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

Out, W.A.

Appendix V. Archaeobotany of Bergschenhoek, the Netherlands

V.1 Introduction

The Early Neolithic site near Bergschenhoek was discovered in 1976 during digging works north of Rotterdam (see fig. V.1). The site was embedded in intra-coastal clay deposits at a depth of 8 m -NAP and was extremely well-preserved. It was excavated in 1978 by the National Museum of Antiquities under the direction of Louwe Kooijmans. This rescue excavation of *c.* 100 m^2 uncovered a small short-term fishing-fowling site and its immediate surroundings. The site has been dated on the basis of three ^{14}C dates to the period 4350-4050 BC, which is in agreement with a restricted number of pottery sherds in a distinct Swifterbant style. This appendix presents the archaeobotanical analyses combined with mollusc analysis. The introduction is based on several preliminary publications (Bloemers *et al.* 1981, 42-45; Casparie 1995, 212-213; Louwe Kooijmans 1977a, 1978, 1985, 92-96, 1986, 7-11, 1987, 238-242).

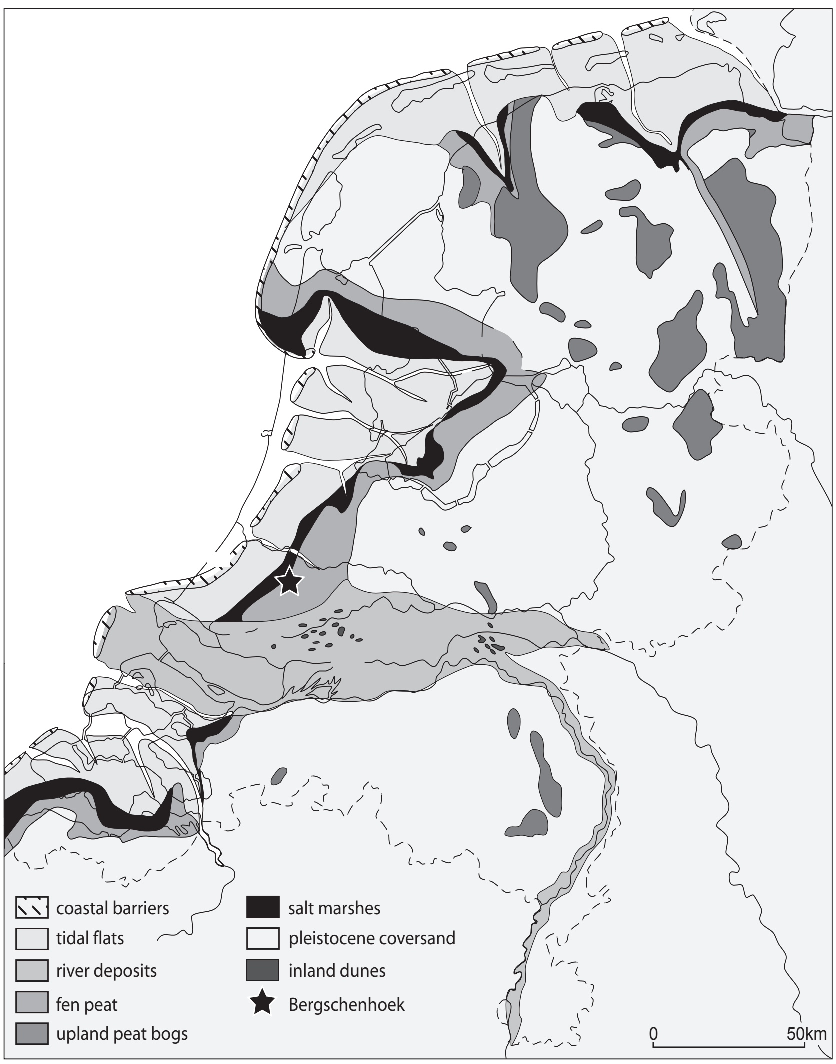

Figure V.1 Bergschenhoek, the Netherlands, location plotted on a palaeogeographical map (*c.* 4200 BC, NITG).

The site was located on a piece of wood peat, measuring *c.* 16 m^2 and *c.* 35 cm thick in the sections. Before compaction, it had presumably originally been up to 70 cm thick. The peat was embedded in slightly humic clay. The sharp and frayed edges of this peat indicated that it was not in primary position, but must have been torn off from a more extensive peat deposit. The possible source, a more extensive layer of similar peat of the same thickness, was discovered at a distance of *c.* 25 m to the north of the site during a prospection of the surroundings of the site by means of corings.

On the surface of this 'peat island' two or three partly overlapping surface hearths had been built, which were subsequently silted over by a thin clay seam. The peat surface was repeatedly raised afterwards with reed bundles, planks, wooden poles and even parts of a fish trap, up to *c.* 30 cm in total, apparently to stabilise and reinforce the surface. A central feature at the site was a complex hearth located on top of the surface hearths, consisting of an eight or nine times repeated sequence of thin layers of spread-out reed covered by brown 'peat mud' and charcoal (Louwe Kooijmans 1987), each representing a new layout of the hearth.

The peat island was embedded in a humic clay, built up in "a sequence of thin clay beds alternating with levels of plant remains, mainly reed", interpreted as the result of "seasonal sedimentation in which the plant remains were laid down during winter and the clay beds in spring and summer" (Louwe Kooijmans 1987, 238). There is an upward decrease in the thickness of the levels, indicating that the water depth decreased through time. In the lower and middle part of the clay some seven levels could be made out. The upper part was more diffuse. If this microstratigraphy represents an annual rhythm, local sedimentation may have covered ten to twenty years.

Finds were recovered from the living surface itself and from all levels in the surrounding clay deposits. They are dominated by large quantities of fish bones and scales, some bones of birds, wild mammals and dog. Objects other than plant and animal remains are scarce and comprise pottery sherds, three pieces of flint, a fragment of a polished stone adze, a fragment of a perforated antler axe and an antler axe blade, an awl made of a long bird bone and a lump of burned clay. Most spectacular are a series of wooden artefacts including a complete fish trap (see fig. 8.1), fragments of at least two others and pieces of rope.

The site is interpreted as a short-term special activity camp with fowling and fishing as the main activities and some additional mammal hunting and gathering. The occupation probably lasted not more than about ten years. The short-lived aspect of the site is confirmed by the microstratigraphy of the surrounding clay. The microstratigraphy of the hearth indicates that the site was intermittently used, probably during seasonal visits in successive years. Occupation in late autumn and/or winter is evident on the basis of the bird remains and macrobotanical evidence (Louwe Kooijmans 1986, 10). Clason and Brinkhuizen (1993) concluded in their zoological analysis to a distinct winter presence, with a minor summer indication. At the time of occupation, the site was located in an ecological zone dominated by eutrophic marshes that more or less had been cut off from former connections with the sea. The fish spectrum indicates fresh to slightly brackish conditions.

According to the first interpretations the peat was in use while floating, especially in view of the occurrence of archaeological finds in levels below the island. Several arguments were however developed against this interpretation. Firstly, the thin clay seam, covering the peat and the early surface hearths, and preceding the main phase of use, cannot be understood in this interpretation. This clay seam implies that the peat must already have been in a fixed position in this stage. The clay moreover links an early stage of site use with a late stage of sedimentation around the peat, showing that the clay deposition largely predates the occupation. Secondly, it is clear from the stratigraphical position of the major (complete) fish trap and from the occurrence of refuse material in the upper levels of the clay microstratigraphy that the site was at any rate used *after* the piece of peat was embedded in the clay and fixed at the documented location. These inferences, however, generate the problem of how to interpret the archaeological material in the lowest levels, like a large part of a fish trap *below* the 'island'.

At last, it was argued that the floating peat would have been too soft to support and stand a number of people. However, the original thickness of the peat was before its compaction more than the observed 35 cm and the surface was raised and reinforced, weakening this objection. The sequence of events appears at any rate to be more complex than assumed earlier.

In the present interpretation, the sequence starts with the exposure of an earlier wood peat situated at a lakeshore, where Swifterbant people had arranged a campsite. Factually a hearth was discovered on the stretch of similar peat to the north of the site, attested during the prospection mentioned above. The artefacts in the lowest level, below the peat, should be explained as refuse that was lost or thrown and washed away at the foreshore in this stage. The margins of the peat along the shoreline would subsequently have started to float as a result of water fluctuations and wave action, and at last parts would have been torn off to drift away. It is assumed that the piece of peat drifted away over only a short distance and soon stranded in the coastal muds above the earlier waste. The first use of the patch of peat is represented by the two or three shallow surface hearths. These may date from a time when the patch was still occasionally floating, or even when it was still connected to the 'mainland'. These hearths were silted over when the clay deposition was almost completed. It is only then that the main use of the site started, that the surface was raised with reed and wood, and the complex hearth was built up. The main consequences for this study are that there never has been a campsite on a 'floating island' and that the major part of the local clay deposition preceded the construction and use of the campsite. It is estimated that the sequence of events will have covered not more then a few decades.

The goal of the botanical and malacological analyses is to reconstruct the natural vegetation, human impact and plant subsistence. Questions are:

- What did the local vegetation look like during occupation?
- What was the strength of marine influence?
- How did occupation effect the local vegetation?
- Which food plants were available and used?
- Do the plant remains give information on seasonality?
- Which wood taxa were used for various purposes such as artefacts and fuel?
- What are indications of the selective use of wood based on the quality of the wood?
- What are the indications of coppice practices?

V.2 Materials and methods

The Institute of Prehistory Leiden (now the Faculty of Archaeology, Leiden University) and the Biological-Archaeological Institute (now the Groningen Institute of Archaeology, University of Groningen) both participated in the archaeobotanical investigations. The analysis performed by the Institute of Prehistory Leiden concerns in the first place two sample boxes (50 x 15 x 10 cm) collected in 1978 for botanical analysis. W.J. Kuijper analysed the material in 1979 and 1980 with help of literature and the reference collection of the institute. Box 1 covered a section of the hearth complex (see fig. V.2 and V.3). Sampling of this box included seven pollen samples with a volume of 1 cm^3, of which pollen and macroremains were investigated. The macroremains of the remaining sediment were investigated by quick-scan. Box 2 was collected 2 metres apart from box 1 in a clay layer next to the peat, which was considered to be contemporaneous with occupation (see fig. V.2 and V.3). Sampling of this box included 11 samples from which both pollen and macroremains were investigated (volume 1 cm^3). Two additional macroremains samples were collected from the box as well. The first additional sample (a) was collected immediately below 8.37 m -NAP and had a volume of 25 cm^3. The second additional sample (b) was collected at 8.37-8.31 m -NAP and had a volume of 75 cm^3.

