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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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7. Reconstruction of the natural vegetation

7.1 Abiotic factors influencing the natural vegetation

During the Middle Holocene, a mild Atlantic climate occurred in the Netherlands, with a mean year temperature of 10° C and 700-800 mm of annual precipitation. Minor fluctuations in climate may have occurred. The period of 5500-3400 BC belongs to the Atlantic and the Sub-Boreal. The Atlantic climate was humid, with a mean summer temperature that was 2 °C warmer than the present climate. Summers were warm and long, while winters were mild and wet (Bakels 1978; Berendsen 1997b; Zagwijn 1986).

The studied Dutch wetland sites dating to the Late Mesolithic, Swifterbant culture and Hazendonk group are located in the Dutch delta where the rivers Rhine, Meuse and Vecht ran into the North Sea. The central river area was located in the Rhine/Meuse river district of the delta, the Vecht region was located in a similar, more northern, district at the border of a lagoon, the Eem region was located in a peat district bordering the same lagoon, and the coastal region was located in the tidal flat and dune district that was directly influenced by sea.

An important process influencing the character and development of the vegetation in the studied regions is the gradual rise of the ground water level, primarily influenced by the eustatic rise of the Mean Sea Level (see fig. 2.1). From 7000 to 4000 BC the sea level rose about 25 metres. The average rate of sea-level rise slowed down through time, with a decline in the rate occurring at *c.* 5650 BC (see paragraph 2.1.4 for a further discussion on the factors that influence the ground water level).

Another factor influencing the development of the vegetation, primarily in the coastal region but indirectly also in other regions, is the formation of a closed beach ridge and the start of progradation of the coast (see paragraph 3.1 for further discussion). The development of a beach-barrier resulted in a more calm conditions behind the coast, and a decrease in marine influence (Berendsen 1997a; Louwe Kooijmans 1985).

7.2 Woodland vegetation

The discussion of woodland vegetation provides presence/absence data on unworked wood and charcoal from trees and shrubs in order to reconstruct the presence and availability of individual species. The finds were mainly derived from refuse layers but also from specific contexts or concentrations. It is assumed that these categories will show the major trends in the presence of taxa for each region. A first underlying assumption is that unworked wood primarily represents the natural vegetation of the site and the exploitation area around the site, although it cannot be excluded that unworked wood represents the waste product of wood working that may have been selected because of its qualities and may have been brought in. A second assumption is that charcoal primarily represents the natural vegetation of the exploitation area, based on the principle of least effort (Shackleton and Prins 1992), although it is likely that people also selected fuel wood for its burning qualities (Shackleton and Prins 1992; Smart and Hoffman 1988; see paragraph 8.7 for further discussion).[1]

1 In order to reconstruct the natural vegetation optimally, future analyses should not include charcoal data from specific contexts such as hearths (*cf.* Asouti 2005).

Table 7.1 shows the identifications of presumably unworked wood from Late Mesolithic and Early and Middle Neolithic wetland sites for which data are available (N = 11) in order of region as well as from three comparable Dutch Late Neolithic sites.[2] The data are based on literature presented in the first part of this thesis and on Zeiler (1997, 210-211). Identifications of some taxa are given on a species level, even though the original identifications were less specific, when this is considered as unproblematic (*e.g.* identifications of *Corylus* sp. are given as *C. avellana* since this *Corylus* species is the only one species known of other archaeobotanical finds (macroremains), from this period and study area and from surrounding regions). The data of the Eem region and Vecht region are placed under the heading "northern regions", and the sites in the central and western river area are placed under the heading "river area". Comparison of the number of identifications per site shows that the representativity of the data varies between sites, which presumably influences the number of taxa per site.

The unworked wood of the studied sites includes at least 22 taxa. Taxa that are found in an unworked state at most Late Mesolithic and Early and Middle Neolithic sites are *Alnus glutinosa*, *Fraxinus excelsior*, *Quercus* sp., *Corylus avellana* and *Salix* sp. (in order of importance, see table 7.1). Comparison of the unworked wood between regions shows that the number of taxa is maximal in the coastal region (19 taxa) and minimal in the northern regions (12 taxa). The small number of sites in the northern regions for which unworked wood data are available probably plays a role here (N = 2). *Juniperus communis* is frequently found in the coastal area and not in the other regions. Comparison of the studied sites with the Late Neolithic sites suggests similarity.

The importance of taxa in the unworked wood of the Late Mesolithic and Early and Middle Neolithic sites has also been investigated at site level (see table 7.2). The Late Neolithic sites are not included in this analysis since they are not part of the scope of the study. The three taxa dominant at a single site were given 3, 2 and 1 points in order of importance, and the total scores of taxa (based on all sites) were compared (the sum of dominance).[3] This analysis shows that *Alnus* sp. is by far the most dominant at the majority of sites, followed by *Quercus* sp., *Salix* sp. and *Ulmus* sp. Comparison with table 7.1 shows that *Alnus glutinosa* and *Quercus* sp. are found at many sites and also in high numbers, that *Fraxinus excelsior* and *Salix* sp. are found at many sites but only in moderate numbers, and that *Ulmus* sp. is found at relatively few sites but in considerable numbers.

