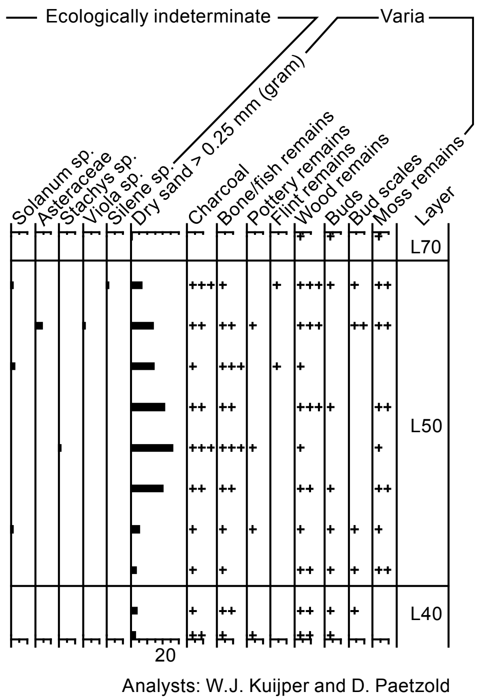


Figure II.6 Brandwijk-Kerkhof, eastern section of the excavation trench, layer 50, macroremains diagram (partly based on Paetzold unpublished data), + = few (1-10), ++ = some tens (10-49), +++ = many tens (50-99). The results are partly based on multiplications, part 3.

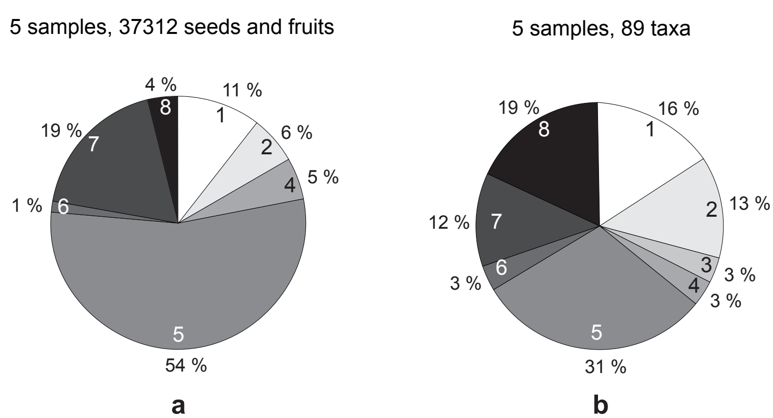


Figure II.7 Brandwijk-Kerkhof, layer 50, macroremains, all lab samples together, a) number of identifications and b) number of taxa, ordered by ecological group (see table II.3). The number of identifications is partly based on multiplications.

The open water taxa increase in the upper part of the diagram as well, indicating the presence of shallow pools and possibly of open water. The decreased occupation intensity at the locality may therefore be caused by the rise of the water level. The occupation does not end completely, as indicated by carbonised chaff of *Triticum* sp., some flint remains and a high value of charcoal at 7 cm (though vertical transport and colluviation processes may play a role as well; see Amkreutz *et al.* 2008).

The upper sample represents the clayey layer 70 (3760-3550 BC). The strongly deviating macroremains assemblage suggests that some erosion preceded the deposition of clay. Dryland woodland is replaced by alder carr with herb undergrowth. This sample interestingly contains a carbonised fruit of *Galium aparine*.

A moss species that was found regularly in the sample box samples of layers 45 and 50 is *Neckera crispa*. This species was probably a common epiphyte on old deciduous trees in moist woodland from 5000 BC until some centuries ago. In the Mesolithic and Neolithic the moss was probably used for domestic purposes. Another moss present at Brandwijk-Kerkhof is *Anomodon viticulosus*. Comparable with *Neckera crispa*, this species grows on bark of trees and also on calcareous rocks (but rocks were not naturally present at Brandwijk-Kerkhof).

II.3.1.5 Lab samples layer 50

Figure II.7 shows the number of macroremains and taxa from each ecological group of all the lab samples of layer 50. Figure II.8 shows the number of macroremains from each ecological group for each lab sample separately (N = 5). In contrast to the other layers, the number and distribution of lab samples makes it possible to compare the distribution of macroremains of layer 50 on the slope of the dune, although the number of samples is still small. The assemblage of sample 36.45, sampled relatively close to the top of the dune, contains mainly fruits of *Urtica dioica*, *Chenopodium album* and *Chenopodium ficifolium* (groups 1 and 2). The dominance of these very strong, resistant fruits indicates that selective corrosion influenced the composition of the sample. Sample 9.69, 2 to 3 metres further away from the top of the dune than the first sample (sample 36.45), shows a strong increase in the diversity of ecological groups. Marsh taxa (group 5) are the dominating ecological group, followed by undisturbed and disturbed dryland vegetation and indicators of open water (groups 1, 2 and 7), while *Alnus glutinosa* increases somewhat. The more important taxa are *Urtica dioica*, *Chenopodium album*, *Capsella bursa-pastoris*, *Lythrum salicaria*, *Salvinia natans*, and *Stellaria aquatica/ media*, probably representing the transition from dryland to wetland vegetation. Sample 27.7, 5 to 6 metres further away from the top than the first sample, shows again increasing percentages of water plants (group 7). The importance of dryland vegetation (groups 1 and 2) has decreased. The percentage of group 1 is still rather high, but this is misleading since it mainly represents fruits of *Urtica dioica*, which is not necessary part of vegetation of dry woodland and woodland edges. Group 8 (no ecological meaning) is well represented, suggesting that in this sample this group is associated with wetland vegetation. The samples 13.124 and 43.542 are both located at the same distance from the top of the dune (6 to 7 metres further downwards than the first sample). Plants of fresh water, marshes and riparian areas dominate in both samples. In conclusion, the lab samples from the top of the dune are rich in ruderals and indicators of disturbed dryland terrain as well as marsh taxa, and appear to be strongly influenced by selective corrosion. On the lower part of the dune slope the importance of marsh plants, riparian plants and water plants increases. This pattern can be linked to the level of the ground water level, resulting in a change in vegetation and preservation.

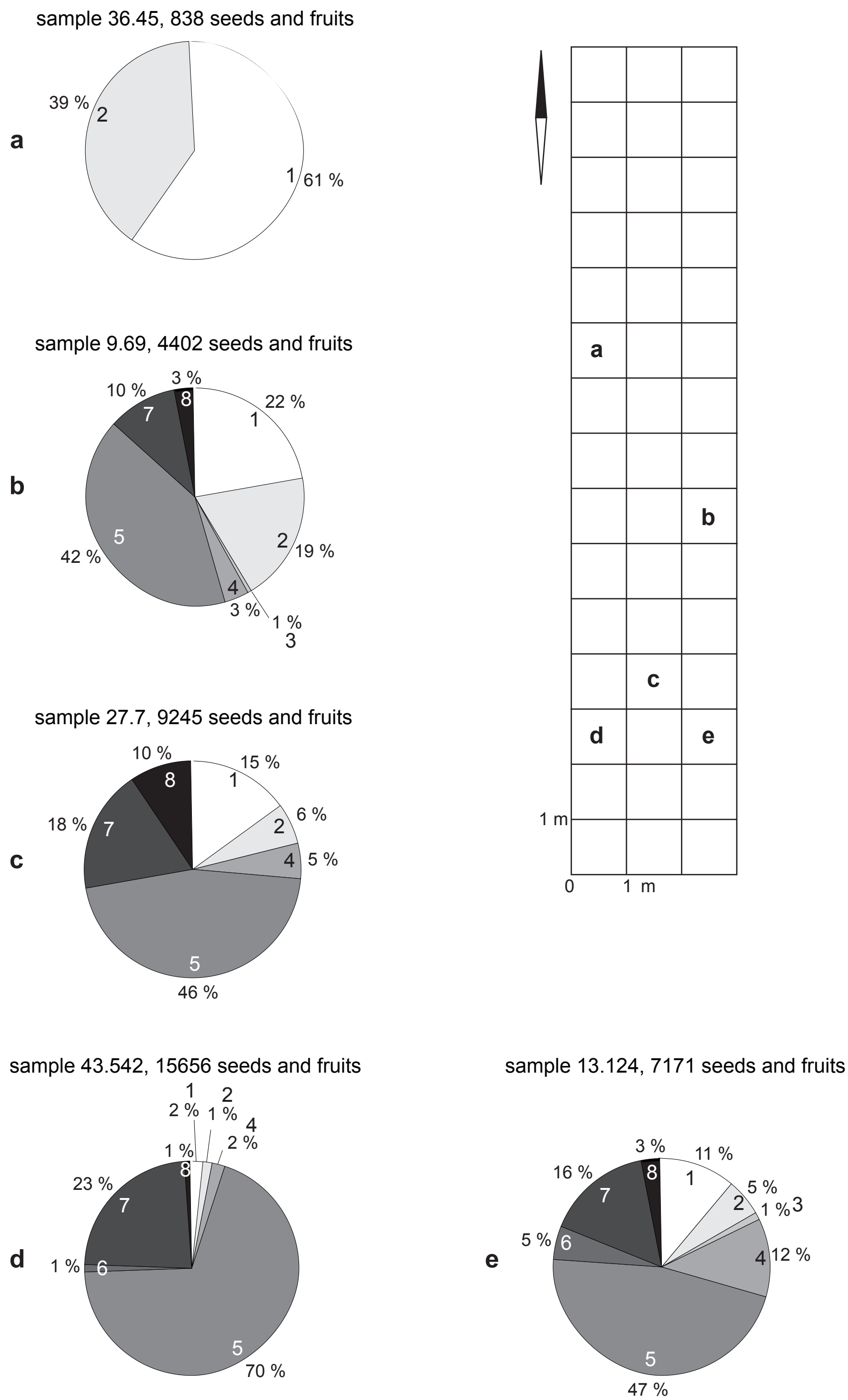


Figure II.8 Brandwijk-Kerkhof, layer 50, macroremains, individual lab samples (a-e), their location and the number of identifications, partly based on multiplications and ordered by ecological group (see table II.3).