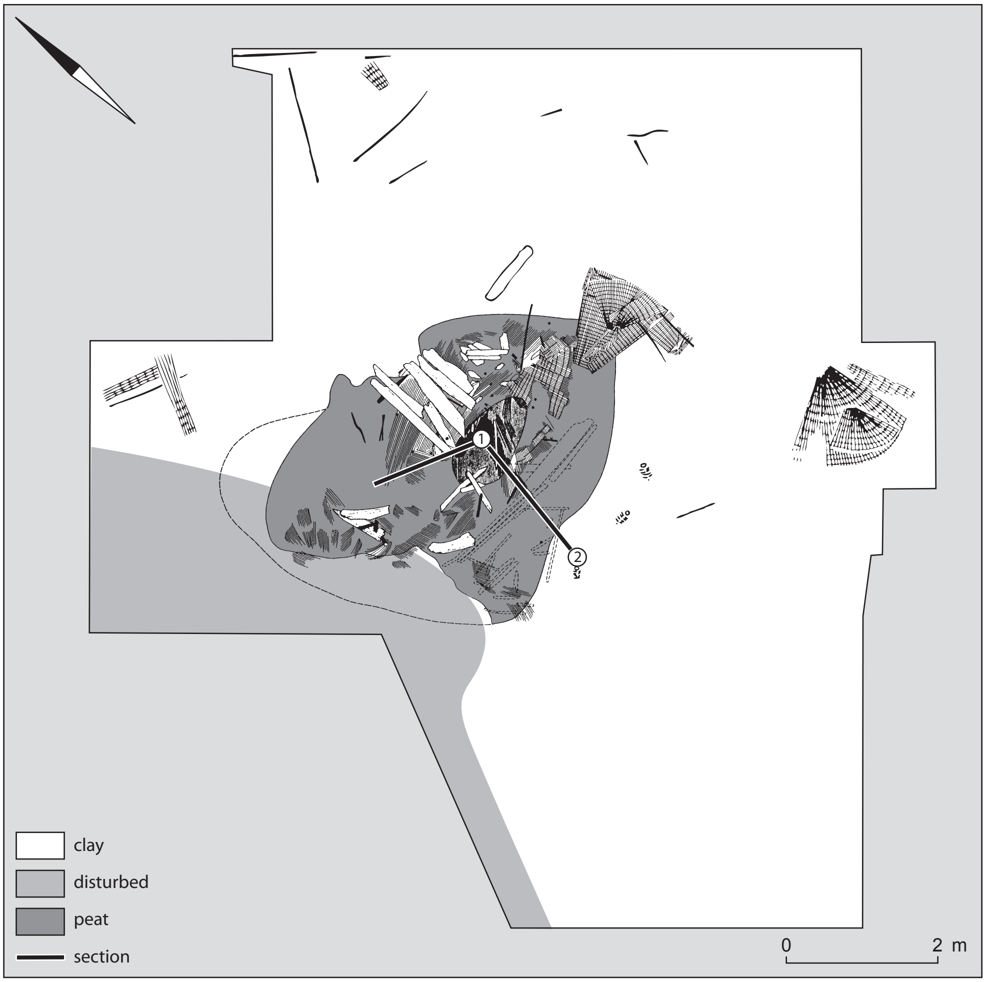

Figure V.2 Bergschenhoek, site plan showing the main features and the location of the sample boxes 1 and 2 (archives National Museum of Antiquities, adapted by L. Amkreutz).

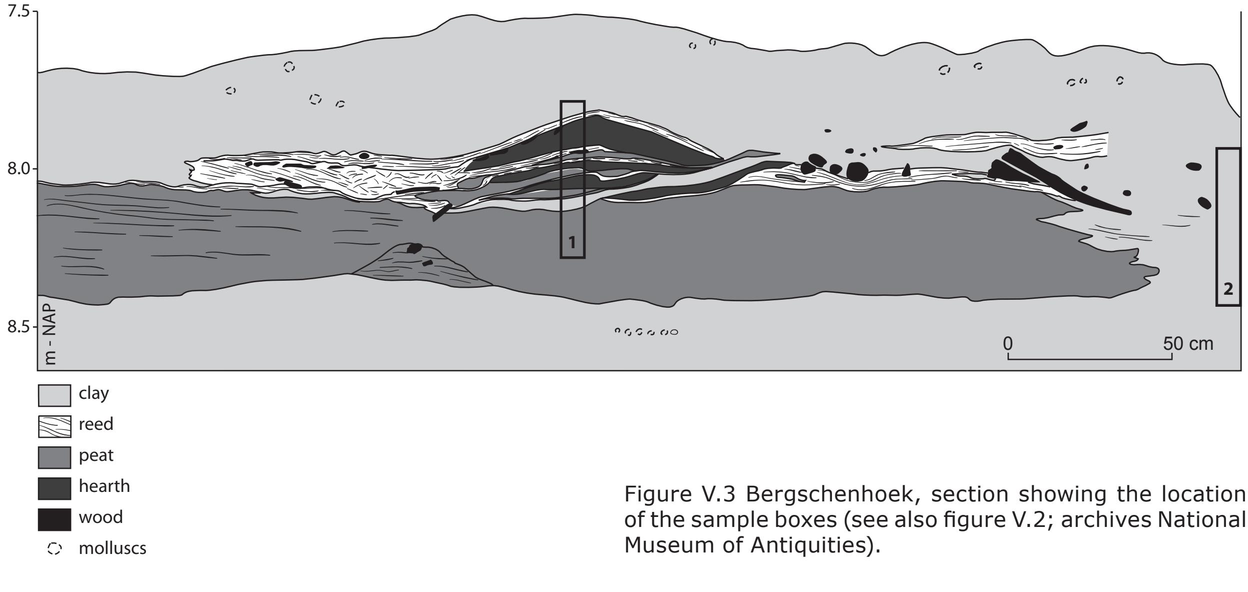

Figure V.3 Bergschenhoek, section showing the location of the sample boxes (see also figure V.2; archives National Museum of Antiquities).

The calculation of the pollen diagrams is based on an upland pollen sum including dryland trees and shrubs and excluding taxa that may have grown in the local vegetation. Taxa such as Chenopodiaceae and *Artemisia* sp. are not included in the pollen sum either since these could be part of the local (brackish) drift litter zone. For the analysis of macroremains samples were sieved at least on a 0.5 mm sieve. *Ranunculus aquatilis*-type represents *Ranunculus* section *Batrachium*. *Veronica beccabunga*-type represents *V. anagallis-aquatica*, *V. beccabunga* and *V. catenata*.

W.J. Kuijper identified molluscs from 24 samples that partly corresponded with occupation, including eight judged samples with a volume of 0.1-5 litres and many single finds and handpicked finds. The sediment of most samples was fine, humic clay. The macroremains that showed up during the malacological analysis were identified as well, resulting in nine additional macroremains samples with a volume varying between 0.1 and 0.5 litres. The methodology of the analysis of macroremains of these samples is as described above.

W.A. Casparie and I.L.M. Stuijts from the Biological-Archaeological Institute analysed wood and charcoal remains in the late seventies. This appendix will present the results from the samples collected in 1976 as well as preliminary results from the samples collected in the following year, based on information in unpublished documents and personal communication with W.A. Casparie. Identification was based on literature (Tjaden 1919; Schweingruber 1978; Greguss 1956) and the reference collection of the institute. Charcoal analysis included the identification of fragments larger than 2 mm from seven samples. These samples contained also macroremains and waterlogged wood. W.A. Casparie kindly discussed the wood and charcoal data with the author in 2007. H.J. During from the Biological-Archaeological Institute analysed moss remains of 18 samples. This list has been put available by W. van Zeist to W.J. Kuijper and has already been published as a species list (Kuijper 2000).

V.3 Results

V.3.1 Pollen and macroremains analysis

Box 1 represents a sequence of wood peat, the hearth complex and a cover of clay. A clay layer of 1 cm thick at 8.13 m -NAP formed the transition between the hearth complex and the underlying peat. The top of the hearth complex consisted of a thin reed layer (1 cm thick) with an even thinner clay layer (a few mms thick) underneath at 7.90-7.85 m -NAP. In the sediment of the hearth complex in the sample box, two additional reed layers were recognised (at 8.05 and 8.00 m -NAP) as well as a clay layer (at 8.10 m -NAP). Figure V.4 shows the analysis of a single pollen sample of box 1. Only the spectrum collected at 7.81 m -NAP in a clay layer contained sufficient pollen for analysis (pollen sum = 316). This sample was dominated by pollen of *Quercus* sp., *Corylus* sp., *Alnus* sp., Poaceae, Cyperaceae and monoletae psilatae fern spores. The herbs represent eutrophic marsh vegetation. The other pollen samples contained few pollen grains, charcoal and insect remains. Figure V.5 shows the results of the analysis of macroremains of box 1 (please note the variation in the sample volume within this box). Interestingly, macroremains of many taxa had been preserved in the sequence of peat, clay, reed and charcoal. Most taxa represent waterlogged macroremains of eutrophic marsh and reed vegetation. Stem remains and fruits of *Phragmites australis* were frequently found, while macroremains of trees and shrubs were absent. The macroremains diagram of box 1 does not show taxa that indicate brackish conditions, but *Atriplex* sp. and *Bolboschoenus* sp./*Schoenoplectus* sp./*Scirpus* sp. could represent such taxa, while many of the other taxa additionally tolerate brackish conditions.