Table 7.3 shows the available charcoal identifications from almost the same group of sites (N = 13) and from comparable Dutch Late Neolithic sites. Again the number of identifications shows that the representativity of the data sets probably varies. Furthermore, the data set from the various sites is obtained by research based on different methods (*e.g.* no uniform size of the investigated fractions, and the use of various excavation methods and sampling strategies). The charcoal identifications include at least 23 taxa. The data are based on the same sources as the unworked wood identifications, and on Bastiaens *et al.* (2007). Taxa that are found at many of the Dutch Mesolithic and Early and Middle Neolithic sites are *Alnus glutinosa*, *Fraxinus excelsior*, *Quercus* sp., *Corylus avellana* and *Ulmus* sp. Comparison of the charcoal identifications between regions shows that the diversity of taxa is maximal in the coastal region (27 taxa), while the number of taxa is equally smaller in the river area and northern regions (17 and 19 taxa). Taxa found at many sites in the coastal region are *Alnus* sp., *Fraxinus excelsior*, *Juniperus communis*, Pomoideae and *Prunus* sp. Taxa found at many sites in the river area are *Alnus* sp., *Fraxinus* sp. and *Ulmus* sp. The taxa that are frequently found in the northern regions are more similar to the taxa from the river area than to the taxa from the coastal region. The taxa of the Belgian site Doel and the taxa of the Late Neolithic sites are quite similar to the taxa found at the Dutch Mesolithic and Early and

2 Most data on unworked wood and charcoal identifications that were available are included. Unidentified finds are not given in the tables 7.1 and 7.2 but are included in the total number of identifications. The data of the Hazendonk include only the data of the phases of the Swifterbant culture and the Hazendonk group. The data of unworked wood from Vlaardingen comprise the finds that are not reported as worked wood or artefacts (Van Beek 1990). Identifications from Vlaardingen that possibly represent worked wood or artefacts are excluded, as well as unlikely identifications. The identification of *Sorbus aucuparia* from Vlaardingen is discussed in appendix VI. The data of Vlaardingen are approached in the same way in table 7.3.

3 The points were only assigned when the data allowed this. The points have been assigned different than explained here for example when there were only two dominant taxa, two equally important dominant taxa, *etc*.

Middle Neolithic regions. *Sorbus* sp. is only found in the charcoal assemblages of some of the Late Mesolithic and Early and Middle Neolithic sites studied, and not with certainty in the assemblages of waterlogged wood (or macroremains; see also paragraph 7.3.5).

The importance of taxa in the charcoal identifications of the Late Mesolithic and Early and Middle Neolithic sites has also been investigated at site level (see tables 7.4 and 7.5). Again the Late Neolithic sites are not included in the analysis since they are outside the scope of the research. The three taxa dominant at a single site were given 3, 2 and 1 points in order of importance, and the total scores of taxa (based on all sites) were compared. The analysis of the most important charcoal taxa for individual sites was based on the number of identifications and based on the charcoal weight.

The analysis of the total dominance scores of taxa of the 11 Late Mesolithic and Early and Middle Neolithic sites gives more or less uniform results when comparing the number of identifications and the weight data. *Alnus* sp., *Quercus* sp., Pomoideae and *Fraxinus* sp. are dominant at most sites although the relative importance of *Quercus* sp. on the one hand and *Fraxinus* sp. and Pomoideae on the other hand differs for each method. The results indicate that *Quercus* sp. is often identified but that the weight of this taxon is relatively limited. A possible explanation is that small fragments of *Quercus* sp. can be identified relatively easy compared to small fragments of other taxa.

Comparison of table 7.3 and tables 7.4 and 7.5 shows that charcoal of *Alnus glutinosa*, *Quercus* sp. and *Fraxinus excelsior* is found are many sites and in considerable quantities, while charcoal of Pomoideae is found in considerable quantities but at less sites. The charcoal data are further discussed in chapter 8.

The patterns in the presence/absence data of unworked wood and charcoal from the various sites strongly correspond to each other, which supports the assumption that the finds generally represent the vegetation (or natural resources in the case of *Pinus* sp.) at the sites and in the surrounding exploitation areas. The charcoal identifications and the importance of Pomoideae charcoal are further discussed in paragraph 8.7.