II.3.1.6 Layer 60 (3940-3820 BC)

The analysis of layer 60 is based on three lab samples from two squares and sieving samples from seven squares (see table II.6). Figure II.9 shows the number of macroremains and taxa from each ecological group from all the lab samples of layer 60. The number of taxa in layer 60 is limited in comparison with layer 50, which is probably related to the lower number of samples. *Urtica dioica*, *Chenopodium album*, and additionally *Solanum nigrum* and *Stellaria aquatica/media* are present with numerous macroremains, indicating forb vegetation of disturbed, open, nutritient-rich terrain. Their dominance might partly be the result of selective corrosion. Both cereal species are present that were attested in layer 50, but *Papaver somniferum* ssp. *setigerum* is not present anymore. Figure II.10 shows the number of macroremains from each ecological group for each separate lab sample. Sample 21.26 is not representative since it contained few macroremains (the number of macroremains of water plants (group 7) for example is equal between sample 21.26 and sample 7.15). It is not possible to distinguish a gradient along the slope within the samples of layer 60 due to the small number of samples.

sample	7.15	20 C	20 D	21 C	22 C	22 D	23 D	24 C	24 D	25 D	7.15	7.54	21.26
sample type	hp	hp	hp	hp	hp	hp	hp	hp	hp	hp	lab	lab	lab
mesh width	-	-	-	-	-	-	-	-	-	-	0.25	0.25	0.25
volume (litre)	?	?	?	?	?	?	?	?	?	?	1	1	1
taxon													
Group 1													
Cornus sanguinea	-	-	-	25	3	7	-	-	-	1	2	-	-
Corylus avellana	-	3	1	4, 1 c	-	2, 1 c	3, 2 c	2	5	3, 1 c	1 c	1 c	1 c
Crataegus monogyna	-	-	-	1	-	-	-	1	-	-	-	-	-
Prunus spinosa	-	-	-	1	1	-	-	-	1	-	-	-	-
Urtica dioica	-	-	-	-	-	-	-	-	-	-	2096	1637	++
Galium aparine	1 c	-	-	-	-	-	-	-	-	-	-	-	-
Group 2													
Brassica rapa	-	-	-	-	-	-	-	-	-	-	12	2	-
Chenopodium album	-	-	-	-	-	-	-	-	-	-	748	255, 1 c	+++
Persicaria lapathifolia	-	-	-	-	-	-	-	-	-	-	4	-	-
Solanum nigrum	-	-	-	-	-	-	-	-	-	-	24	46, 2 c	1 c
Group 3													
Hordeum vulgare var. nudum	-	-	-	-	-	1 c	-	-	-	-	-	-	-
Hordeum vulgare, internodia	-	-	-	-	-	-	-	-	-	-	-	8 c	-
Hordeum vulgare/Triticum sp.	4 c	-	-	-	-	-	-	-	-	-	-	4 c	-
Triticum dicoccon	-	-	-	-	-	-	-	-	-	-	-	1 c	-
Triticum sp., glume bases	-	-	-	-	-	-	-	-	-	-	-	6 c	-

Table II.6 part 1.

sample	7.15	20 C	20 D	21 C	22 C	22 D	23 D	24 C	24 D	25 D	7.15	7.54	21.26
Group 5													
Alisma sp.	-	-	-	-	-	-	-	-	-	-	16	-	-
Carex acutiformis	1	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium cannabinum	-	-	-	-	-	-	-	-	-	-	-	1	-
Iris pseudacorus	-	-	-	-	1	-	-	-	-	-	-	-	-
Lycopus europaeus	-	-	-	-	-	-	-	-	-	-	20	-	-
Mentha aquatica/arvensis	-	-	-	-	-	-	-	-	-	-	16	-	-
Schoenoplectus lacustris/ tabernaemontani	-	-	-	-	-	-	-	-	-	-	-	1	-
Group 7													
Salvinia natans	-	-	-	-	-	-	-	-	-	-	++	-	++
Trapa natans	-	-	-	-	-	-	-	-	-	-	-	1 c	-
Group 8													
Rumex sp.	-	-	-	-	-	-	-	-	-	-	16 c	-	-
Stellaria aquatica/media	-	-	-	-	-	-	-	-	-	-	80	66	-
Group 9													
Cenococcum geophilum, sclerotia	-	-	-	-	-	-	-	-	-	-	-	-	+++

hp = handpicked sample
lab = botanical sample
c = carbonised
x, yc = x macroremains of which y are carbonised
+ = few (1-10)
++ = some tens (10-49)
+++ = many tens (50-99)
- = not present

Table II.6 Brandwijk-Kerkhof, layer 60, macroremains, part 2.

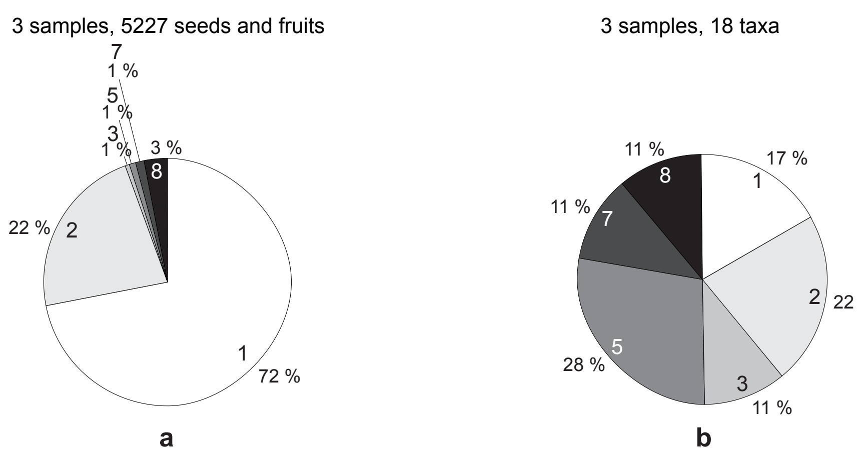


Figure II.9 Brandwijk-Kerkhof, layer 60, macroremains, all lab samples together, a) number of identifications and b) number of taxa, ordered by ecological group (see table II.3). The number of identifications is partly based on multiplications.

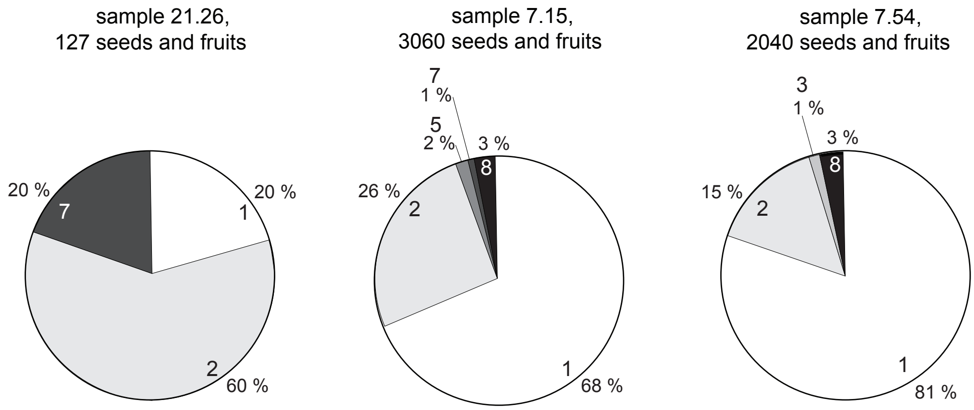


Figure II.10 Brandwijk-Kerkhof, layer 60, macroremains, individual lab samples, number of identifications, partly based on multiplications and ordered by ecological group (see table II.3).

II.3.1.7 Crop plants

Layer 50 and layer 60, dating to 4220-3820 BC, contained small quantities (*c.* 100 remains) of *Triticum dicoccon* and *Hordeum vulgare* var. *nudum*. These two cereals are commonly found at Early and Middle Neolithic Dutch wetland sites. In the samples of layer 50, containing most cereal remains, *T. dicoccon* is clearly dominant to *H. vulgare*. Layer 50 contained waterlogged and carbonised grains, glume bases and internodia of *Triticum dicoccon*, and waterlogged and carbonised grains and internodia of *Hordeum vulgare* var. *nudum*. Layer 60 contained a carbonised grain and carbonised glume bases of *Triticum dicoccon*, and carbonised grains and internodia of *Hordeum vulgare* var. *nudum*. A single grain of *Triticum monococcum*-type found in the material of layer 50, probably represents a grain of *Triticum dicoccon* that developed in the top of an ear. *Triticum monococcum*-type is very scarce in the Dutch wetlands (see chapter 11). The practice of local cereal cultivation is discussed in Out (2008a) and in the discussion below (paragraph II.4.3). It is concluded that crop cultivation was either practised on a small scale or that cereals were imported from elsewhere. Interestingly, the introduction of crop plants coincides with indications of the introduction of cattle and possibly domestic pig (see paragraph II.1), after the earlier presence of sheep/goat. The question raised is whether these patterns are related to each other and whether crop cultivation was more often introduced as part of a mixed farming system. Alternatively, both indications of increased agricultural activity at Brandwijk-Kerkhof could simply be related to increased occupation intensity during the formation of layer 50.

The presence of cereals in layers 50 and 60 is in contrast to the absence of cereals in layers 30 and 45. The number of analysed samples from layers 30 and 45 is somewhat small and the sampling strategy too restricted to establish the absence/presence of crop plants, which is due to the restricted thickness and extent of these layers. Layer 30, however, is contemporaneous with occupation at Hardinxveld-Giessendam where an absence of crop plants has been demonstrated (Bakels and Van Beurden 2001; Bakels *et al.* 2001). The sampled material from layer 45 consists of a monolith, but the analysis of 15 samples (volume 10 x 0.15 litres) sieved on a mesh width of 0.25 mm did not show any remains of crop plants. The transition to the use of crop plants as shown by the results of this analysis therefore seems to reflect the true transition to the adoption of crop cultivation at Brandwijk-Kerkhof. It is argued that the introduction of crop plants at Brandwijk-Kerkhof also represents the introduction of crop plants in the central river area, under the influence of contact with the Michelsberg culture (Out 2008a).

Layer 50 also contained waterlogged seeds of the crop plant *Papaver somniferum* ssp. *setigerum*. The significance of the absence of *Papaver somniferum* ssp. *setigerum* in layer 60 can be questioned in view of the selective corrosion mentioned above that affected the macroremains assemblage of layer 60 and the fact that *Papaver* seeds rarely remain preserved in a carbonised state. The importance and function (crop or weed) of the species at Brandwijk-Kerkhof is unclear; this is problematic for other Neolithic sites in Northwestern Europe as well (Bakels 1982). Firstly, poppy may have been part of the occupation waste instead of a plant that grew at the site, since its presence in the sample box samples corresponds with the presence of sand, charcoal and bone remains. Secondly, the scarcity of the species at other Early and Middle Neolithic Dutch wetland sites interestingly indicates that it was not a common species. The species was absent at Hardinxveld-Giessendam and the Hazendonk despite detailed archaeobotanical research there. Other finds from Dutch Neolithic wetlands are known from Schokland-P14, Vlaardingen and western Flevoland (see paragraph 11.2.1), but these may all represent younger finds. These results imply that opium poppy may have been imported to Brandwijk-Kerkhof. In regions south of the central river area, *Papaver somniferum* ssp. *setigerum* is known from the LBK (Bakels 2000), the Blicquy group (Belgium; Bakels *et al.* 1992) and the Michelsberg culture (northern France; Bakels 1999), of which the latter is contemporaneous with occupation at Brandwijk-Kerkhof.

II.3.1.8 Carbonised macroremains of non-cultivated plants

Presence of carbonised remains of edible parts of plants is generally used as an indication of use and/or consumption (see chapter 9). Table II.7 shows the carbonised plant remains of Brandwijk-Kerkhof. Taxa other than crop plants that were found in a carbonised state in more than one layer are *Corylus avellana, Galium aparine*, *Solanum nigrum*, *Alnus glutinosa*, *Schoenoplectus lacustris/tabernaemontani* and *Trapa natans*. Layer 50 contains the largest number of taxa found in a carbonised state, correlated with the high number of archaeological remains and botanical samples. Concentrations of carbonised plant remains were absent.