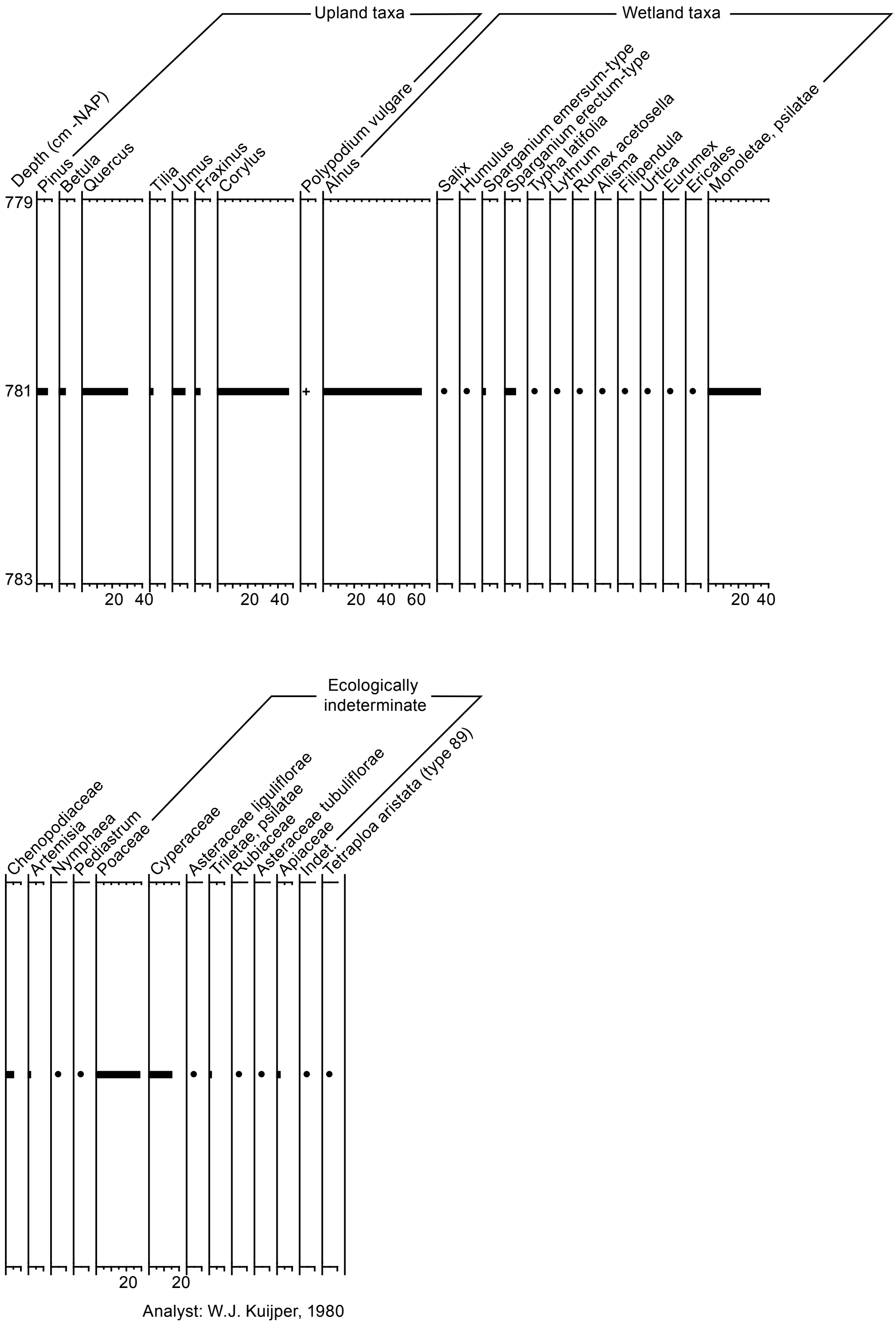

Figure V.4 Bergschenhoek, box 1, pollen, + = present, • = less than 1%.

The preservation of waterlogged macroremains in the hearth complex is remarkable and could be explained in various ways. Firstly, the macroremains could have been deposited by the water during periods that the hearth was not used. Alternatively, the macroremains could have been brought up by people as part of the reed bundles. In both cases the macroremains would represent plant material that remained outside the influence of the fire unintentionally. A second hypothesis is that the material was brought up with the intention to restrict the fire. It could have been brought up as part of moist organic material that was intentionally brought up the surface to protect the soil underneath from the fire, or with water or wet material that was used to extinguish the fire.

In addition to the waterlogged macroremains, several marsh taxa have been found in a carbonised state. The carbonised state of these taxa is in the first place considered to represent the burning of bundles of reed mixed with other marsh taxa, since all taxa found in a carbonised state could have been part of the local reed vegetation. These bundles were probably brought to the site to raise the surface level and/or improve the spatial lay-out of the hearth. The carbonised state could furthermore be the result of the carbonisation of macroremains deposited unintentionally by water, or intentionally by people with water or as part of the moist organic layer below the hearth (as discussed above). Another explanation, which is related to plant food, is discussed below (see discussion).

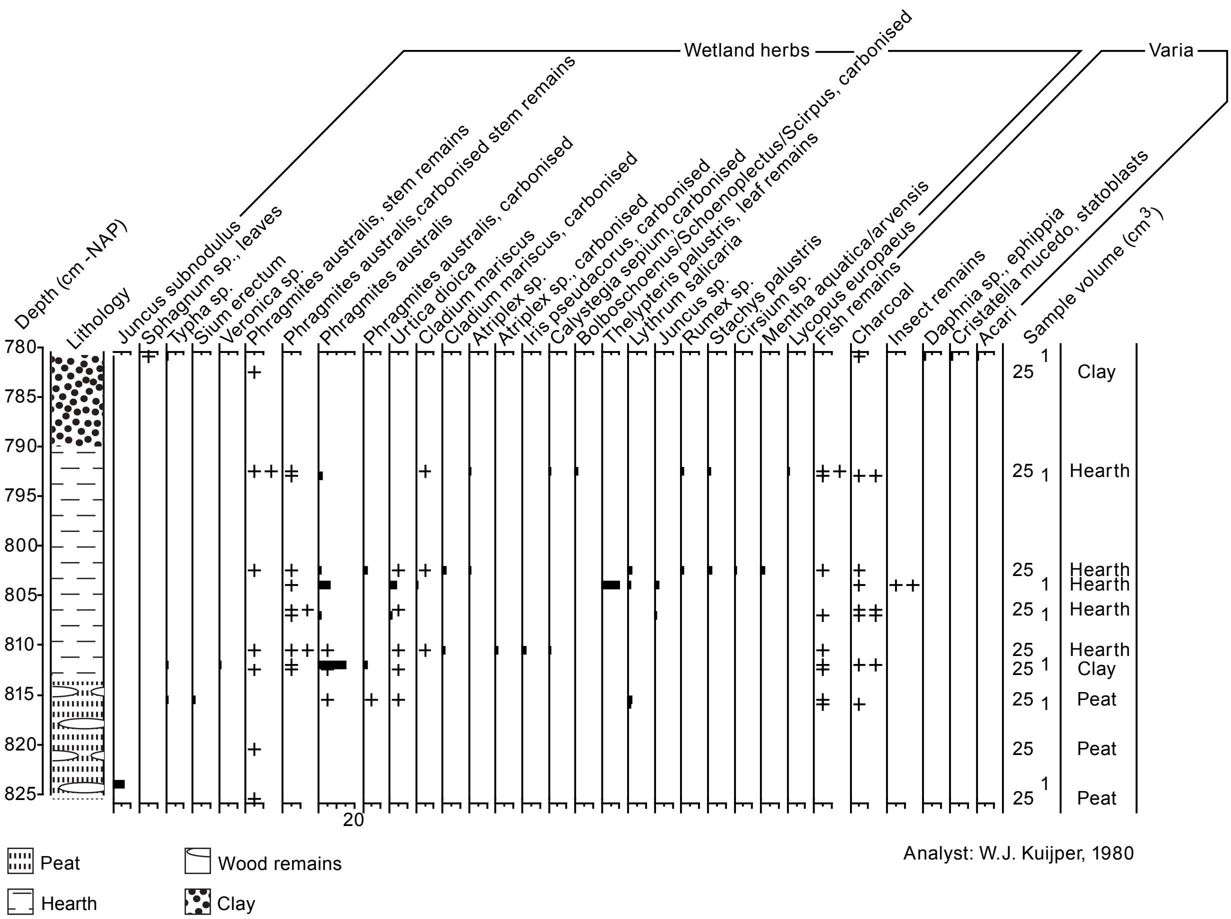

Figure V.5 Bergschenhoek, box 1, macroremains, + = few (1-9), ++ = several tens (10-49).

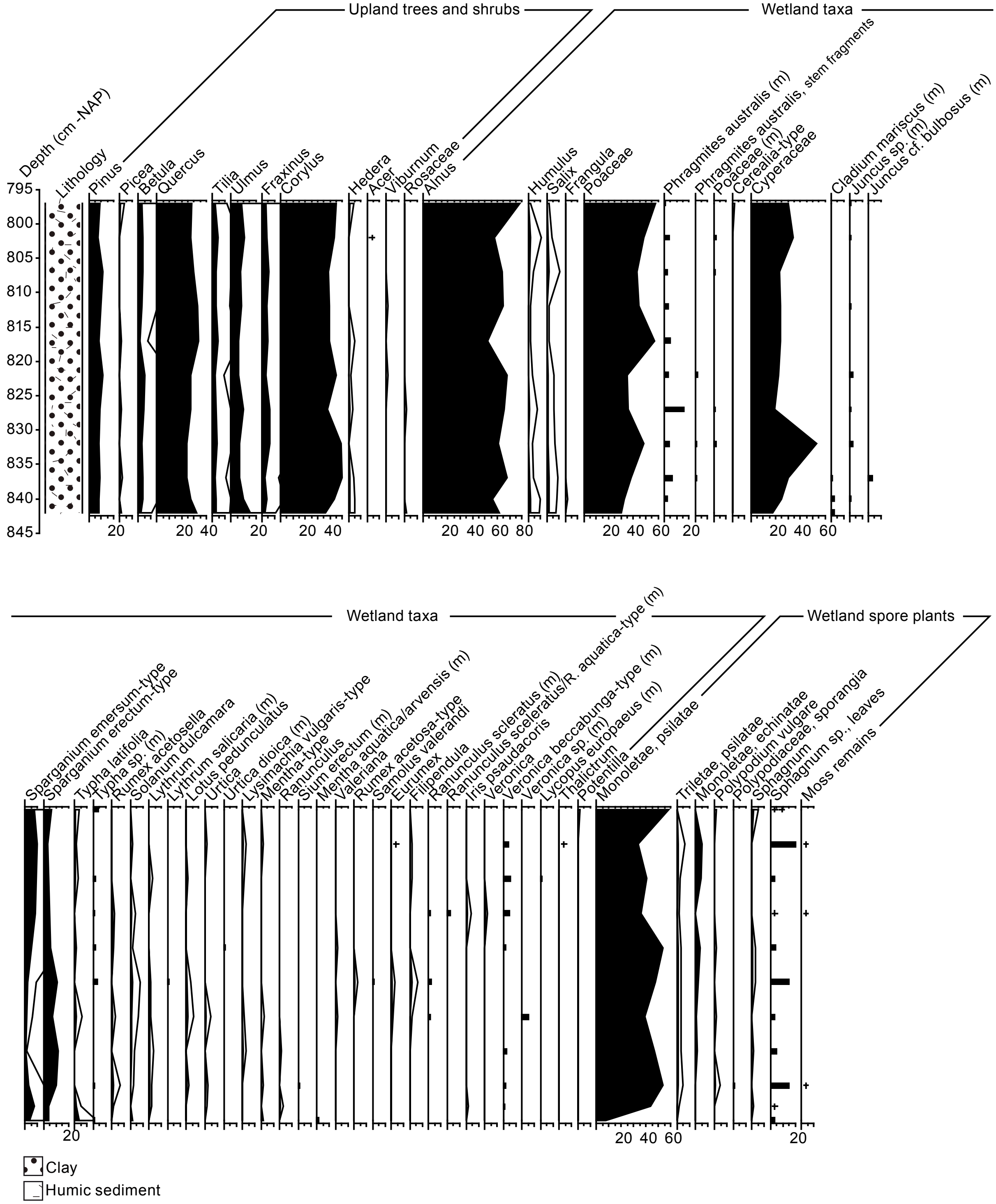

Figure V.6 part 1.