Taxa found in a carbonised state at Brandwijk-Kerkhof of which seeds and fruits, roots and/or leaves may have been consumed are *Corylus avellana*, *Quercus* sp., *Cornus sanguinea, Trapa natans*, *Schoenoplectus* sp., *Phragmites australis* and *Nymphaea alba*, and possibly *Chenopodium album*, *Rumex* sp. and *Poa* sp. Indications of consumption are the strongest for *C. avellana* since this species is present in most samples in a carbonised state, followed by remains of *Triticum dicoccon* (analysis with and without handpicked samples gives similar results). Nuts (*Corylus avellana*, *Quercus* sp. and *Trapa natans*) and tubers may have functioned as staple food since they have a high energetic value and can be stored after roasting and/or grinding. The carbonised remains of *Quercus* sp. however comprised only a single fragment of a cupula, which may represent waste from fuel instead of waste from food. Taxa that were only present in a waterlogged state at Brandwijk-Kerkhof and that also contain edible parts (seeds, fruits and/or roots s.l.) are *Malus sylvestris*, *Prunus spinosa*, *Crataegus monogyna*, *Rubus fruticosus*, *Allium* sp., *Pteridium aquilinum*, *Typha* sp., *Scirpus* sp. and *Nuphar lutea* (the selection of taxa that is presented here as edible is based on suggestions on edible plants from Bakels and Van Beurden 2001; Brinkkemper *et al.* 1999; Perry 1999). *Ranunculus ficaria*, another species with edible tubers, was not found in the assemblage, but is nevertheless expected in the environment of Brandwijk-Kerkhof as well, as suggested by finds at Hardinxveld-Giessendam and the Hazendonk.

The following taxa are found in a carbonised state at Brandwijk-Kerkhof but are not known as food plants: *Alnus glutinosa*, *Galium aparine*, *Galium palustre*, *Lycopus europeus*, *Solanum nigrum* and *Sparganium erectum*. The presence of such taxa in a carbonised state is comparable with other Dutch wetland sites and is further discussed in chapter 9. Plants may of course have been used in many other ways than for consumption, which may result in the carbonisation of macroremains as well. Use-wear analysis indeed indicates the use of plants in ways other than consumption, such as plant working including working of taxa like grasses or reed (Van Gijn *et al.* 2001, 190; Van Gijn and Verbruggen 1992).

layer taxon	L30	L45	L50	L60	L70
Group 1					
Quercus sp., cupulae	-	-	+	-	-
Cornus sanguinea	-	-	+	-	-
Corylus avellana	+	+	+	+	-
Galium aparine	+	-	+	+	+
Group 2					
Solanum nigrum	-	-	+	+	-
Chenopodium album	-	-	-	+	-
Group 3					
Hordeum vulgare var. nudum	-	-	+	+	-
Triticum dicoccon	-	-	+	+	-
Group 4					
Alnus glutinosa	+	-	+	-	-
Alnus glutinosa, cones	-	-	+	-	-
Group 5					
Galium palustre	-	-	+	-	-
Lycopus europaeus	-	-	+	-	-
Phragmites australis	-	-	+	-	-
Phragmites australis, stem fragments	-	-	+	-	-
Schoenoplectus tabernaemontani	-	-	+	-	-
Schoenoplectus lacustris/tabernaemontani	+	-	+	-	-
Sparganium erectum	+	-	-	-	-
Group 7					
Nymphaea alba	-	-	+	-	-
Trapa natans	-	-	+	+	-
Group 8					
Poa sp.	-	-	+	-	-
Rumex sp.	-	-	-	+	-

+ = present - = not present

Table II.7 Brandwijk-Kerkhof, carbonised macroremains from various layers. The data are based on lab samples, finds collected from the 1.5 mm sieve and handpicked finds.

II.3.1.9 Arable weeds

The analysis of arable weeds could possibly give more information as to whether crop plants were cultivated in the exploitation area of Brandwijk-Kerkhof or whether they were imported from elsewhere (see the discussion in Out 2008a and below). A major problem for the interpretation of potential arable weeds, however, is in distinguishing arable weeds as such. Many of the ruderals and indicators of disturbance found at Brandwijk-Kerkhof, represented by both pollen and macroremains, indicate ecological conditions that are more or less similar to the ecological conditions of arable weeds: disturbed and open soil, the presence of nutrients and the presence of light. These conditions are created and favoured when anthropogenic disturbance and/or arable farming takes place, both in modern and in prehistoric times. In the river area, however, natural processes also result in these conditions, especially at water edges. The river water is a source of nutrients, while water activity is a source of disturbance. Tree falls and wild animals cause disturbance of the soil as well. As a consequence, ruderals do not necessarily represent arable weeds. Potential arable weeds may therefore represent the natural vegetation, or arable weeds that were part of the weed vegetation of small arable plots, or weed macroremains that were imported to the site together with the crop product, or taxa that were introduced to the site together with the crop but that became part of the synanthropic vegetation despite the absence of arable fields. This complexity makes it difficult to reconstruct the status of potential arable weeds.

Carbonised macroremains that are found within concentrations of carbonised crop plants are generally considered as arable weeds, assuming that the crop plants and other taxa became carbonised during the same event of crop processing (Hillman 1981). Concentrations of crop plants were not found at Brandwijk-Kerkhof, however. This classic method can therefore not be used to identify the arable weeds.

Instead of the weed analysis as is commonly applied (based on Hillman 1981), it was first investigated which taxa were present in a carbonised state in samples that contain carbonised remains of crop plants. These include the taxa *Solanum nigrum*, *Chenopodium album*, *Poa* sp., *Corylus avellana*, *Cornus sanguinea*, *Alnus glutinosa*, *Schoenoplectus lacustris/tabernaemontani* and *Trapa natans*. All these species probably grew in the local and/or extra-local vegetation of Brandwijk-Kerkhof since they were also recovered in a waterlogged state and since their ecology is similar to the ecology of the vegetation present at Brandwijk-Kerkhof. Only the first three species (*Solanum nigrum*, *Chenopodium album*, *Poa* sp.) could represent potential arable weeds, considering their preferred ecological conditions. The other species, and possibly also *Chenopodium album* and *Poa* sp., could represent plant food or other use plants (discussed above).

As a second approach, a selection of potential arable weeds was made, including the herb taxa of all habitats where one could locate an arable field: woodland and woodland edges of dry terrain, grassland, and open and/or disturbed dry to slightly humid terrain.[21] Table II.8 shows the list of potential arable weeds found in the pollen and macroremains assemblages of Brandwijk-Kerkhof, separated by preservation type. The table shows the presence of carbonised and waterlogged macroremains of potential weeds for the site for layers without and with crop plants.

21 The selection of taxa is explained in chapter 10.

layer	L30 + L45			L50 + L60		
crop plants present	-			+		
category	C	W	P	C	W	P
taxon						
Alliaria petiolata	-	+	-	-	cf. +	-
Arctium cf. lappa	-	-	-	-	+	-
Artemisia sp.	-	-	+	-	-	+
Atriplex patula/prostata	-	+	-	-	+	-
Brassica rapa	-	-	-	-	+	-
Capsella bursa-pastoris	-	-	-	-	+	-
Cardamine pratensis	-	-	-	-	+	-
Chaerophyllum bulbosum/temulum	-	-	-	-	+	-
Chelidonium majus	-	+	-	-	-	-
Chenopodiaceae	-	-	+	-	-	+
Chenopodium album	-	+	-	+	+	-
Chenopodium ficifolium	-	-	-	-	+	-
Fallopia convolvulus	-	+	-	-	+	-
Polygonum convolvulus-type	-	-	-	-	-	+
Fallopia dumetorum	-	-	-	-	+	-
Galeopsis-type	-	+	-	-	+	-
Galium aparine	+	-	-	+	+	-
Galium sp.	-	-	-	-	+	-
Glechoma hederacea	-	+	-	-	-	-
Hypericum cf. tetrapterum	-	-	-	-	+	-
Lapsana communis	-	-	-	-	+	-
Luzula sp.	-	-	-	-	+	-
Moehringia trinervia	-	+	-	-	+	-
Persicaria lapathifolia	-	+	-	-	+	-
Persicaria cf. maculosa	-	+	-	-	+	-
Polygonum persicaria-type	-	-	-	-	-	+
Plantago lanceolata	-	-	-	-	-	+
Polygonum aviculare	-	-	-	-	cf. +	-
Silene sp.	-	+	-	-	+	-
Solanum nigrum	-	-	-	+	+	-
Sonchus asper	-	-	-	-	+	-
Sonchus sp.	-	-	-	-	+	-
Stellaria media	-	-	-	-	+	-
Torilis japonica	-	-	-	-	+	-
Torilis sp.	-	-	-	-	+	-
Urtica dioica	-	+	-	-	+	-
Valeriana officinalis	-	-	-	-	+	-

Table II.8 Brandwijk-Kerkhof, potential arable weeds from the layers without crops plants and the layers with crop plants. C = carbonised macroremains, W = waterlogged macroremains, P = pollen, + = present, - = not present.

The potential arable weeds that were found in a carbonised state are more likely to represent arable weeds since the carbonised state indicates that they were handled by people. The potential arable weeds found in a carbonised state are *S. nigrum*, *C. album*, *Poa* sp., *Galium aparine* and *Rumex* sp. All taxa found in a carbonised state except for *Rumex* sp. were present in samples that contained carbonised remains of cereals as well, supporting that they may represent arable weeds. Only *S. nigrum* and *G. aparine* were present in a carbonised state in more than one sample that contained carbonised cereal remains. The taxa that probably represent arable weeds are not indicative of specific soils and/or locations (*cf.* Bakels 2000). All potential weeds found in a carbonised state were furthermore also found in a waterlogged state at Brandwijk-Kerkhof, which suggests that they were part of the local vegetation, and were already present in the region before the introduction of crop plants (only *Poa* sp. is found only once, but Poaceae were common in the region; see Bakels *et al.* 2001 and Bakels and Van Beurden 2001). The possibility that these taxa represent field weeds does therefore not argue against local crop cultivation or non-local crop cultivation.

Comparison of the potential arable weeds present in the layers without crop plants (layers 30 and 45) and layers with crop plants (layers 50 and 60) shows that the latter layers contain 19 taxa that were not present before (see table II.8). Some of these taxa are the oldest finds from the central river area: *Brassica rapa*, *Cardamine pratensis*, *Chaerophyllum bulbosum/temulum*, *Hypericum cf. tetrapterum*, *Lapsana communis*, *Luzula* sp. and *Polygonum aviculare*. The first presence of some of these taxa may be the result of the introduction of crop plants, and it is therefore possible that some of the taxa represent arable weeds. The evidence is weak, however, since the taxa are only found in a waterlogged state, and since alternative explanations such as increased human impact could also explain the presence of some taxa. Therefore, the introduction of these taxa at the wetlands remains a subject for future research (see also chapter 10).

II.3.2 Wood and charcoal analysis

The analysis of wood and charcoal remains is based on Hänninen and Vermeeren (1998). Table II.9 shows the results of the analysis of wood remains. The analysed wood remains (N = 71) originate from seven different layers.[22] Only the number of remains of layer 50 approaches a representative sample size. *Alnus* sp., *Quercus* sp. and *Corylus* sp. dominate the wood assemblage of all layers together. The finds include pointed wood remains interpreted as posts, worked wood remains (apart from the pointed remains) and unworked wood remains. Twelve of the wood remains were partly carbonised, this mainly includes unworked wood remains that may represent fuel.

The worked wood remains comprised all taxa that are represented in the wood assemblage and likely represent (the remains of) artefacts or the waste material of wood working, but artefacts with a known function other than posts were not recognised. The assemblage of layer 50 contains two pieces of *Quercus* sp. that are cleaved in a radial direction (see fig. II.11). These wood remains may possibly represent elements of the bottom of small containers comparable with casks (see Leuzinger 2002, 95-98, discussing wooden artefacts of *Quercus* sp. found at the wetland site Arbon Bleiche 3 in Switzerland with similar dimensions as the artefact found at Brandwijk-Kerkhof) or alternatively a canoe partition (see Eberschweiler 2004; Louwe Kooijmans and Kooistra 2006).

22 Comparison with table II.2 shows that dates are not available for all layers.

layer	L15			L30			L40			L50		
category	NW	P	W	NW	P	W	NW	P	W	NW	P	W
taxon												
Alnus sp.	-	1	-	-	-	-	1	1	1+1?	13	1?	1+1?
cf. Alnus sp.	-	-	-	-	-	-	-	-	-	2	-	-
Cornus sp.	-	-	-	-	-	-	-	-	-	4	-	1
Corylus sp.	-	1?	-	-	-	-	2	-	-	5	1	-
Euonymus sp.	-	-	-	-	-	-	-	-	-	-	-	1
Fraxinus sp.	-	-	-	-	1+1?	-	1	-	-	1	-	-
Pomoideae	-	-	-	-	-	-	1	-	-	-	-	1
Quercus sp.	-	2	-	-	-	-	-	-	1?	-	2	2+1?
Viburnum sp.	-	-	-	-	-	-	-	-	-	-	-	1?
Indet./bark	-	-	-	-	-	-	2	-	-	8	-	-
total		3+1?			1+1?		7	1	1+2?	33	3+1?	6+3?

layer	L55			L60			L80			all layers			total	
category	NW	P	W	NW	P	W	NW	P	W	NW	P	W	N	%
taxon														
Alnus sp.	-	-	-	1	1	-	-	-	-	15	3+1?	2+2?	23	32
cf. Alnus sp.	-	-	-	-	-	-	-	-	-	2	-	-	2	3
Cornus sp.	1	-	-	-	-	-	-	-	-	5	-	1	6	8
Corylus sp.	1	-	-	-	-	-	-	-	1?	8	1+1?	1?	11	16
Euonymus sp.	-	-	-	-	-	-	-	-	-	-	-	1	1	1
Fraxinus sp.	1	-	-	-	-	-	-	-	-	3	1+1?	-	5	7
Pomoideae	-	-	-	-	-	-	-	-	-	1	-	1	2	3
Quercus sp.	-	-	-	2	-	-	-	-	-	2	4	2+2?	10	14
Viburnum sp.	-	-	-	-	-	-	-	-	-	-	-	1?	1	1
Indet./bark	-	-	-	-	-	-	-	-	-	10	-	-	10	14
total	3			3	1				1?	46	9+3?	7+6?	71	

NW = non-worked
P = pointed
W = worked in another way than pointed
- = not present
? = possibly belonging to a specific category

Table II.9 Brandwijk-Kerkhof, wood from various layers (Hänninen and Vermeeren 1998).

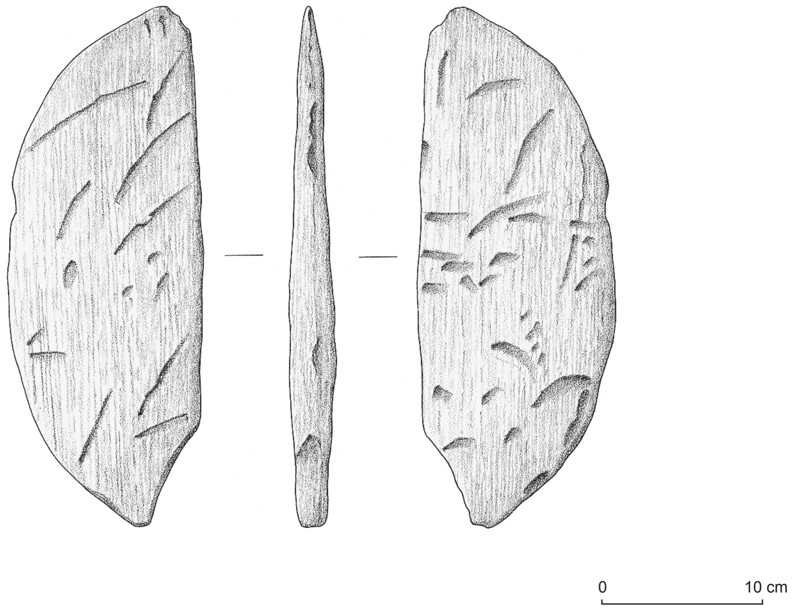


Figure II.11 Brandwijk-Kerkhof, layer 50, worked piece of wood of *Quercus* sp., cleaved in radial direction from the tree, drawing: E. van Driel after Jeltje Schreurs.

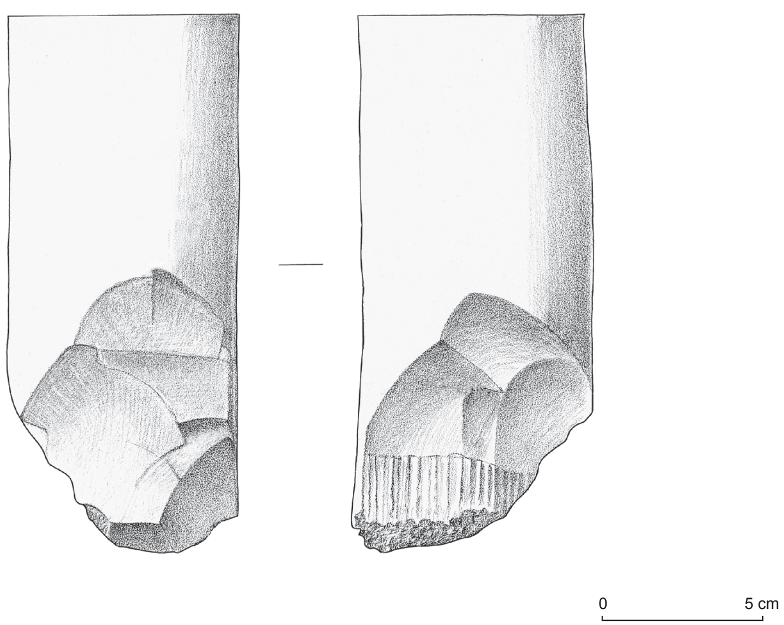


Figure II.12 Brandwijk-Kerkhof, layer 50, pointed post of *Quercus* sp., drawing: E. van Driel after Jeltje Schreurs.

The identified pointed posts are from *Alnus* sp., *Corylus* sp., *Fraxinus* sp. and *Quercus* sp. Most posts are pointed relatively simply (see fig. II.12 for an example). In a preliminary publication a row of pointed posts is mentioned (Van Gijn and Verbruggen 1992). The structure consisted of pointed posts of *Alnus* sp., *Corylus* sp. and *Quercus* sp., found in the adjacent squares 10 and 25 at a distance of *c.* 0.5 metres from each other[23] (Van Poecke 1991). The function of the posts is unclear; they may have functioned as a landing stage since the posts were probably located at the water edge. Wattle work was not found in between the posts.

There are only weak indications of the selective use of wood based on the quality of the wood and the functions of artefacts, since artefacts were not recognised in the wood assemblage. Firstly, *Quercus* sp. may have been selected for its qualities concerning construction since the number of pointed and worked wood remains made of *Quercus* sp. is larger than the number of unworked wood remains made of *Quercus* sp. (see table II.9). Secondly, *Euonymus* sp. (representing *E. europaeus*) was only found in a worked state. It is possible that *Euonymus* sp. was imported from elsewhere, since pollen and seeds of this species were not found at the site, which could indicate selective use. On the other hand, the species might have been attested in the assemblage of the unworked wood if the number of identified wood remains had been larger. Finally, the evidence of the selective use of wood from contemporaneous sites in the region (Louwe Kooijmans *et al.* 2001a, b; appendix III) indicates that the selective use of wood based on the quality of the wood was probably not uncommon at Brandwijk-Kerkhof.

The season of cutting was determined for two wood remains of layer 15 as summer/autumn and probably autumn, and for two wood remains of layer 50 as spring/summer and probably autumn. For both layers the results do not necessarily mean that the site was occupied in both seasons during the same year.

Table II.10 shows the results of the charcoal analysis. The analysis included 109 pieces from three layers (other layers contained charcoal remains as well but these were not investigated). The number of samples of layer 50 is too small to be representative (Hänninen and Vermeeren 1998) and the number of charcoal

	N				%			
layer taxon	L30	L50	L60	total	L30	L50	L60	total
Alnus sp.	24	18	41	83	92	64	75	76
Cornus sp.	-	1	1	2	-	4	2	2
Corylus sp.	-	4	3	7	-	14	5	6
Fraxinus sp.	2	1	4	7	8	4	7	6
Quercus sp.	-	-	3	3	-	-	5	3
Viburnum sp.	-	1	-	1	-	4	-	1
Indet.	-	3	3	6	-	11	5	6
total	26	28	55	109				

- = not present

Table II.10 Brandwijk-Kerkhof, charcoal from various layers (Hänninen and Vermeeren 1998).

23 The series of pointed posts dates to L50 or L60. It is not certain whether the information on the identifications of the posts of the structure is complete.

identifications of individual phases is too small to reconstruct changes in the vegetation through time. *Alnus* sp. is the dominant taxon in the assemblage of all layers together. Layer 30 contained only remains of *Alnus* sp. and *Fraxinus* sp. Layer 50 contains an increased number of taxa, dominated by *Alnus* sp. and afterwards *Corylus avellana*. The assemblage of layer 60 is highly similar to the assemblage of layer 50. There are indications of the use of wood affected by fungi and insects, probably dead wood. Interestingly, carbonised ants were even present in a piece of alder wood; these probably represent *Lasius fuliginosus*, see figure II.13 (the shining black ant, nestling in decaying or dead trees, pers. comm. Hakbijl in Hänninen and Vermeeren 1998).

Comparison of the wood and charcoal assemblages indicates that *Euonymus* sp. and Pomoideae are present in the wood assemblage but absent in the charcoal assemblage. There are not enough data to conclude whether *Euonymus* sp. was present in the local vegetation or not. Pomoideae may represent *Malus sylvestris*, *Pyrus pyraster*, *Crataegus monogyna* and/or *Sorbus aucuparia*. Only seeds and fruits of *Malus sylvestris* and *Crataegus monogyna* have been found at Brandwijk-Kerkhof, so the wood probably represents one of these two species. The numbers of macroremains indicate that both were probably present in the local vegetation although collection probably played a role as well.

Sample 13.124 contained a knot made of bark of *cf. Acer* sp./*Ulmus* sp. Bark of *Acer* sp./*Ulmus* sp. was used for knots at Hardinxveld-Giessendam Polderweg as well (Louwe Kooijmans *et al.* 2001b) and thus might indicate the selective use of taxa. The many fish scales in the sample and the location of this sample indicate that the knot may have been part of fishing gear.

Figure II.13 Brandwijk-Kerkhof, layers 30 and 50, carbonised ant, *cf. Lasius fuliginosus*, magnification 20 x.