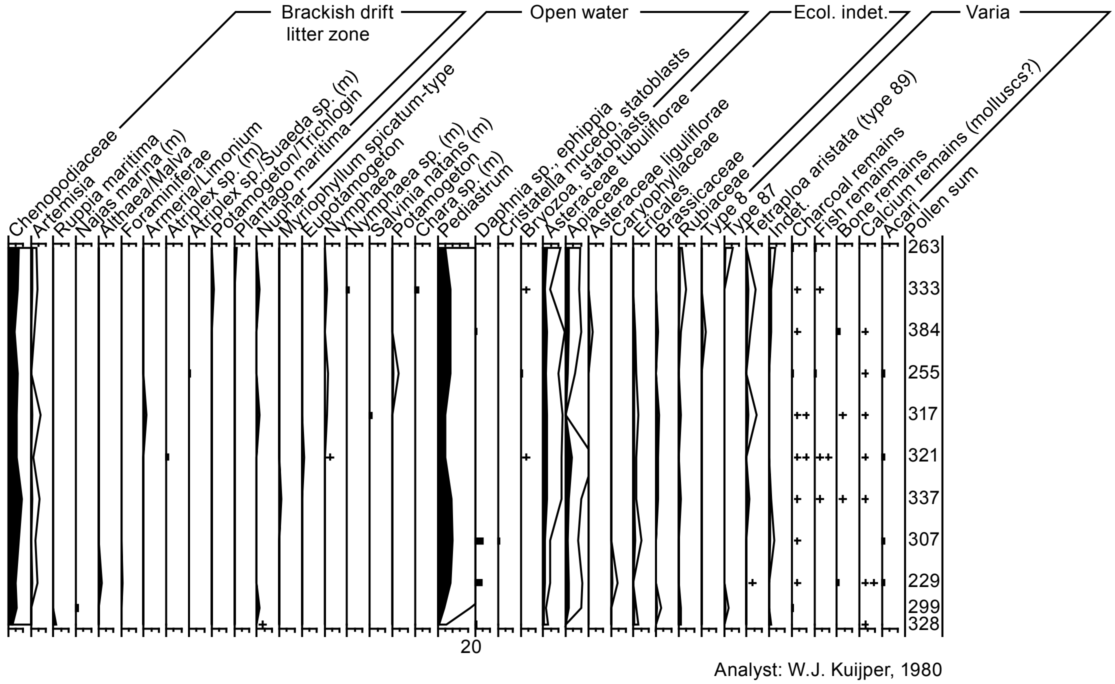

Figure V.6 Bergschenhoek, box 2, pollen and macroremains, m = macroremains s.l., + = few (1-9), ++ = several tens (10-49), part 2.

sample taxon	a	b	sample taxon	a	b
marsh vegetation			*marsh vegetation (cont.)*		
Atriplex sp.	-	1	Phragmites australis	11	-
Bolboschoenus sp./Schoeno-plectus sp./Scirpus sp.	2	2	Ranunculus sceleratus	2	-
			Solanum dulcamara	-	1
Carex pseudocyperus	1	2	Urtica dioica	1	-
Cladium mariscus	8	-			
Lycopus europaeus	2	-	*varia*		
Najas marina	1	-	Charcoal	+	+
Phragmites australis,			Fish remains	+	+
stem remains	+	+	Moss remains	-	2

+ = few (1-9)
- = not present

Table V.1 Bergschenhoek, box 2, additional macroremains, all waterlogged.
Sample a) depth: below 8.37 m -NAP, volume: 25 cm^3 ; sample b) depth: 8.37 - 8.31 m -NAP, volume: 75 cm^3.

The sediment of box 2 consisted of very humic clay, mixed with fine plant remains especially at 8.37-8.32 and 8.18-8.12 m -NAP. The level at 8.37-8.32 m -NAP also contained a small bone fragment and a mollusc. Figure V.6 (see previous pages) shows the results of the pollen and macroremains analysis of box 2. The preservation state of pollen of this sample box was relatively good. The identifications of the two additional macroremains samples of box 2 are given in table V.1 (see previous page).

In the lower part of the diagram of box 2, the macroremains of *Phragmites australis*, *Cladium mariscus*, *Juncus* sp., *Typha* sp., *Veronica beccabunga*-type and *Sphagnum* sp. indicate the local presence of reed marsh vegetation. *V. beccabunga*-type probably represents *V. catenata* when considering the local vegetation and environmental conditions (Weeda *et al.* 1988, 217). *Najas marina* and *Ruppia maritima* indicate brackish conditions. The first phase is followed by a peak in the curve of Cyperaceae pollen, and fruits of *C. mariscus* are replaced by seeds of *Juncus* sp., suggesting a decrease in the water depth resulting from local clay sedimentation.

The middle part of the diagram shows a decrease in Poaceae pollen and *V. beccabunga*-type seeds, and the increased presence of fruits of *Ranunculus sceleratus*, which grows on open, disturbed, very eutrophic and waterlogged soil (Weeda *et al.* 1985, 246). These changes probably correspond to human impact and represent the disturbance of the reed vegetation, since the values of charcoal and fish remains reach maximal values at these levels. At the same time, the composition of the herb taxa identified by pollen analysis shows a change, since the curves of *Lythrum* sp., *Lotus pedunculatus*, *Urtica* sp., *Lysimachia* sp., *Mentha*-type and *Ranunculus* sp.decrease, while the curves of *Valeriana* sp., *Rumex acetosa*-type, *Eurumex* and *Filipendula* sp. increase. These changes may indicate the development of forb vegetation in the reed, which may be related to human impact. Taxa indicative of brackish conditions are only represented by pollen identifications that may represent secondary deposition, and possibly by fruits from *Atriplex* sp. and *Atriplex* sp./*Suaeda* sp.

The middle part of the diagram shows the presence of a seed of *Samolus valerandi*, which grows on moist, moderate eutrophic or brackish soil in dune valleys and fens, and can be found together with *Phragmites australis*, *Bolboschoenus maritimus* and *Juncus maritimus* (Van der Meijden 1996; Weeda *et al.* 1988, 371-2). This find represents the oldest find of the Netherlands (RADAR version 2005) and is unique for Dutch Mesolithic and Neolithic wetland sites. Microremains of *Samolus* sp. are interestingly also reported from the Late Neolithic site Vlaardingen (Van Regteren Altena *et al.* 1963a). Waterlogged macroremains of this species have also been found at the Funnel Beaker site Wangels in north Germany (Kroll 2001).

In the upper part of the diagram the curve of Poaceae recovers, while seeds of *Typha* sp. are frequently present together with *Veronica beccabunga*-type. The curves of the herbs that decreased in the middle part of the diagram additionally increase in the upper part, while the curves of several herbs that were well represented in the middle part of the diagram decrease and disappear. This recovery indicates that the changes in the herb pollen composition in the middle part of the diagram are related to human impact, although the underlying process is not completely understood. In the uppermost sample a single Cerealia-type pollen grain is present. Again taxa indicative of brackish conditions are represented by pollen identifications only.

The diagram indicates that the local vegetation consisted of eutrophic marsh vegetation. The smooth curves of the dryland trees, the scarcity of shrubs and the absence of macroremains of trees and shrubs indicate the absence of trees and shrubs in the local vegetation, although the fluctuations in the curve of *Alnus* sp. indicate that this taxon may have been present in the extra-local vegetation.

Table V.2 shows the macroremains identifications from samples collected for analysis of molluscs. Three samples correspond to an early phase of occupation, three samples correspond to the period after occupation, and for some samples the context is unclear. The variation of taxa in these samples is large, which can be related to the relatively large volume and the potential variation in sample locations. The samples only contain waterlogged remains. Taxa indicative of eutrophic open water and marshes dominate. Taxa that are present in most samples are *Urtica dioica*, *Cladium mariscus*, *Schoenoplectus tabernaemontani*, *Carex pseudocyperus*, *Atriplex* sp. and *Sphagnum* sp. These were probably very common in the local vegetation, indicating reed and sedge marsh vegetation at the site, although seed production and selective preservation could play a role in the representation of some of these taxa as well. In contrast to the sample boxes, fruits and cones of *Alnus glutinosa* are present in several of these samples. A relatively rare species is *Ceratophyllum cf. submersum*, which was also found at Swifterbant and Rijswijk-A4 (Van Zeist and Palfenier-Vegter 1981; paragraph 3.9.2). A single sample contemporaneous with occupation contained macroremains of potential food plants, such as *Malus sylvestris*, *Corylus avellana* and *Prunus spinosa*. The charcoal samples also contained hazelnut shell fragments and three stones of *Prunus* sp. (preservation state unknown), and additionally carbonised apples (Bakels 1991, 283 based on pers. comm. Van Zeist). These remains probably represent gathered plant food (see also discussion). Taxa that are (potentially) indicative of brackish conditions were present in samples that represent the period during and after occupation: *Juncus maritimus*, *Bolboschoenus maritimus*, *Triglochin palustris* and *Najas marina*, which all tolerate both freshwater conditions and moderate brackish conditions. The samples that are not dated also contain *Aster tripolium* that favours brackish conditions.