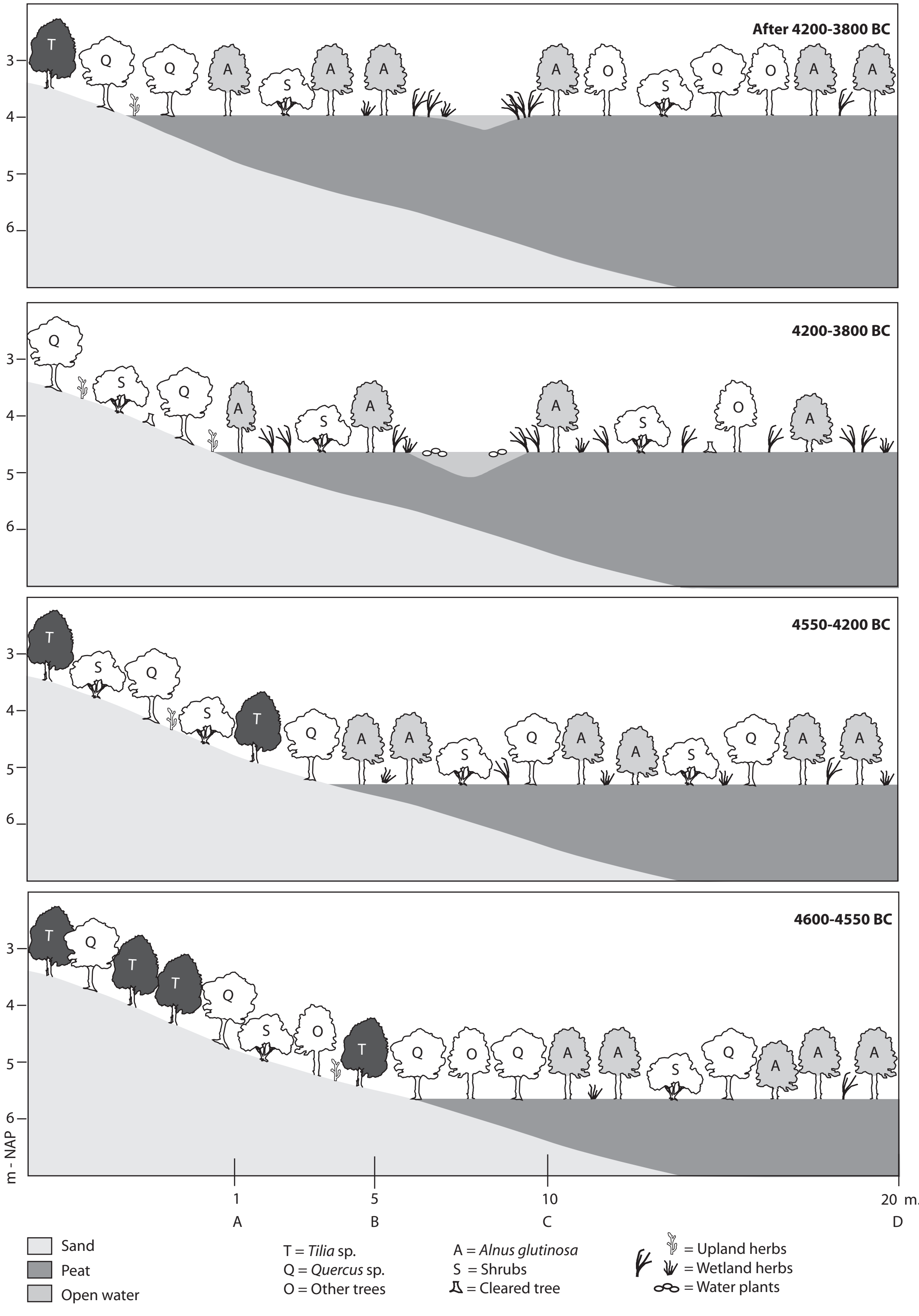
II.4 Discussion

II.4.1 Reconstruction of the natural vegetation

The main results on the natural vegetation based on the pollen and macroremains of the four cores taken north of the dune are summarised here, while the results on human impact are discussed in the next paragraph (both based on Out 2008a). Four cores were sampled north of the dune at 1, 5, 10 and 20 metres distance respectively from where the peat that was formed during deposition of layer 50 was attached to the dune sand. Figure II.14 schematically shows the development of the vegetation based on the analysis of these cores. The top of the dune (0.5 m -NAP) is not shown in the figure. The four reconstructions correspond with the period of the formation of layer 30 (4600-4550 BC), the period before layer 50 (4550-4200 BC), layer 50 and/or 60 (4200-3800 BC), and the period of recovery after layer 50 and/or 60 (after 3800 BC).

The reconstruction of the vegetation based on the four cores indicates that the natural vegetation of the higher parts of the dune at Brandwijk-Kerkhof consisted of deciduous *Tilia*/*Quercus*/*Corylus* woodland. The vegetation on the lower slopes and in the surrounding wetland area consisted of alder carr and eutrophic freshwater marsh vegetation. This vegetation was present during all registered occupation phases. The increasing ground water level resulted in the general succession of the vegetation of the dune slope from woodland of dry terrain into woodland of moist terrain and/or marsh and open water. This succession resulted in a decrease in the quantity of woodland of dry terrain at the dune. Open water became present in the near surroundings of the dune (west of the sample locations) at 4200-3800 BC. After 3800 BC, the open water was still present but probably further away from the sampling points. The presence of macroremains of dryland trees (*Tilia* sp., *Quercus* sp., *Fraxinus excelsior* and *Corylus avellana*) indicates that dryland woodland was still present at the dune during the later occupation phases, although alder carr probably dominated on the lower and middle parts of the slopes.

The analysis of macroremains, wood and charcoal from the excavation that is presented here supports the earlier presented reconstruction of the natural vegetation and does not result in important alterations of the reconstruction. Woodland of dry terrain, alder carr vegetation, marsh vegetation and water plants form the major elements of the natural vegetation. Most taxa indicate moderately to highly eutrophic conditions. Some parts of the vegetation may have been rather dense, as demonstrated by the presence of woodland of dry terrain and indicators of partly shaded terrain (*Polypodium vulgare*, *Galeopsis*-type and *Moehringia trinervia*). Comparison of layer 30 and layer 50 shows a decrease in the importance of dryland vegetation and an increase in marsh vegetation, which can be related to the rise of the ground water table. The assemblage of layer 60, which contains several macroremains of dryland shrubs in a primarily waterlogged state, supports the presence of woodland of dry terrain after the main occupation. During formation of layer 70 however, woodland of dry terrain on the slopes was replaced by alder carr at the location of the excavation trench as a result of the submerging of the dune.


After 4200-3800 BC
4200-3800 BC
4550-4200 BC
4600-4550 BC
m - NAP
3
4
5
6
1
A
5
B
10
C
20 m.
D
Sand
Peat
Open water
T = *Tilia* sp.
Q = *Quercus* sp.
O = Other trees
A = *Alnus glutinosa*
S = Shrubs
= Cleared tree
= Upland herbs
= Wetland herbs
= Water plants

The presence of especially *Quercus* sp. and in lesser degree other trees (possibly *Fraxinus* sp., *Ulmus* sp. and *Acer campestre*) in the marsh, as drawn in figure II.14, is the subject of debate since parallels for bog oaks are not known from recent vegetation types. Oaks and other trees of softwood alluvial woodland Alno-Padion and/or Filipendulo-Alnetum, see references below) can grow in marshes when growing on a mineral subsurface or on peat containing a small quantity of clay. Germination of seedlings of at least oak and ash is possible during phases of increased drainage of the marsh, possibly as the result of flooding or channel activity (Kooistra *et al.* 2006; Sass-Klaassen and Hanraets 2006). The pollen diagrams of the two cores sampled at 10 and 20 metres away from the dune show values of *Quercus* sp. that are relatively low compared with values of *Alnus* sp., but the macroremains show considerable quantities of buds and/or bud scales of *Quercus* sp. It can be questioned whether the bud scales were blown away from trees present at the dry surface or that they represent the local presence of oaks. It is unclear whether the absence of other macroremains is indicative of absence of local oaks. The most parsimonious interpretation therefore is to reject local presence of *Quercus* sp. in the marsh. The study of wetland wood at Zwolle-Stadshagen however represents an interesting parallel that supports that local presence of oak in the marsh at Brandwijk-Kerkhof is possible. At Zwolle, the pollen curves of *Quercus* sp., *Fraxinus* sp. and *Ulmus* sp. were again very low compared with *Alnus* sp., and the diagram was interpreted as representing alder carr (Alnetea glutinosae). Complete trees of *Quercus* sp., *Fraxinus* sp. and *Ulmus* sp. were however found in the peat, indicative of local presence. Clay was only observed in the relevant horizons during micromorphological analysis (Kooistra *et al.* 2006; Sass-Klaassen and Hanraets 2006). Interestingly, the germination of seedlings at Brandwijk-Kerkhof during later phases could have been triggered during relative dry periods. Micromorphological analysis of the sediment in the excavation trench indeed supported that the peat dried out during a short period (pers. comm. Verbruggen 2006, see the results of layer 50 in paragraph II.3.1). The sample box of layer 50 furthermore contained minor quantities of clay, and even smaller quantities of clay may similarly have been present in the peat north of the dune during that phase. The conditions therefore may have enabled the occurrence of *Quercus* sp. In addition, clearance of vegetation during occupation may have decreased competition, resulting in better possibilities for germination as well (*cf.* Sass-Klaassen and Hanraets 2006). The presence of bog oaks at Brandwijk-Kerkhof could have been studied in better detail if the wood remains found in the cores had been identified. The systematic identification of wood from pollen cores is therefore suggested for future research.

The macroremains from the excavation show the presence of a shrub species that was not present in the cores: *Crataegus monogyna*. The species was probably present in the local vegetation in moderate or low quantities. It is unclear whether the wood and charcoal data support a local presence since it is not possible to identify wood remains of the species on species level. The local presence of *Tilia* sp., *Rhamnus cathartica*, *Acer campestre*, *Ulmus* sp., *Ligustrum vulgare*, *Sambucus nigra*, *Prunus* sp. is additionally indicated by the pollen and/or macroremains assemblage, but these taxa were not found in the wood and charcoal assemblage either. This difference between the various assemblages may be related to the limited size of the excavation and the limited number of samples of wood and charcoal. The scarcity of some shrubs in the natural vegetation may additionally play a role as well. *Tilia* sp. is usually found in low quantities at excavations at Dutch wetland sites, probably due to the soft wood. Remains of *Ulmus* sp., *Betula* sp. and *Salix* sp. were only found in the pollen assemblage.

Figure II.14 opposite page, Brandwijk-Kerkhof, periods corresponding with the various layers, schematic vegetation reconstruction of the vegetation at the northern side of the dune, based on (partial) analysis of pollen and macroremains of four cores. The vegetation icons are not to scale. The group of 'shrubs' includes *Corylus avellana, Rhamnus cathartica, Cornus sanguinea, Crataegus monogyna, Prunus spinosa, Sambucus nigra, Viburnum opulus, Ligustrum vulgare, Rubus fruticosus, Rhamnus frangula* and *Myrica* sp. *C. avellana*, a dryland shrub, may also have been present as a tree. The group of "other trees" include *Fraxinus excelsior, Ulmus* sp. and *Acer campestre*, which may have been more common than suggested in the reconstruction. *Salix* sp. may additionally have been present along the open water. The group of wetland herbs also include grasses and sedges. See the text for further explanation.

Ulmus sp. and *Salix* sp. may nevertheless have been present in the extra-local vegetation in low quantities, since macroremains of these taxa usually do not remain preserved. The scarcity of remains of *Betula* sp. probably reflects the scarcity of the taxon at Brandwijk-Kerkhof. *Sambucus* sp. was only found in the pollen assemblage and not in the macroremains, wood or charcoal assemblage. The absence of fruits of *Sambucus* sp. remains unexplained. A larger data set of wood and charcoal might have revealed *Sambucus* sp. after all.