In addition to the analysed samples, the excavators remember that they observed many rhizomes of *Nymphaea alba* and/or *Nuphar lutea* during excavation (especially in the early layer a that dates to the period before occupation), and many waterlogged pods of *Iris pseudacorus*, full of seeds (particularly in the reed that was used to raise the surface). These remains probably represent the natural vegetation, which is supported by their waterlogged state, although it cannot be excluded that the tubers and possibly the pods of *I. pseudacorus* had been collected. Carbonised seeds of *I. pseudacorus* have been found in the hearth at Bergschenhoek, at the Hazendonk and at Hardinxveld-Giessendam Polderweg (De Kort 1998). The carbonised state suggests handling by people, but a likely function is not known.

relation to occupation	during early occupation			after occupation		relation to occupation unknown			
sample	1461	1645	1229	trench 3	trench 3	core 29	23-05-78		WJKA/B
volume (litre)	0.1	0.25	0.1	0.1	0.2	0.1	0.5	1	0.5
sediment		detritus-gyttja		clay			humic clay	clayey detritus	clay
taxon									
Dryland vegetation									
Malus sylvestris	1	-	-	-	-	-	-	-	-
Corylus avellana	1	-	-	-	-	-	-	-	-
Prunus spinosa	1	-	-	-	-	-	-	-	-
Alnus glutinosa*	10	2	2	1	-	-	-	-	-
Alnus glutinosa*, cones	-	1	-	-	-	-	-	-	-
Urtica dioica	1	-	1	1	2	-	1	++	+
Moehringia trinervia	-	-	-	-	-	4	1	-	-
Persicaria maculosa	-	-	-	-	-	-	-	1	-
Carduus crispus	-	-	-	-	-	-	1	-	-
Persicaria lapatifolia, perigons	-	-	-	-	+	-	-	-	-

Table V.2 part 1.

relation to occupation	during early occupation			after occupation		relation to occupation unknown			
Marsh vegetation									
Alisma plantago-aquatica	2	2	cf. 2	-	-	-	-	1	-
Bolboschoenus maritimus	-	-	cf. +	3	-	-	-	-	-
Carex pseudocyperus	+	4	4	-	2	-	-	+	-
Carex sp.	-	-	4	-	4	-	-	-	-
Carex sp., bicarpellate	1	-	-	-	-	-	-	-	-
Carex sp., tricarpellate	+	6	-	-	-	-	-	-	-
Cladium mariscus	+++	++	++++	9	++	++	+	++	+
cf. Epilobium sp.	-	-	-	-	-	-	-	1	-
Eupatorium cannabinum	2	-	1	-	-	-	-	+	-
Iris pseudacorus	1	-	-	-	-	-	-	-	-
Lychnis flos-cuculi	-	-	1	-	-	-	-	-	-
Lycopus europaeus	-	-	-	-	-	-	1	+	1
Mentha aquatica/arvensis	1	-	1	-	1	-	-	+	-
Najas marina	2	-	4	1	-	-	-	-	-
Phalaris arundinacea	-	1	-	-	-	-	-	-	-
Phragmites australis	5	2	-	-	1	-	-	++	-
Rumex hydrolapathum	+	2	3	-	-	1	-	-	-
Schoenoplectus tabernaemontani	++	12	++	-	6	5	+	+	1
Solanum dulcamara	-	3	-	-	-	-	-	1	-
Sparganium cf. erectum	1	-	-	-	-	-	-	-	-
Stachys palustris	-	1	1	-	-	-	-	-	-
Typha sp.	2	1	2	-	-	-	-	+	-
Zannichellia palustris ssp. pedicellata	-	-	-	-	-	-	1	-	-
Wetland pioneer vegetation									
cf. Sium erectum	1	2	2	-	1	-	-	-	-
Hydrocotyle vulgaris	3	-	-	-	-	-	-	1	-
Ranunculus sceleratus	-	1	1	-	-	-	-	++	-
Triglochin palustris	1	-	-	-	-	-	-	-	-
Open water vegetation									
Nuphar lutea	22	1	1	-	-	-	-	-	-
Nymphaea alba	2	3	1	-	-	-	-	-	-

Table V.2 part 2.

relation to occupation	during early occupation		after occupation		relation to occupation unknown			
Open water vegetation (cont.)								
Ceratophyllum cf. submersum	-	-	3	-	-	-	-	-	-
Chara sp.	-	+	-	-	-	-	-	-	-
Potamogeton sp.	-	-	-	-	-	-	-	+	-
Ranunculus aquatilis-type	-	-	1	-	-	-	-	-	-
Brackish drift litter zone									
Aster tripolium	-	-	-	-	-	-	2	-	-
Aster sp.	-	-	-	-	-	-	-	-	+
Juncus maritimus	-	1	-	-	-	-	-	-	-
Ecologically indeterminate									
Apiaceae	-	-	-	-	-	-	-	1	-
Atriplex sp.	-	-	6	-	1	5	1	++	+
Zannichellia sp.	-	-	-	-	-	-	-	-	1
Varia									
Charcoal remains	+	+	-	-	-	+	-	+	-
Fish remains	-	++	+	-	-	+	-	-	-
Moss remains	-	+	-	-	-	-	-	-	-
Sphagnum sp., leaves	++	++	+	++	+	-	-	++	+
Insect remains	-	-	+	-	-	-	-	-	-
Electra crustulenta	-	+	-	-	-	-	-	-	-
Bryozoa, statoblasts	-	+	+	-	-	-	-	-	-
Cristatella mucedo, statoblasts	-	+	+	-	-	-	-	-	-
Lophopus crystallinus, statoblasts	-	+	-	-	-	-	-	-	-
Daphnia sp., ephippia	-	+	+	-	-	-	-	-	-
Foraminiferae	-	+	-	-	-	-	-	-	-
Acari	-	1	-	-	-	-	-	-	-
Nereis sp., mandibulae	-	1	3	-	-	-	-	-	-

+ = few (1-9) +++ = many tens (50-99) - = not present
++ = several tens (10-49) ++++ = several hundreds (100-499)

* *Alnus glutinosa*, a wetland species, is included in the dryland vegetation here as it was probably not part of the local marsh vegetation at Bergschenhoek.

Table V.2 Bergschenhoek, macroremains from the samples collected for malacological analysis, all waterlogged, part 3.

V.3.2 Wood and charcoal analysis

V.3.2.1 Wood and charcoal from the excavation in 1976

The test excavation of 1976 revealed the southern part of the site Bergschenhoek (see fig. V.2). Charcoal and wood finds from this excavation all represent material that was present on top of the peat. Table V.3 shows the results of the analysis of 624 ml of charcoal. Charcoal of *Alnus glutinosa* (520 ml) dominates the assemblage while *Fraxinus excelsior*, *Ulmus* sp. and *Prunus* sp. are represented by small quantities.

Tables V.4, V.5 and V.6 show the identifications of waterlogged wood, classified into unworked wood, worked wood (including artefacts) and wood from charcoal samples. The preservation of the waterlogged wood remains was relatively good. *Alnus glutinosa* (wood and bark) is dominant in all three categories, which indicates the presence of alder carr in the exploitation area of the site. Other taxa are *Fraxinus excelsior*, *Betula* sp. and *Salix* sp. *Betula* sp. was only found in the assemblage of worked wood, while *cf. Tilia* sp. was only found as rope.

sample taxon	29	30	40	43b	47b	47d	57	total
Alnus glutinosa	5	20	70	100	120	120	85	520
Fraxinus excelsior	-	-	2	20	1	25	-	48
Ulmus sp.	-	-	4	7	2	5	5	23
Prunus-type	-	-	-	4	-	-	-	4
Indet.	-	-	2	15	1	1	10	29

- = not present

Table V.3 Bergschenhoek, charcoal in milliliters (Casparie and Stuijts unpublished data).

sample	taxon	description
37a1	Alnus sp.	4 large fragments, partly carbonised
37a2	Alnus sp.	branch, 2 fragments, Ø 3.5 cm
38a	Alnus sp.	branch, Ø 1.3 cm
38g	Alnus sp.	branch, Ø 1.5 cm, three years
38j	Alnus sp.	small trunk, Ø 5 to 6 cm
38k	Alnus sp.	small trunk, Ø 4 to 4.5 cm
38l	Alnus sp.	small trunk, Ø 3 to 4 cm
28b*	Fraxinus sp.	roundwood, Ø 5.7 cm
37b	Salix sp.	7 branches, Ø 2.0 to 5.5 cm

Ø = diameter

Table V.4 Bergschenhoek, unworked wood used to reinforce the site surface (Casparie and Stuijts unpublished data).

sample	taxon	interpretation and description
28a	Alnus sp.	plank, 13 x 3.2 cm
28d	Alnus sp.	plank, 6 x 2.6 cm
38c **	Alnus sp.	small beam
38d **	Alnus sp.	small beam, 5 fragments
38e **	Alnus sp.	haft?, 4 fragments
38f **	Alnus sp.	beam or post, 3 fragments, pointed?
38h	Alnus sp.	2 wedges?, 4.1 x 1.8 cm
38i	Alnus sp.	pointed post, Ø 4.5 cm
38n **	Alnus sp.	plank, Ø 2 x 7.5 cm
38o **	Alnus sp.	plank, 2 x 8 cm
38p **	Alnus sp.	plank, 2.2 x 8.5 cm
39	Alnus sp.	plank, 1.8 x 12 cm
28c	Betula sp.	pointed post, Ø 4 to 4.5 cm
44	Betula sp.	twig with rope from bark of cf. Tilia
38b	Fraxinus sp.	haft?, Ø c. 3 cm
38s*	Fraxinus sp.	post, Ø 4.2 cm

Ø = diameter

* and ** = wood in different samples is similar and may be prepared (in the past) from a single tree

Table V.5 Bergschenhoek, worked wood including artefacts (Casparie and Stuijts unpublished data).

sample	taxon	quantity
29	Alnus sp., bark	2 ml
30	Alnus sp., bark	15 ml
47b	Alnus sp., bark	2 ml
47d	Alnus sp., bark	10 ml
40	Fraxinus sp.	1 small fragment

Table V.6 Bergschenhoek, wood from charcoal samples, see table V.3 for the corresponding sample numbers (Casparie and Stuijts unpublished data). ml = milliliter.

Wooden artefacts are beams of *Alnus* sp., two pointed posts of *Alnus* sp. and *Fraxinus* sp., two possible hafts of *Alnus* sp. and *Fraxinus* sp., two possible wedges of *Alnus* sp. and a twig of *Betula* sp. winded with rope of bark of *cf. Tilia* sp. (see photograph in Louwe Kooijmans 1977a). Unpublished drawings show that the finds comprised much more rope. Several worked remains of *Alnus glutinosa* may originate from a single tree (Casparie *s.a.*, see table V.5). The wedges may represent the waste of wood working (*cf.* Louwe Kooijmans and Kooistra 2006, 240-242).

The analysis of the wood resulted in observations on growing conditions and seasonality. Two fragments of *Fraxinus* sp. that may originate from the same tree both showed continuous growth that was very slow, especially during the last twenty years (28b and 38s). Bad growth conditions could be related to rising water tables, brackish conditions or competition amongst others. Five pieces of wood lacked wood formed during summer, indicating clearance during spring (28c, 38g, 38j, 38k and 38l).

It is likely that all wood excavated in 1976 was intentionally gathered and does not represent the local vegetation, since the results indicate that the wood remains represented trunks, branches and artefacts only, while small twigs, fruits and leaves of the attested taxa were very scarce. The bark remains could represent waste of wood working. This is supported by the scarcity of macroremains of *Alnus glutinosa* and the limited percentage of alder pollen, which would probably have been present in larger quantities if alder had been part of the local vegetation during occupation.

V.3.2.2 Wood from the excavation in 1978

Unpublished and published texts give some additional information on the further results of wood and charcoal identifications from Bergschenhoek. The finds of this excavation were collected from the peat and from the surrounding clay sediments. Unpublished notes by Louwe Kooijmans (primarily based on research by Casparie and Stuijts) mention *Alnus* sp., *Salix* sp., *Fraxinus* sp., *Betula* sp., *Tilia* sp., *Ulmus* sp., *Prunus spinosa* and *Malus sylvestris* as the attested wood species. Charcoal identifications are possibly included in this list. An unpublished manuscript (Casparie *s.a.*) provides information on materials and methods of the wood and charcoal analysis. The document shows that the results of the excavation in 1976 are not representative of the complete data set. Casparie discusses identification and possible confusion between the wood of *Cornus* sp. and *Viburnum* sp., *Alnus* sp. and *Corylus* sp. and *Salix* sp., *Populus* sp. and *Salix* sp., *Malus*-type and *Sorbus*-type, and *Prunus avium-type*, *Prunus padus-type* and *Prunus spinosa*-type. It is furthermore mentioned that it was very difficult to identify small branches of *Sambucus* sp. with certainty. Although the text presents methodology only and no results, it suggests identification and presence of all taxa that are mentioned in the discussion, with exception of the three *Prunus* types. The material interestingly included roots from *Malus*-type and/or *Prunus*-type. It is moreover noted that branches of *Malus*-type (including *Sorbus* sp.) and *Prunus*-type showed traumatic tissues (irregularly grouped cells formed in the region of wounds) that were interpreted as being indicative of the repeated removal of young branches (see also discussion).

The unpublished manuscript informs us on the charcoal analysis and mentions a volume of 1.5 litres corresponding with 1000 fragments. It is concluded that the species list resulting from charcoal identifications is shorter than that of the wood identifications, and that this is probably caused by the specific use of wood for fuel and not by the number of charcoal samples or identification problems. *Corylus* sp., *Betula* sp., *Viscum* sp. and *Sambucus* sp. “for example” were lacking in the charcoal assemblage, which suggests that these species were identified during wood analysis.

Comparison of all available data on wood identifications indicates the identification of *Alnus glutinosa*, *Betula* sp., *Cornus sanguinea*, *Corylus avellana*, *Fraxinus excelsior*, *Malus*-type, *Populus* sp., *Prunus spinosa*-type, possibly other *Prunus* types, Rosaceae, *Salix* sp., possibly *Sambucus nigra*, *Sorbus*-type, *cf. Tilia* sp., *Ulmus* sp., *Viburnum opulus* and *Viscum album*. The available information does not allow making separate lists of identifications of waterlogged wood and charcoal. The charcoal assemblage at least contained *Alnus glutinosa*, *Fraxinus excelsior*, *Prunus* sp. and *Ulmus* sp., and did not contain *Betula* sp., *Corylus* sp., *Sambucus* sp. and *Viscum* sp. The identification of waterlogged wood of *Viscum album* is remarkable since this species is only known from charcoal identifications from several Mesolithic and Early and Middle Neolithic Dutch wetland sites, but not from identifications of waterlogged wood (see chapter 7).

V.3.2.3 Other wood data

Publications and site maps inform that wood remains, including the remains of a dug-out canoe made of *Alnu*s wood[42] and the remains of several fish traps, had been laid down on the peat in two directions, at right angles to each other, in order to stabilise and raise the surface level. This function of the wood remains explains the presence of planks, pointed posts, roundwood, beams and unworked trunks and branches at the site. The presence of one of the fish traps in horizontal position in between two sub-layers of the hearth supports intentional deposition of this trap for stabilising the surface as well. For the other traps, the reason of deposition is less clear. Some of the remains together formed a platform (Louwe Kooijmans 1986, 10, 1987, 238, see also fig. V.2 and fig. 8.6). Several posts were found in vertical position, and may represent the supporting elements of the platform, or of another structure such as a hut. The common presence of wood at the site indicates that wood was sufficiently available in the exploitation area. The use of wood representing former artefacts for the improvement of the surface level however indicates that wood was not thrown away but was re-used if possible.

The most spectacular wood finds of Bergschenhoek are the remains of several fish traps. At least four fish traps are represented, and many scattered fragments suggest that the occupants of the site used even more fish traps. The fish traps date to various stages. One was found in the clay below the peat, one was found at the edge of the peat, one was found in the hearth and one was found elsewhere in the clay. Two fish traps contained funnels while one represents a funnel only. The largest fish trap, made of *c.* 200 withies kept together with two consolidating withies (hoops) and rope, has a length of 1.7 metres and at the opening a width of 0.6 metres. Unpublished documentation shows that the consolidating withies were pointed. The investigation of the fish traps included hundreds of identifications and thousands of observations of wood under the microscope for the determination of the age of the wood. The sample size was this large to get representative results on the taxa used for the fish traps. It is probable that all fish traps were investigated, although the number of identifications per separate fish trap is not known. All fish traps were made of unsplitted twigs of *Cornus cf. sanguinea* (dogwood) that had a length up to 2 metres and an age of 1 year, while some twigs had an age of 2 years. Unpublished information suggests that some elements of a trap may have been made of *cf. Sambucus* sp. (Casparie *s.a.*), but after further identification it has been concluded that all withies represent *C. cf. sanguinea* (pers. comm. Casparie 2007). There is no information on the identification of consolidating withies. The rope used as part of the fish traps has been identified as bark of *cf. Tilia* sp. (not *Juncus* sp. or *Scirpus* sp. as mentioned in other publications). In addition to the fish traps, two or three deformed, intensively coppiced stools (root systems) of dogwood were found at the site (pers. comm. Casparie 2007; precise location unknown). These stumps indicate that shrubs of *Cornus sanguinea* were growing within a few km distance from the site, and that they were cleared of their shoots at or near the site, indicating that some of the fish traps were manufactured locally.

42 The interpretation of several planks as a canoe is based on the shape and curve of the planks, the wood species, and the fine working of the wood (pers. comm. Louwe Kooijmans 2007).

Other excavated and published artefacts are two arrow shafts with an incision at the end and double pointed hooked sticks interpreted as leister prongs (wood identifications unknown). The presumed leister prongs have a length of *c.* 40 cm and are comparable with those known from Denmark and northern Germany dating to the Neolithic (Meurers-Balke 1981). A comparable wooden artefact made from *Fraxinus excelsior* is known from the Middle Neolithic site Ypenburg (Kooistra 2008). The Danish and German finds are reported to be made of *Corylus* sp. and Pomoideae dominantly and additionally of *Betula* sp., *Cornus sanguinea*, *Crataegus* sp., *Fraxinus excelsior*, *Malus* sp., *Pyrus* sp., *Sorbus* sp., *Quercus* sp., *Ulmus* sp. and *Viburnum* sp. (Meurers-Balke 1981, 135; Schmölcke *et al.* 2006; Skaarup 1980, 7).

V.3.3 Moss analysis

The data and interpretation of the mosses are based on an unpublished manuscript by During.[43] Table V.7 shows the identifications of mosses from 18 samples. The richest samples were excavated in 1976 and probably derived from the southern part of the site. The analysis resulted in the identification of many epiphytes, including taxa that could have lived on *Fraxinus* sp., *Ulmus* sp. and *Salix* sp., taxa living on tree stumps, taxa indicative of disturbed environments, and taxa living in marshes and reed vegetation. The species indicate the presence of marsh vegetation and carr or softwood alluvial woodland. A taxon that is mentioned explicitly in the document of During is *Hylocomium brevirostre*, which is nowadays a rare species of dune vegetation but may have occurred in fens in the past. There is no information on quantities except that relatively large quantities were found of *Anomodon viticulosus*, *Neckera* sp. (not *N. crispa*) and *Hylocomium brevirostre*. These large quantities may represent the intentional collection of these taxa at Bergschenhoek. Ten of the moss species found at Bergschenhoek were also found at Swifterbant (Van Zeist and Palfenier-Vegter 1981). This correspondence may be the result of similar natural vegetation in both regions, similar site formation processes and/or similar use of mosses.

V.3.4 Mollusc analysis

Table V.8 shows the results of the malacological analysis (see also the macroremains from the mollusc samples for further information on the contents of the samples). The samples, partly corresponding with the periods during and after occupation, showed the presence of 13 species, containing three species that prefer brackish conditions and ten species that prefer freshwater conditions. The number of freshwater species decreased through time. Remains of *Electra crustulenta*, frequently found on mollusc species that live in brackish water, were interestingly found growing on the freshwater species *Anodonta anatina*. The size and conditions of the molluscs as well as the ecological preferences of the taxa indicate that all taxa probably represent the local mollusc fauna. There are no explicit indications that the taxa were handled or gathered by people.

The species indicate the presence of a riparian zone at the edge of a calm body of open water where tidal influence was small or absent. The taxa furthermore indicate that the water was slightly brackish as the result of scarce marine influxes. Two interpretations are possible. Firstly, the water may have been slightly brackish continuously, resulting in the combined presence of taxa indicative of freshwater and brackish water. The transition between fresh and brackish water should have been very gradual to explain the presence of both fresh water and brackish water taxa. Secondly, the brackish influxes may have varied periodically (over a period of several years), and as a result indicators of freshwater and brackish water did not live at the site contemporaneously. The second scenario is considered as the most likely explanation.