Marine influence at Brandwijk-Kerkhof seems to have been absent or very small. Pollen of *Armeria maritima* was present in one of the pollen cores (Out 2008a), which is characteristic of high salt marshes. It was probably transported by water during a heavy storm or by wind and does not represent the local vegetation since it is represented by a single pollen grain only. Other pollen diagrams of sites in the central river area occasionally contain pollen of halophytic taxa as well (see chapter 2.8.2). At Brandwijk-Kerkhof there are also some species that do not need but nevertheless tolerate brackish water (*Najas marina*, *Zachinellia palustris*, *Phragmites australis* and *Schoenoplectus tabernaemontani*). The presence of major marine influence at Brandwijk-Kerkhof is however excluded by the absence of macroremains of taxa that exclusively grow under brackish/marine conditions and by the dominance of taxa that do not tolerate marine influences (*Berula erecta*, *Hydrocotyle vulgaris* and many others; Cappers 1994). The presence especially of *Elatine triandra* suggests fluctuating water levels (Brinkkemper *et al.* 2008).

II.4.2 Human impact

The indications of human impact based on the pollen cores are discussed elsewhere (Out 2008a), but the main results will be briefly mentioned here (see also figure II.14). At 4600-4550 BC, human impact was restricted, resulting in a slight increase in herbs and shrubs. It cannot be excluded that natural processes played a role as well in the observed changes in the vegetation. At 4550-4200 BC, alder carr became more dominant on the lower slopes of the dune. The vegetation became more open due to restricted human impact and/or natural disturbance, as indicated by the increase in shrubs. At 4200-3800 BC, open water became present in the near surroundings of the dune (west of the four cores). Human impact was maximal, resulting in the clearance of trees and more open vegetation. Only the changes in the pollen diagram contemporaneous with this period (the top of layer 50 and/or 60) can accurately be attributed to human impact. Signals of human impact are characterised by a slight decrease in *Tilia* sp., a decrease in macroremains of *Alnus* sp. and an increase in the dryland shrubs, dryland herbs that are characteristic of human impact (*Artemisia* sp., *Plantago lanceolata*, *Polygonum persicaria-type* and *Polygonum convolvulus-type*), wetland herbs that indicate disturbance and open patches (*Filipendula ulmaria*, *Urtica dioica*, *Berula erecta* and *Eupatorium cannabinum*), Poaceae and Cyperaceae. There is no relationship between the strength of the signal of human impact and the distance between the dry dune surface and the sample point, at least over a distance of 20 metres. After 3800 BC, the open water was still present but probably further away from the sampling points. Human impact decreased, resulting in the partial recovery of the woodland.

The macroremains data from the excavation show primarily the submergence of the dune and the general disturbance of the vegetation. A sound comparison of human impact through time based on macroremains, wood and charcoal is restricted by the unequal availability of samples from the different layers (occupation periods) since most material is available from the most intensive occupation period (layer 50). Reconstructions of human impact on the southern slope of the dune before, during and after occupation are available for the periods contemporaneous with layers 45 and 50. The data show the clearance of alder carr during both occupation periods, and clearance of *Tilia* sp. and an increase in shrubs and anthropogenic indicators contemporaneous with layer 50. Both occupation periods are followed by the (partial) recovery of the vegetation. These developments through time correspond to the results obtained at the northern side of the dune.

Comparison of the indications of human impact from the cores and from the excavation shows many similarities. At both sides of the dune indications of human impact appear to be largest during layer 50 (for the cores this concerns layer 50 and/or 60 since these layers could not be recognised separately), including the clearance of *Tilia* vegetation and alder carr, resulting in the increased presence of shrubs and anthropogenic indicators. The presence of people did not result in large-scale deforestation, and dry terrain woodland recovered and remained present after occupation. An apparent difference between the results from the cores and the excavation is the presence of crop plant macroremains and carbonised macroremains at the excavation, which may of course be related to the differences in the number of samples and sample volume but also with the stronger human impact at the southern site of the dune (as indicated by the distribution of archaeological remains).

The importance of *Alnus glutinosa* in the wood and charcoal assemblages is in accordance with indications of the clearance of *Alnus glutinosa* vegetation by people in the diagrams of the cores (especially concerning layer 50 and/or 60) and in the macroremains diagram of layer 45. The additional importance of *Quercus* sp. and *Corylus* sp. in the wood assemblage suggests that these taxa may have been cleared as well. They were indeed present in the local vegetation, and fluctuations in the curves of these taxa in the pollen and macroremains diagrams may therefore represent clearance as well (see the pollen diagrams of core B and D and the macroremains diagrams of core B, C and D in Out 2008a). The wood and charcoal data suggest that most wood was collected locally, although it may have been collected at the other nearby dunes as well. There are some indications of the selective use of *Quercus* sp. and possibly *Euonymus europaeus*. The find of a knot demonstrates the use of the bark of trees, although this way of using plant material probably remains strongly underrepresented in our knowledge.

II.4.3 Seasonality and site function

Carbonised macroremains can provide information on the season of occupation at the site. Carbonised remains of *Corylus avellana*, *Cornus sanguinea* and *Trapa natans* point to occupation during September/October, although macroremains (nuts) of these taxa can be stored when roasted and in that case may give a wrong indication on seasonality. Remains of *Galium aparine* point to occupation between July and September, while *Solanum nigrum* and *Nymphaea alba* indicate occupation between August and October. In conclusion, the carbonised plant remains indicate that occupation occurred at least in September or August-October during the phases contemporaneous with the layers 30, 50 and 60. The carbonised cereals do not give information on seasonality since there is no indisputable evidence of local crop cultivation. The wood remains demonstrate human activity in spring/summer and probably autumn for layer 50. Particular fish remains confirm the summer occupation for layer 50 and 60, but less strongly for layer 30[24] (Ball 1997; Raemaekers 1999). Together the data support autumn and possibly summer occupation for layer 30 and summer and autumn occupation for layer 50 and 60. The information on seasonality is too general to tell whether people were present at the site for months continuously or visited the site intermittently.

The archaeobotanical data indicate that the collection of edible parts of plants and the possibility to collect storable fruits may have been one of the reasons to visit Brandwijk-Kerkhof. The practice of local cereal cultivation is discussed elsewhere (Out 2008a, see also paragraph 11.6.13). It is concluded that crop cultivation was either practised locally on a small scale, or elsewhere. This location elsewhere may be another dune (*e.g.* the higher and more extensive dune Brandwijk-Donk), but could also be in a different region, like the Pleistocene sand soils to the south of the river area. A new argument on local crop cultivation, resulting from the data presented here, is that the assemblage of potential arable weeds does not exclude local crop cultivation.

24 In the fish assemblage of layer 30, some of the summer indicators of layer 50 and 60 are absent (mullet family and sturgeon). Remains of the salmon are present in layer 30 and may represent summer indicators, but may also represent small individuals that remain present in the river area during the whole year.

The indications of summer and autumn occupation from layer 50 onwards do not exclude local crop cultivation either. However, the indications of local crop cultivation would be stronger if indications of occupation during late spring would be available. Moreover, the unique presence of opium poppy can be interpreted as an indication of the importation of crop plants.

Analysis of preliminary data from the excavation resulted in the conclusion that both the mammal and fish spectra through time suggest a continuity of site function at Brandwijk-Kerkhof (Van Gijn and Verbruggen 1992; Raemaekers 1999). The data however show some shifts from layer 50 onwards. The archaeological remains are spread over a larger area than before and the refuse layer is generally thicker, suggesting more intensive occupation (more people or longer visits). There are stronger indications of summer occupation besides autumn occupation, as shown by changes in the fish spectrum (see discussion on seasonality above). In contrast to layer 30, there is evidence of the presence of cattle, and stronger evidence of the presence of domestic pig, which was possibly absent before. The number of plant taxa found in a carbonised state increased and crop plants were introduced. In addition the pollen diagrams show maximal human impact during the formation of layer 50 and/or 60. Although hunting, fishing, fowling and gathering probably remained very important for the people who visited the dune, it is clear that some changes took place in local subsistence and occupation intensity, which may indicate a shift in site function. A final conclusion on the site function should, however, be based on a broader range of evidence.

sample	22 C	23 C	23 D	24 C	24 D	25 C	25 D	26 C	26 D
sample type	hp	hp	hp	hp	hp	hp	hp	hp	hp
mesh width	-	-	-	-	-	-	-	-	-
volume (litre)	?	?	?	?	?	?	?	?	?
taxon									
Group 1									
Tilia sp.	-	-	-	-	-	-	-	-	-
Quercus sp.	-	1	-	-	-	-	-	-	-
Quercus sp., cupulae	-	-	-	-	-	1	-	-	-
Quercus sp., juvenile	-	-	-	-	-	-	-	-	-
Fraxinus excelsior	-	-	-	-	-	-	-	-	-
Cornus sanguinea	-	1	-	1	-	9	3	9	21
Corylus avellana	2	-	8, 1 c	++	+, 1 c	5	3	19	26
Corylus avellana, catkins	-	-	-	-	-	-	-	-	-
Crataegus monogyna	-	-	-	-	-	-	1	-	1
Malus sylvestris	-	-	-	-	-	-	-	-	-
Malus sylvestris, parenchyma	-	-	-	-	-	-	-	-	-
Viburnum opulus	-	-	-	-	-	-	-	1	-
Prunus sp.	-	-	-	-	-	-	-	-	-
Prunus spinosa	-	-	-	-	-	-	-	-	1
Rubus fruticosus	-	-	-	-	-	-	-	-	-
Fallopia dumetorum	-	-	-	-	-	-	-	-	-
Urtica dioica	-	-	-	-	-	-	-	-	-
Galium aparine	-	-	-	-	-	-	-	-	-
Lapsana communis	-	-	-	-	-	-	-	-	-
Chaerophyllum bulbosum/temulum	-	-	-	-	-	-	-	-	-
Group 2									
Arctium cf. lappa	-	-	-	-	-	-	-	-	-
Atriplex patula/prostrata	-	-	-	-	-	-	-	-	-
Brassica rapa	-	-	-	-	-	-	-	-	-
Capsella bursa-pastoris	-	-	-	-	-	-	-	-	-
Chenopodium album	-	-	-	-	-	-	-	-	-
Chenopodium ficifolium	-	-	-	-	-	-	-	-	-
Fallopia convolvulus	-	-	-	-	-	-	-	-	-

Table II.5 part 1a.

sample	22 C	23 C	23 D	24 C	24 D	25 C	25 D	26 C	26 D
Group 2 (cont.)									
Persicaria cf. maculosa	-	-	-	-	-	-	-	-	-
Persicaria lapathifolia	-	-	-	-	-	-	-	-	-
Polygonum aviculare	-	-	-	-	-	-	-	-	-
Solanum nigrum	-	-	-	-	-	-	-	-	-
Stellaria media	-	-	-	-	-	-	-	-	-
Group 3									
Hordeum vulgare var. nudum	-	-	-	-	-	-	-	-	-
Hordeum vulgare, internodia	-	-	-	-	-	-	-	-	-
Triticum dicoccon	-	-	-	-	-	-	-	-	-
Triticum dicoccon, glume bases	-	-	-	-	-	-	-	-	-
Triticum dicoccon, rachis segments	-	-	-	-	-	-	-	-	-
Triticum dicoccon, spikelet forks	-	-	-	-	-	-	-	-	-
Papaver somniferum ssp. setigerum	-	-	-	-	-	-	-	-	-
Group 4									
Alnus glutinosa	-	-	-	-	-	-	-	-	-
Alnus glutinosa, buds	-	-	-	-	-	-	-	-	-
Alnus glutinosa, bud scales	-	-	-	-	-	-	-	-	-
Alnus glutinosa, cones	-	-	-	-	-	-	-	-	-
Alnus glutinosa, male catkins	-	-	-	-	-	-	-	-	-
Salix sp., buds	-	-	-	-	-	-	-	-	-
Humulus lupulus	-	-	-	-	-	-	-	-	-
Group 5									
Alisma plantago-aquatica	-	-	-	-	-	-	-	-	-
Angelica sylvestris/Peucedanum palustre	-	-	-	-	-	-	-	-	-
Apium nodiflorum	-	-	-	-	-	-	-	-	-
Carex acutiformis	-	-	-	-	-	-	-	-	-
Elatine triandra	-	-	-	-	-	-	-	-	-
Elatine hydropiper	-	-	-	-	-	-	-	-	-
Eupatorium cannabinum	-	-	-	-	-	-	-	-	-
Filipendula ulmaria	-	-	-	-	-	-	-	-	-
Galium palustre	-	-	-	-	-	-	-	-	-
Hypericum cf. tetrapterum	-	-	-	-	-	-	-	-	-

Table II.5 part 1b.

sample	22 C	23 C	23 D	24 C	24 D	25 C	25 D	26 C	26 D
Group 5 (cont.)									
Iris pseudacorus	-	-	-	-	-	-	1	-	-
Lythrum salicaria	-	-	-	-	-	-	-	-	-
Mentha aquatica/arvensis	-	-	-	-	-	-	-	-	-
Oenanthe aquatica	-	-	-	-	-	-	-	-	-
Oenanthe sp.	-	-	-	-	-	-	-	-	-
Phragmites australis, rhizome buds	-	-	-	-	-	-	-	-	-
Phragmites australis, stem fragments	-	-	-	-	-	-	-	-	-
Rumex hydrolapathum	-	-	-	-	-	-	-	-	-
Sagittaria sagittifolia	-	-	-	-	-	-	-	-	-
Schoenoplectus lacustris	-	-	-	-	-	-	-	-	-
Schoenoplectus lacustris/ tabernaemontani	-	-	-	-	-	-	-	-	-
Schoenoplectus tabernaemontani	-	-	-	-	-	-	-	-	-
Scirpus sylvaticus	-	-	-	-	-	-	-	-	-
Sium latifolium	-	-	-	-	-	-	-	-	-
Sparganium erectum	-	-	-	-	-	-	-	-	-
Stachys palustris	-	-	-	-	-	-	-	-	-
Thelypteris palustris, leaves	-	-	-	-	-	-	-	-	-
Thelypteris palustris, sporangia	-	-	-	-	-	-	-	-	-
Typha sp.	-	-	-	-	-	-	-	-	-
Valeriana officinalis	-	-	-	-	-	-	-	-	-
Group 6									
Apium cf. repens	-	-	-	-	-	-	-	-	-
Persicaria hydropiper	-	-	-	-	-	-	-	-	-
Stellaria aquatica	-	-	-	-	-	-	-	-	-
Group 7									
Callitriche sp.	-	-	-	-	-	-	-	-	-
Ceratophyllum demersum	-	-	-	-	-	-	-	-	-
Chara sp.	-	-	-	-	-	-	-	-	-
Najas marina	-	-	-	-	-	-	-	-	-
Najas minor	-	-	-	-	-	-	-	-	-
Nuphar lutea	-	-	-	-	-	-	-	-	-
Nymphaea alba	-	-	-	-	-	-	-	-	-

Table II.5 part 1c.

sample	22 C	23 C	23 D	24 C	24 D	25 C	25 D	26 C	26 D
Group 7 (cont.)									
Potamogeton sp.	-	-	-	-	-	-	-	-	-
Ranunculus aquatilis-type	-	-	-	-	-	-	-	-	-
Salvinia natans	-	-	-	-	-	-	-	-	-
Trapa natans	-	-	-	-	-	-	-	1	-
Zannichellia palustris	-	-	-	-	-	-	-	-	-
Group 8									
Apiaceae	-	-	-	-	-	-	-	-	-
Brassica sp.	-	-	-	-	-	-	-	-	-
Carex sp.	-	-	-	-	-	-	-	-	-
Carex sp., bicarpellate	-	-	-	-	-	-	-	-	-
Carex sp., tricarpellate	-	-	-	-	-	-	-	-	-
Carex sp. in utricle	-	-	-	-	-	-	-	-	-
Galium sp.	-	-	-	-	-	-	-	-	-
Galeopsis bifida-type	-	-	-	-	-	-	-	-	-
Sonchus sp.	-	-	-	-	-	-	-	-	-
Hypericum sp.	-	-	-	-	-	-	-	-	-
Juncus effusus-type	-	-	-	-	-	-	-	-	-
Juncus sp.	-	-	-	-	-	-	-	-	-
Luzula sp.	-	-	-	-	-	-	-	-	-
Poa sp.	-	-	-	-	-	-	-	-	-
Poaceae	-	-	-	-	-	-	-	-	-
Ranunculus repens-type	-	-	-	-	-	-	-	-	-
Rumex sp.	-	-	-	-	-	-	-	-	-
Rumex sp., perianths	-	-	-	-	-	-	-	-	-
Stellaria aquatica/media	-	-	-	-	-	-	-	-	-
Stellaria sp.	-	-	-	-	-	-	-	-	-
Indet.	-	-	-	-	-	-	-	-	-

hp = handpicked sample
sieve = sample from sifting residue
lab = botanical sample
c = carbonised
x, yc = x macroremains of which y are carbonised

\+ = few (1-10)
++ = some tens (10-49)
\- = not present

Table II.5 Brandwijk-Kerkhof, layer 50, macroremains, part 1d.

sample	27 D	13.124	13.125	24.523	26.13	26.27	26.633	27.26
sample type	hp	sieve	hp	hp	hp	hp	hp	hp
mesh width	-	1.5	-	-	-	-	-	-
volume (litre)	?	?	?	?	?	?	?	?
taxon								
Group 1								
Tilia sp.	-	-	-	-	-	-	-	-
Quercus sp.	-	-	-	1	-	-	-	-
Quercus sp., cupulae	-	-	-	1	-	-	-	-
Quercus sp., juvenile	-	-	-	-	-	-	-	-
Fraxinus excelsior	-	-	-	-	-	-	-	-
Cornus sanguinea	4	1	1	-	-	-	-	-
Corylus avellana	5	10, 1 c	5, 1 c	-	-	10, 2 c	-	1 c
Corylus avellana, catkins	-	-	-	-	-	-	-	-
Crataegus monogyna	-	-	1	-	-	-	1 cf.	-
Malus sylvestris	-	-	-	-	-	-	-	-
Malus sylvestris, parenchyma	-	-	-	-	-	-	-	-
Viburnum opulus	-	-	-	-	-	-	-	-
Prunus sp.	-	-	-	-	-	-	-	-
Prunus spinosa	-	1	-	-	-	-	-	-
Rubus fruticosus	-	1	-	-	-	-	-	-
Fallopia dumetorum	-	-	-	-	-	-	-	-
Urtica dioica	-	-	-	-	-	-	-	-
Galium aparine	-	1 c	-	-	-	-	-	-
Lapsana communis	-	-	-	-	-	-	-	-
Chaerophyllum bulbosum/temulum	-	-	-	-	-	-	-	-
Group 2								
Arctium cf. lappa	-	-	-	-	-	-	-	-
Atriplex patula/prostrata	-	-	-	-	-	-	-	-
Brassica rapa	-	-	-	-	-	-	-	-
Capsella bursa-pastoris	-	-	-	-	-	-	-	-
Chenopodium album	-	7	31	-	-	-	-	-
Chenopodium ficifolium	-	-	-	-	-	-	-	-
Fallopia convolvulus	-	-	-	-	-	-	-	-

Table II.5 part 2a.

sample	27 D	13.124	13.125	24.523	26.13	26.27	26.633	27.26
Group 2 (cont.)								
Persicaria cf. maculosa	-	-	7	-	-	-	-	-
Persicaria lapathifolia	-	2	6	-	-	-	-	-
Polygonum aviculare	-	-	-	-	-	-	-	-
Solanum nigrum	-	-	-	-	-	-	-	-
Stellaria media	-	-	-	-	-	-	-	-
Group 3								
Hordeum vulgare var. nudum	-	1 c	-	-	-	-	-	-
Hordeum vulgare, internodia	-	-	-	-	-	-	-	-
Triticum dicoccon	-	1 c	-	-	-	-	-	-
Triticum dicoccon, glume bases	-	-	-	-	-	-	-	-
Triticum dicoccon, rachis segments	-	-	-	-	-	-	-	-
Triticum dicoccon, spikelet forks	-	-	-	-	-	-	-	-
Papaver somniferum ssp. setigerum	-	-	-	-	-	-	-	-
Group 4								
Alnus glutinosa	-	-	1	-	-	-	-	-
Alnus glutinosa, buds	-	-	-	-	-	-	-	-
Alnus glutinosa, bud scales	-	-	-	-	-	-	-	-
Alnus glutinosa, cones	-	-	-	-	-	-	-	-
Alnus glutinosa, male catkins	-	-	-	-	-	-	-	-
Salix sp., buds	-	-	-	-	-	-	-	-
Humulus lupulus	-	4	-	-	-	-	-	-
Group 5								
Alisma plantago-aquatica	-	-	-	-	-	-	-	-
Angelica sylvestris/Peucedanum palustre	-	-	-	-	-	-	-	-
Apium nodiflorum	-	-	-	-	-	-	-	-
Carex acutiformis	-	-	-	-	-	-	-	-
Elatine triandra	-	-	-	-	-	-	-	-
Elatine hydropiper	-	-	-	-	-	-	-	-
Eupatorium cannabinum	-	-	-	-	-	-	-	-
Filipendula ulmaria	-	-	-	-	-	-	-	-
Galium palustre	-	-	-	-	-	-	-	-
Hypericum cf. tetrapterum	-	-	-	-	-	-	-	-

Table II.5 part 2b.

sample	27 D	13.124	13.125	24.523	26.13	26.27	26.633	27.26
Group 5 (cont.)								
Iris pseudacorus	-	-	-	-	-	-	-	-
Lythrum salicaria	-	-	-	-	-	-	-	-
Mentha aquatica/arvensis	-	-	-	-	-	-	-	-
Oenanthe aquatica	-	-	-	-	-	-	-	-
Oenanthe sp.	-	-	-	-	-	-	-	-
Phragmites australis, rhizome buds	-	-	-	-	-	-	-	-
Phragmites australis, stem fragments	-	-	-	-	-	-	-	-
Rumex hydrolapathum	-	-	-	-	-	-	-	-
Sagittaria sagittifolia	-	-	-	-	-	-	-	-
Schoenoplectus lacustris	-	-	8	-	-	-	-	-
Schoenoplectus lacustris/ tabernaemontani	-	-	-	-	-	-	-	-
Schoenoplectus tabernaemontani	-	-	-	-	-	-	-	-
Scirpus sylvaticus	-	-	-	-	-	-	-	-
Sium latifolium	-	-	-	-	-	-	-	-
Sparganium erectum	-	-	-	-	-	-	-	-
Stachys palustris	-	-	1	-	-	-	-	-
Thelypteris palustris, leaves	-	-	-	-	-	-	-	-
Thelypteris palustris, sporangia	-	-	-	-	-	-	-	-
Typha sp.	-	-	-	-	-	-	-	-
Valeriana officinalis	-	-	-	-	-	-	-	-
Group 6								
Apium cf. repens	-	-	-	-	-	-	-	-
Persicaria hydropiper	-	-	-	-	-	-	-	-
Stellaria aquatica	-	-	-	-	-	-	-	-
Group 7								
Callitriche sp.	-	-	-	-	-	-	-	-
Ceratophyllum demersum	-	1	-	-	-	-	-	-
Chara sp.	-	-	-	-	-	-	-	-
Najas marina	-	1	-	-	-	-	-	-
Najas minor	-	-	-	-	-	-	-	-
Nuphar lutea	-	2	-	-	-	-	-	-
Nymphaea alba	-	17	12	-	-	-	-	-