43 Unpublished manuscript by H.J. During (1980), attached to a personal letter from W. van Zeist to W.J. Kuijper, 1 October 1998.

sample	1552	1566	1621	387	1223	1382	244	279	271	296	42	47A	47B	47C	48	49	50	54
taxon																		
Anomodon viticulosus	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Aulacomnium palustre	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Brachythecium																		
cf. rutabulum	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	-
Brachythecium velutinum	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+	-	+
Dicranoweisia cirrata	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Homalia trichomanoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Homalothecium sericeum	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	+	+
Hylocomium brevirostre	-	-	+	-	+	+	-	-	+	+	-	-	-	-	-	-	-	-
Hypnum andoi	-	-	-	-	-	+	-	-	-	-	+	+	+	+	+	+	+	+
Isothecium myosuroides	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
Kindbergia praelonga	-	-	-	-	-	-	-	-	-	+	+	+	-	-	+	+	-	-
Leptodictyum riparium	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+
Leucodon sciuroides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Neckera complanata	-	-	+	+	-	+	+	-	-	-	-	-	+	+	-	+	+	+
Neckera crispa	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neckera pumila	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Platyhypnidium riparioides	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Sphagnum palustre	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+	+	-	-
Ulota sp.	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-

+ = present

- = not present

Table V.7 Bergschenhoek, mosses (During unpublished data).

relation to occupation	during early occupation						during occupation						
sample	1131	1925	684	1229	1461	1645	285	519	912	913	trench 5, top fish trap	1161	1235
volume (litre)				0.1	0.1	5							
sample type	sf	sf	sf	sf	sf		sf	sf	sf	sf	sf	sf	sf
taxon													
Brackish water													
Cerastoderma glaucum	-	-	-	++	8	15	-	-	-	-	++	19	6
Hydrobia ventrosa	-	-	-	29	2	++	33	-	-	-	5	1	-
Scrobicularia plana	-	-	-	-	-	-	-	-	-	-	-	-	1
Fresh water													
Unio pictorum	1	-	-	1	1	-	-	-	-	-	-	-	-
Anondonta anatina	-	1	1	-	2	1	-	1	1	++	-	-	-
Bithynia leachii	-	-	-	-	-	-	-	-	-	-	-	-	-
Bithynia tentaculata	1	1	1	++	++	++	-	-	-	-	-	-	-
Planorbarius corneus	-	-	-	-	1	-	-	-	-	-	-	-	-
Planorbis planorbis	-	-	-	-	-	-	1	-	-	-	-	-	-
Radix peregra	-	-	-	-	-	-	3	-	-	-	3	-	-
Stagnicola palustris	-	-	-	-	-	-	1	-	-	-	1	-	-
Theodoxus fluviatilis	-	-	-	-	-	-	10	-	-	-	-	-	-
Valvata piscinalis	-	-	-	1	2	-	-	-	-	-	-	-	-

Table V.8 part 1.

relation to occupation	after occupation			relation to occupation unknown							
sample	trench 2	trench 2	trench 3	trench 2, 16-05-1978	trench 2, 05-05-1978	trench 2, 26/30-204/208	trench 2	core 29	WJK	WJKA	WJKB
volume (litre)		0.25	0.1					0.1		0.5	0.5
sample type	sf		sf	sf	sf	sf	sf		sf		
taxon											
Brackish water											
Cerastoderma glaucum	1	2	21	1	-	12	-	20	++	1	7
Hydrobia ventrosa	-	26	36	-	-	-	-	++	++	6	++
Scrobicularia plana	1	1	3	-	-	-	-	-	1	-	-
Fresh water											
Unio pictorum	-	-	-	2	2	-	2	-	-	-	-
Anondonta anatina	-	-	-	-	-	-	-	-	-	-	-
Bithynia leachii	-	-	-	-	-	-	1	-	-	-	-
Bithynia tentaculata	-	-	-	-	-	-	-	2	-	-	-
Planorbarius corneus	-	-	-	-	-	-	-	-	-	-	-
Planorbis planorbis	-	-	-	-	-	-	-	-	-	-	-
Radix peregra	-	-	-	-	-	-	-	-	-	-	-
Stagnicola palustris	-	-	1	-	-	-	-	-	-	-	-
Theodoxus fluviatilis	-	1	-	-	-	-	-	-	4	1	1
Valvata piscinalis	-	-	-	-	-	-	-	-	-	-	-

sf = single finds and hand-picked finds
++ = tens
- = not present

Table V.8 Bergschenhoek, molluscs (Kuijper unpublished data), part 2.

V.4 Discussion

V.4.1 Reconstruction of the natural vegetation

The reconstruction of the natural vegetation is based on all presented data including those from the sample boxes. The results from pollen and macroremains analysis from both boxes correspond very well with each other and indicate that Bergschenhoek was located in the middle of eutrophic reed marsh vegetation. The moss analysis partly confirms this interpretation. The pollen and macroremains data strongly indicate that trees were absent in the local vegetation, since marsh taxa dominate and macroremains from trees and shrubs are very scarce. Only *Alnus glutinosa* may have been present in the environs, since macroremains were found and since this taxon shows minor fluctuations in the pollen diagram of box 2. The macroremains of alder may have been transported by water or brought into the site with wood.

The data from the wood and charcoal and also some mosses give a quite different view on the vegetation than the pollen and macroremains since the results strongly indicate the presence of alder carr and alluvial woodland vegetation. The data from the moss analysis partly confirm this reconstruction of the natural vegetation as well. The most probable explanation for this contrast between the data sets of pollen, macroremains, wood and charcoal is that the pollen and macroremains primarily represent the local and extra-local vegetation while the wood was gathered at a larger distance. The mosses indicative of woodland would primarily have been brought in together with the wood or by the intentional gathering of the moss itself.

Alder, dominant in the wood and charcoal, was certainly the most common of all trees in the marshes that surrounded the site. The species probably did not grow at the excavated patch of peat itself, but may have been present at less than a km distance. *Salix* sp. may also commonly have been present in the marshes. Taxa such as *Cornus sanguinea*, *Malus*-type, *Populus* sp., *Prunus* sp., Rosaceae, *Sambucus nigra*, *Sorbus*-type and *Viburnum opulus* may have been present in patches of well-developed alder carr. They may also have grown in alluvial woodland vegetation on higher patches in the landscape, together with *Corylus avellana*, *Fraxinus excelsior* and *Ulmus* sp. The large variety of these taxa indicates that alluvial woodland vegetation was present within the exploitation area of Bergschenhoek, *i.e.* at a distance of *c.* 5 km (see paragraph 1.3). Locations where such vegetation may have grown were present are the dunes at Hillegersberg and the central station of Rotterdam at *c.* 2 km distance from Bergschenhoek (Guiran and Brinkkemper 2007; see also chapter 6). *Tilia* sp. may also have been present on the higher parts of these dunes. The absence of acorns and wood of *Quercus* sp. at Bergschenhoek is however remarkable since oaks are expected to have grown on the dunes as well (*e.g.* Voorrips 1964; see also chapter 2). A single exception to the indications of the absence of wood at the site itself are the finds of roots of *Malus*-type and/or *Prunus*-type, indicating the local presence of a species that belongs to these types, assuming that the collection and import of roots of such a species is unlikely. Local presence is tentatively confirmed by the presence of Rosaceae pollen. A possible candidate is *Sorbus aucuparia*, which is able to grow in reed marsh at patches with a relatively solid, dry surface and on dead wood (Weeda *et al.* 1987, 92). Scarce finds of macroremains of *M. sylvestris* and *P. spinosa* tentatively suggest the local presence of such trees, but these macroremains may also have been gathered elsewhere for consumption. Local presence of *M. sylvestris* and *P. spinosa* is furthermore less likely since the local environment was probably too wet for these taxa (in contrast to what was suggested in an earlier publication).

The habitat and possible local presence of *Cornus sanguinea* needs special attention (see discussion above and below). *C. sanguinea* may have grown in the river flood plains, woodland edges and woodland clearances (Weeda *et al.* 1987) and was probably not uncommon in the coastal region and river area (Out 2008b). It is however highly improbable that *C. sanguinea* grew at the site itself since the local environment was too wet. The unexpected presence of intensively coppiced stools of *C. sanguinea* at Bergschenhoek has therefore resulted in the conclusion that the shrubs were transported to the site from a nearby location.

The results of the archaeobotanical and malacological analyses indicate that the site was located in a riparian zone at the edge of a calm body of open water. The molluscs show a combination of freshwater and brackish water taxa, with a dominance of freshwater taxa, and indicate that the strength of brackish influxes may have varied periodically over a period of several years. The macroremains assemblage indicates slightly brackish conditions, since taxa that do not tolerate brackish conditions (*e.g. Caltha palustris*) are absent, since many attested freshwater taxa tolerate minor brackish conditions, and since most taxa that are indicative of brackish conditions also tolerate freshwater conditions. The brackish conditions must have been so moderate that alder carr could have survived, possibly on slightly elevated patches in the landscape. Macroremains of true halophilous plant taxa were probably part of the drift litter zone, where macroremains of local and non-local taxa are deposited during high water. This could especially concern fruits of *Ruppia maritima*, since the obligate preference of this species for brackish conditions does not correspond with the further results on salinity. Organic material in the drift litter zone furthermore may have represented an excellent habitat for species like Chenopodiaeceae (*C. glaucum* and *C. rubrum*) and *Atriplex* sp. Brackish influxes occurred at least during and after occupation, as indicated by both the botanical remains and the molluscs. The location of Bergschenhoek in between the tidal flats and freshwater marshes implies marine influxes from an estuary located at some distance in western direction.

V.4.2 Human impact

V.4.2.1 Human impact on the vegetation and deposition processes

The most direct aspects concerning human impact on the vegetation at Bergschenhoek are shown by the raising of the surface with wood and bundles of reed. The available data on wood (including drawings of the site) strongly support the intentional deposition for the improvement of the surface. The idea of intentional deposition of reed bundles, such as the large quantities and the uniform direction within single layers, is mainly based on observations during excavation (Louwe Kooijmans 1977a). In earlier publications the site Bergschenhoek has been compared with Swifterbant-S3, and the evidence and interpretation for raising the surface with reed is highly comparable between both sites (see also Van Zeist and Palfenier-Vegter 1981, 139).

The two sample boxes offer a unique possibility to study human impact. Box 1 represents a hearth complex on top of the peat. The results show that macroremains remained preserved in the hearth both in a carbonised and waterlogged state. Despite indications of intermittent occupation, the investigated spectra of box 2, sampled two metres further away and next to the peat, do not show clear separate occupation phases. There are indications of anthropogenic reduction of the reed vegetation and the development of forb vegetation, while a decrease in alder may be related to human impact as well. The diagram of box 2 does not show other indications of deforestation since woodland was not present in the (extra-) local vegetation.

Taxa of which macroremains were found in a carbonised state are *Phragmites australis*, *Cladium mariscus*, *Atriplex* sp., *Iris pseudacorus*, *Calystegia sepium*, *Bolboschoenus* sp./*Schoenoplectus* sp./*Scirpus* sp. (all in the hearth) and *Malus sylvestris* (location and precise context unknown). Fruits of *P. australis* (reed) were found in all hearth samples, and stem fragments of *Phragmites australis* were additionally found as well. Their carbonised state is in the first place considered to represent the carbonisation of bundles of reed mixed with other plants from reed vegetation (discussed above). In addition to this first interpretation, it can be added that some macroremains may represent remains of food preparation in the hearth (discussed below). The taxa found in a carbonised state in the hearth at Bergschenhoek are not known from hearths at other Late Mesolithic and Early and Middle Neolithic Dutch wetland sites, except for *Cladium mariscus* (see chapter 9). Taxa that are most commonly found in a carbonised state in hearths at Dutch wetland sites are *Corylus avellana*, *Quercus* sp., *Galium aparine* and *Cladium mariscus*, which are hardly found at Bergschenhoek.

The exceptional selection of taxa found carbonised in the hearth suggests that the carbonisation is the result of very specific deposition processes, which could be related to the construction and use of the hearth, as well as the natural vegetation around the hearth. Hearths at *e.g.* Hoge Vaart contained carbonised macroremains of many other marsh taxa (see chapter 5). Comparison of carbonised macroremains from hearths from Dutch Late Mesolithic and Early and Middle Neolithic wetland sites thus indicates that the available data sets on botanical macroremains are not representative yet for the variety of processes resulting in the deposition of plant material in hearths.

V.4.2.2 Plant subsistence

The number of macroremains from potential food plants found in a carbonised state at Bergschenhoek is remarkably small, leaving very little indications of consumption (see the following paragraph). Several explanations are possible, such as the influence of the sampling strategy, the number of samples, relevant use and preparation processes and locations, the function of the hearth and the recognition of plant food. The number of artefacts (other than wooden artefacts) is however relatively small as well, which indicates that the scarcity of plant food may be a true result of the activities at the site. This can be explained by the function of the site as a short-term hunting/fishing/fowling camp, where the collection of plant food did not play an important role, and by the seasonal human presence, since the site was occupied in autumn/winter (discussed below) when plant food was rather scarcely available in the natural vegetation. Storage of plant food presumably did not take place either at special activity sites as Bergschenhoek.

Most macroremains found in a carbonised state in the hearth may represent food plants. This concerns *Atriplex* sp. (edible fruits and leaves), *Bolboschoenus maritimus* (edible rhizomes and possibly fruits; Kubiak-Martens 2006), *Cladium mariscus* (edible fruits; Mears and Hillman 2007), *Phragmites australis* (edible rhizomes) and *Schoenoplectus* sp. (possible edible rhizomes and fruits; Mears and Hillman 2007). However, it can be questioned whether any edible parts were left of these plants in autumn and winter, especially concerning the leaves of *Atriplex* sp. On the one hand the carbonised finds in a context of possible food preparation support that they were used as food. On the other hand, the evidence of consumption of these taxa is not very strong, since they also could represent the natural vegetation used for raising the surface.

In addition to the carbonised finds of potential food plants, some of the waterlogged macroremains found at the site may represent food plants as well: macroremains of *Corylus avellana*, *Malus sylvestris* and *Prunus spinosa*, rhizomes of *Nymphaea alba* and/or *Nuphar lutea*, and several edible herbs (*e.g. Persicaria maculosa*). The evidence of consumption of these taxa is however restricted in view of the restricted evidence of handling by people. Only the consumption of *M. sylvestris* is supported by the finds of carbonised apples, and additionally the consumption of nuts of *C. avellana* since hazel was not part of the local vegetation and must have been brought to the site. The wood identifications furthermore indicate the availability of fruits of *Cornus sanguinea* (edibility discussed in chapter 9) and Rosaceae.

Local crop cultivation at the peat island Bergschenhoek was impossible in any case when considering the size of the site and the environmental conditions. Crop plants are represented at Bergschenhoek by a single pollen grain of Cerealia-type only. Its meaning remains unclear since there is no confirmation from the macroremains of cereals and since this single grain may represent one of the local grass species. Although no cereal grains were found, there is however no absolute evidence of the absence of macroremains, because systematic botanical sampling was not included in the excavation program. The absence of crop plants at Bergschenhoek is usually related to site function. The absence could however also be related to the absence of crop plants in the Swifterbant culture, but only if occupation took place at the beginning of the period 4350-4050 BC (see also chapter 11).

The reconstruction of the natural vegetation strongly indicates that wood must have been scarce in the direct vicinity of the site, and that the collection of wood must have taken place at some km distance from the site, where wood was not scarce. There are no indications that wood was imported from other macroregions over a large distance. A part of the mosses was probably collected at some km distance from the site as well. The moss data suggest the intentional collection of *Anomodon viticulosus*, *Neckera* sp. (not *N. crispa*) and *Hylocomium brevirostre*.

The artefacts and worked wood show that people used *Alnus glutinosa*, *Betula* sp., *Cornus sanguinea* and *Fraxinus excelsior* for the manufacture of artefacts. Most artefacts and worked wood concern alder. Although the small number of artefacts does not enable firm conclusions, this result suggests that people did not select their wood for manufacturing artefacts based on the quality of the wood and the function of the artefacts but used primarily the species most commonly available. This would mean that the choice for alder to make a dugout canoe does not necessarily represent selective choice either. The fish traps are a major exception since these offer excellent evidence that people selectively used twigs of *Cornus sanguinea* to make fish traps in a very skilful way, which moreover corresponds with other fish traps from the same period and region (Out 2008b).

The charcoal assemblage demonstrates the use of *Alnus glutinosa*, *Fraxinus excelsior*, *Prunus* sp. and *Ulmus* sp. for fuel, while other taxa were possibly used as well. The data do not indicate the selection of wood for fuel based on the qualities of the wood. It is instead more likely that the assemblage represents the availability of taxa in the exploitation area.

The investigation of the wood from Bergschenhoek resulted in the conclusion that shrubs of *Cornus sanguinea* were coppiced on a large scale and during a considerable period (Casparie 1995, 212-213). W.A. Casparie and I.L.M. Stuijts based this conclusion on the investigation of wood remains from Bergschenhoek on the one hand and research on the coppicing of dogwood at modern-day plant nurseries on the other hand. The aim here is to present the underlying arguments and to make them as clear as possible (based on pers. comm. Casparie 2007, 2008).

- For the fish traps hundreds of twigs of dogwood were used that mostly had an age of one year; some two years.
- The unnatural, exceptional length of the twigs (up to *c.* 2 metres) indicates that people had developed excellent coppicing techniques.
- The large numbers of twigs and the short live cycle of fish traps (three to four years) suggest that people used many thousands of twigs.
- The cut-off stumps found at the site were completely deformed, suggesting long-lasting coppice practices.

The data set strongly supports coppicing because of the large number of twigs with a similar age, the large length of the twigs and the finds of deformed stumps. The data set is moreover exceptionally representative because of the large number of identifications and age observations. Natural processes (drifting of ice sheets) can result in 'natural coppicing' as well, but it is hardly possible that this would have resulted in the availability of such good material. Wood of *Malus*-type and *Prunus*-type, not used for fish traps, furthermore showed traumatic tissues (irregularly grouped cells formed in the region of wounds), also suggesting coppicing. Hard evidence of coppicing practices in prehistory is very difficult to obtain (see chapter 8). The indications of coppicing at Bergschenhoek are however relatively strong, and represent the best of all indications of the coppicing of wood found at Dutch Mesolithic and Early and Middle Neolithic wetland sites, especially thanks to the work by W.A. Casparie and I.L.M. Stuijts.

In addition to coppicing, it has been proposed that people may even have cultivated dogwood (pers. comm. Casparie 2008). The assumed relatively low density of shrubs of *Cornus sanguinea* in the natural vegetation (not to confuse with common presence in the region) has resulted to the expectation that people would have relocated shrubs and put them together, perhaps as a kind of osier-beds, somewhere on the most suitable soils in the vicinity of Bergschenhoek in order to facilitate coppicing activities and the collection of the twigs, thus guaranteeing a sufficient supply of rods and reducing travelling time (Casparie 1995, 213). It may also be argued that the indications of the extraordinary well-developed coppicing technique imply cultivation. Dogwood is furthermore considered as a species that is highly suitable for pruning, coppicing, relocation and cultivation. For example, an osier bed consisting of *c.* 100 shrubs in an area of 50 x 50 metres would have been sufficient to produce 2000 suitable withies a year (*i.e.* 50% of the total of branches grown) that could be used for the manufacture of *c.* ten fish traps a year (see also the discussion on cultivation in Casparie 1986). The possibilities to prove or reject such a cultivation option and calculations are restricted, since it is not possible to reconstruct the origin of individual shrubs on such a detailed scale. The scenario therefore remains an option.

V.4.3 Seasonality

The carbonised state of some macroremains provides information on seasonality. Macroremains of *Calystegia sepium* and *Iris pseudacorus* are present between July-September and September-October respectively, indicating autumn. The carbonised finds of *Malus sylvestris* support the indications of autumn, although collection and storage of apples cannot be excluded. *Atriplex* sp. and *Phragmites australis* flower in late summer and autumn, and fruits can thus be expected in autumn as well. *Cladium mariscus* flowers in June and July and may indicate late summer or early autumn. All taxa may have been deposited before getting carbonised. Taxa that flower or produce macroremains in spring and early summer are however clearly absent. It can thus be concluded that the new information on seasonality from the macroremains indicates autumn or winter occupation. A small number of wood remains indicate clearance during spring. The indications of coppicing and local manufacture of fish traps imply activity during autumn or winter since this is the best period for the collection of twigs. Overall the new archaeobotanical results confirm the earlier conclusions on seasonal late autumn and winter occupation.

V.5 Acknowledgements

This appendix is dedicated to Wil Casparie (†) who was actively involved in the investigations on the site Bergschenhoek and gave much support during the writing of this appendix. The author would like to thank I.L.M. Stuijts, L.B.M. Verhart, L.P. Louwe Kooijmans, C.C. Bakels, W.J. Kuijper and C.E. Vermeeren for permission to use the available data and for information, suggestions and discussion.