Table II.5 part 2c.

sample	27 D	13.124	13.125	24.523	26.13	26.27	26.633	27.26
Group 7 (cont.)								
Potamogeton sp.	-	9	3	-	-	-	-	-
Ranunculus aquatilis-type	-	-	-	-	-	-	-	-
Salvinia natans	-	-	-	-	-	-	-	-
Trapa natans	-	-	-	-	1 c	-	-	-
Zannichellia palustris	-	-	-	-	-	-	-	-
Group 8								
Apiaceae	-	-	-	-	-	-	-	-
Brassica sp.	-	-	2	-	-	-	-	-
Carex sp.	-	4	2	-	-	-	-	-
Carex sp., bicarpellate	-	-	-	-	-	-	-	-
Carex sp., tricarpellate	-	-	-	-	-	-	-	-
Carex sp. in utricle	-	-	-	-	-	-	-	-
Galium sp.	-	-	-	-	-	-	-	-
Galeopsis bifida-type	-	1	1	-	-	-	-	-
Sonchus sp.	-	-	-	-	-	-	-	-
Hypericum sp.	-	-	-	-	-	-	-	-
Juncus effusus-type	-	-	-	-	-	-	-	-
Juncus sp.	-	-	-	-	-	-	-	-
Luzula sp.	-	-	-	-	-	-	-	-
Poa sp.	-	-	-	-	-	-	-	-
Poaceae	-	-	-	-	-	-	-	-
Ranunculus repens-type	-	-	-	-	-	-	-	1
Rumex sp.	-	1	-	-	-	-	-	-
Rumex sp., perianths	-	-	-	-	-	-	-	-
Stellaria aquatica/media	-	-	-	-	-	-	-	-
Stellaria sp.	-	-	-	-	-	-	-	-
Indet.	-	-	-	-	-	-	-	-

hp = handpicked sample - = not present
sieve = sample from sifting residue
lab = botanical sample
c = carbonised
x, yc = x macroremains of which y are carbonised

Table II.5 Brandwijk-Kerkhof, layer 50, macroremains, part 1d.

sample	28.93	36.45	43.542	9.69	13.124	27.7	36.45	43.542
sample type	sieve	sieve	sieve	lab	lab	lab	lab	lab
mesh width	1.5	1.5	1.5	0.25	0.25	0.25	0.25	0.25
volume (litre)	?	?	?	1	1	1	1	1
taxon								
Group 1								
Tilia sp.	-	-	-	-	-	1	-	-
Quercus sp.	-	-	-	-	-	-	-	-
Quercus sp., cupulae	-	-	-	1	-	1	-	1 c
Quercus sp., juvenile	-	-	-	-	-	1	-	-
Fraxinus excelsior	-	-	-	-	-	-	-	1
Cornus sanguinea	6	-	13, 1 c	3	3	2	-	5
Corylus avellana	14, 1 c	-	-	6, 1 c	3	4, 1 c	1 c	8, 1 c
Corylus avellana, catkins	-	-	-	-	-	-	-	3
Crataegus monogyna	-	-	-	1	3	-	-	1
Malus sylvestris	-	-	-	2	5	-	-	1 cf.
Malus sylvestris, parenchyma	-	-	-	-	2	-	-	-
Viburnum opulus	-	-	-	-	1	-	-	-
Prunus sp.	-	-	-	-	-	-	-	1
Prunus spinosa	-	-	-	-	-	-	-	-
Rubus fruticosus	-	-	-	-	-	-	-	-
Fallopia dumetorum	-	-	-	4	4	-	-	-
Urtica dioica	-	-	-	956	784	1376	+++++	248
Galium aparine	-	-	-	-	-	1	-	-
Lapsana communis	-	-	-	-	-	1	-	1
Chaerophyllum bulbosum/temulum	-	-	-	-	-	1	-	-
Group 2								
Arctium cf. lappa	-	-	-	-	1	-	-	-
Atriplex patula/prostrata	-	-	-	-	-	8	-	-
Brassica rapa	-	-	-	4	56 cf.	68	-	28
Capsella bursa-pastoris	-	-	-	272	-	-	-	-
Chenopodium album	8	-	3	428	136	340	++++	96
Chenopodium ficifolium	-	-	-	20	-	-	+++	-
Fallopia convolvulus	-	-	-	4	-	-	-	-

Table II.5 part 3a.

sample	28.93	36.45	43.542	9.69	13.124	27.7	36.45	43.542
Group 2 (cont.)								
Persicaria cf. maculosa	-	-	2	-	-	4	-	-
Persicaria lapathifolia	4	-	4	32	38	99	-	40
Polygonum aviculare	-	-	-	32	-	-	-	-
Solanum nigrum	-	-	-	20	160, 32 c	40	6, 3 c	40
Stellaria media	-	-	-	36	-	-	-	-
Group 3								
Hordeum vulgare var. nudum	-	-	1 c	-	-	-	1	-
Hordeum vulgare, internodia	-	-	-	4 c	-	1	-	-
Triticum dicoccon	1 c	2 c	-	-	2 c	3 c, 2 c cf.	-	3 c
Triticum dicoccon, glume bases	-	-	-	-	40 c	12 c	-	4 c
Triticum dicoccon, rachis segments	-	-	-	-	8 c	-	-	-
Triticum dicoccon, spikelet forks	-	-	-	-	2 c	2, 1 c	-	-
Papaver somniferum ssp. setigerum	-	-	-	16	32	-	-	-
Group 4								
Alnus glutinosa	-	-	-	148	816	467	-	300
Alnus glutinosa, buds	-	-	-	2	2	3	-	14
Alnus glutinosa, bud scales	-	-	-	-	17	5	-	15
Alnus glutinosa, cones	-	-	-	4	12	8, 1 c	-	12
Alnus glutinosa, male catkins	-	-	-	+	1	2	-	-
Salix sp., buds	-	-	-	-	9	-	-	-
Humulus lupulus	1	-	-	4	7	-	-	-
Group 5								
Alisma plantago-aquatica	-	-	-	48	112	56	-	28
Angelica sylvestris/Peucedanum palustre	-	-	-	-	-	1	-	-
Apium nodiflorum	-	-	-	-	-	32	-	-
Carex acutiformis	-	-	2	4 cf.	8 cf.	8	-	-
Elatine triandra	-	-	-	-	-	192	-	768
Elatine hydropiper	-	-	-	-	1888	1536	-	5776
Eupatorium cannabinum	-	-	-	-	8	64	-	-
Filipendula ulmaria	-	-	-	8	-	1	-	4
Galium palustre	-	-	-	8, 4 c	-	-	1 c	4
Hypericum cf. tetrapterum	-	-	-	-	64	-	-	-

Table II.5 part 3b.

sample	28.93	36.45	43.542	9.69	13.124	27.7	36.45	43.542
Group 5 (cont.)								
Iris pseudacorus	-	-	1	-	-	-	-	-
Lythrum salicaria	-	-	-	1664	1056	1968	-	3256
Mentha aquatica/arvensis	-	-	-	32	64	4	1	-
Oenanthe aquatica	-	-	-	2	-	1	-	-
Oenanthe sp.	-	-	-	-	-	-	-	1 cf.
Phragmites australis, rhizome buds	-	-	-	+	-	-	-	-
Phragmites australis, stem fragments	-	-	-	1 c	-	-	-	-
Rumex hydrolapathum	-	-	-	12	34	4	-	2
Sagittaria sagittifolia	-	-	-	-	2	-	-	-
Schoenoplectus lacustris	4	-	-	12	54	-	-	-
Schoenoplectus lacustris/ tabernaemontani	-	-	-	-	-	-	2 c	12
Schoenoplectus tabernaemontani	-	-	-	-	-	40 cf.	-	10 c
Scirpus sylvaticus	-	-	-	-	-	1	-	-
Sium latifolium	-	-	-	8	4	2	-	4
Sparganium erectum	-	-	-	-	-	2	-	1
Stachys palustris	-	-	-	4	-	-	-	4
Thelypteris palustris, leaves	-	-	-	1	-	3	-	5
Thelypteris palustris, sporangia	-	-	-	-	-	1	-	-
Typha sp.	-	-	-	-	-	208	-	256
Valeriana officinalis	-	-	-	4	2	1	-	-
Group 6								
Apium cf. repens	-	-	-	-	144	-	-	20
Persicaria hydropiper	-	-	-	4	-	1	-	4
Stellaria aquatica	-	-	-	-	216	-	-	124
Group 7								
Callitriche sp.	-	-	-	-	-	-	-	128
Ceratophyllum demersum	-	-	13	-	-	-	-	-
Chara sp.	-	-	-	-	64	64	-	256
Najas marina	-	-	-	-	2	2	-	-
Najas minor	-	-	-	-	-	-	-	4
Nuphar lutea	1	-	8	-	-	-	-	1
Nymphaea alba	7	-	-	-	28	5	1 c	11

Table II.5 part 3c.

sample	28.93	36.45	43.542	9.69	13.124	27.7	36.45	43.542
Group 7 (cont.)								
Potamogeton sp.	12	-	-	-	14	5	-	4
Ranunculus aquatilis-type	-	-	-	-	360	52	-	40
Salvinia natans	-	-	-	448	640	1552	-	3200
Trapa natans	-	1 c	-	1	10, 1 c	2	-	3
Zannichellia palustris	-	-	-	-	8	-	-	-
Group 8								
Apiaceae	-	-	-	-	2 cf.	-	-	-
Brassica sp.	-	-	-	-	-	-	-	-
Carex sp.	2	-	-	-	-	-	-	-
Carex sp., bicarpellate	-	-	-	-	34	4	-	8
Carex sp., tricarpellate	-	-	-	-	12	-	-	-
Carex sp. in utricle	-	-	-	-	1	-	-	-
Galium sp.	-	-	-	-	-	8	-	-
Galeopsis bifida-type	4	-	-	-	12	5	-	2
Sonchus sp.	-	-	-	-	2	-	-	-
Hypericum sp.	-	-	-	-	-	1	-	-
Juncus effusus-type	-	-	-	-	64	-	-	-
Juncus sp.	-	-	-	-	-	192	-	128
Luzula sp.	-	-	-	-	-	-	-	8
Poa sp.	-	-	-	-	96	68 cf.	-	24 cf., 16 c cf.
Poaceae	-	-	-	-	-	2	-	-
Ranunculus repens-type	-	-	-	8	-	-	-	-
Rumex sp.	-	-	-	4	-	-	-	-
Rumex sp., perianths	-	-	-	4	-	-	-	-
Stellaria aquatica/media	-	-	-	128	-	596	-	-
Stellaria sp.	-	-	-	-	-	-	-	1
Indet.	-	-	-	-	-	4	-	16

hp = handpicked sample
sieve = sample from sifting residue
lab = botanical sample
c = carbonised
x, yc = x macroremains of which y are carbonised

+ = few (1-10)
++ = some tens (10-49)
+++ = many tens (50-99)

++++ = some hundreds (100-499)
+++++ = many hundreds (500-999)
- = not present

Table II.5 Brandwijk-Kerkhof, layer 50, macroremains, part 3d.