site / taxon	Acer sp.	Alnus glutinosa	Betula sp.	Cornus sanguinea	Corylus avellana	Crataegus-type	Euonymus europaeus	Fraxinus excelsior	Hedera helix	Juniperus communis	Ligustrum vulgare	Lonicera periclymenum	Malus-type	Pinus sp.	Populus sp.	Pomoideae
River area																
Bergschenhoek	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Hazendonk	+	+	-	+	+	-	-	+	-	-	-	-	-	-	-	+
Brandwijk-Kerkhof	-	+	-	+	+	-	-	+	-	-	-	-	-	-	-	+
De Bruin	-	+	+	+	+	-	+	+	-	-	-	-	-	-	-	+
Polderweg	+	+	-	+	+	-	-	+	-	-	-	-	-	-	-	+
Coastal region																
Rijswijk-A4	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Wateringen 4	+	+	-	+	+	-	-	-	-	+	-	-	-	-	-	+
Schipluiden	-	+	-	+	+	-	+	+	-	+	+	-	-	-	-	+
Ypenburg	+	+	-	+	+	-	-	+	-	+	-	-	-	+	-	+
Northern regions																
Swifterbant-S3	-	+	+	-	+	-	-	+	-	-	-	-	+	-	+	-
Hoge Vaart-A27	-	+	+	-	-	-	-	+	-	-	-	-	-	+	-	-
total (N sites)	4	11	3	7	8	-	2	9	-	4	1	-	1	2	1	7
Late Neolithic																
Hazendonk	+	+	-	+	+	-	-	+	-	-	-	-	-	-	-	+
Hekelingen III	+	+	-	+	+	+	-	+	+	-	-	-	-	-	-	-
Vlaardingen	+	+	-	-	+	+	-	+	-	-	-	+	-	-	-	-

+ = present - = not present

Table 7.1 part 1.

site \ taxon	Prunus sp.	Prunus spinosa-type	Prunus padus-type	Quercus sp.	Rhamnus cathartica	Rhamnus frangula	Rosa-type	Salix sp.	Sorbus aucuparia	Taxus baccata	Tilia sp.	Ulmus sp.	Viburnum opulus	Identifications (N)
River area														
Bergschenhoek	-	-	-	-	-	-	-	+	-	-	-	-	-	15
Hazendonk	-	-	-	+	-	-	-	-	-	-	-	+	+	100
Brandwijk-Kerkhof	-	-	-	+	-	-	-	-	-	-	-	-	-	46
De Bruin	-	-	-	+	-	cf.+	-	+	-	-	+	+	+	188
Polderweg	-	-	+	+	-	-	-	+	-	-	+	+	+	225
Coastal region														
Rijswijk-A4	-	-	-	-	-	-	-	+	-	-	-	-	-	3
Wateringen 4	-	cf. +	cf. +	+	-	-	-	-	-	-	-	-	-	64
Schipluiden	+	+	-	+	+	-	+	+	-	+	-	+	+	440
Ypenburg	+	-	-	+	+	-	-	+	-	+	-	-	+	243
Northern regions														
Swifterbant-S3	-	-	-	+	-	-	-	+	-	-	-	+	-	92
Hoge Vaart-A27	-	-	-	+	+	-	-	+	-	-	+	-	-	202
total (N sites)	1	2	2	9	3	1	1	8	-	2	3	5	5	
Late Neolithic														
Hazendonk	+	-	-	+	-	-	-	+	-	-	-	+	-	125
Hekelingen III	-	+	-	-	-	-	cf. +	+	-	-	-	+	-	946
Vlaardingen	-	+	-	-	-	-	-	-	+	+	-	+	-	?

+ = present - = not present

Table 7.1 Studied sites and comparable Late Neolithic sites, unworked wood, part 2.

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

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

Table 7.2 Studied sites, unworked wood, the three most important taxa from each site.

site / taxon	Acer sp.	Acer campestre	Alnus glutinosa	Betula sp.	Cornus sanguinea	Corylus avellana	Euonymus europaeus	Fraxinus excelsior	Ilex aquifolium	Juniperus communis	cf. Ligustrum sp. / cf. Lonicera sp.
River area											
Barendrecht 20.125	-	-	+	-	+	-	-	+	-	-	-
Bergschenhoek	-	-	+	-	-	-	-	+	-	-	-
Brandwijk-Kerkhof	-	-	+	-	+	+	-	+	-	-	-
De Bruin	-	-	+	cf. +	+	+	-	+	-	-	-
Polderweg	-	-	+	+	+	+	+	+	-	-	-
Coastal region											
Sion	-	-	+	-	-	-	-	+	-	+	-
Wateringen 4	-	-	+	-	+	-	-	+	-	+	-
Schipluiden	-	-	+	-	+	+	+	+	-	+	+
Ypenburg	+	-	+	+	+	+	+	+	+	+	-
Northern regions											
Swifterbant-S3	-	-	+	+	-	+	-	+	-	-	-
Schokland-P14	+	-	+	-	-	+	-	+	-	-	-
Hoge Vaart-A27	+	-	+	+	-	+	+	+	-	-	-
Belgium											
Doel Deurganckdok -sector B	-	-	cf. +	-	+	+	-	+	-	-	-
total (N sites)	3	-	13	5	8	9	4	13	1	4	1
Late Neolithic											
Hekelingen III	-	-	+	-	+	+	-	+	-	-	-
Vlaardingen	-	+	+	+	-	+	-	+	-	-	-

+ = present - = not present

Table 7.3 part 1.

site / taxon	cf.Ligustrum sp.	Malus-type	Pinus sp.	Populus sp.	Pomoideae	Prunus sp.	Prunus spinosa-type	Prunus avium/padus	Prunus avium-type	Prunus sp./Sorbus aucuparia	Quercus sp.	Rhamnus sp.	Rhamnus catharica
River area													
Barendrecht 20.125	-	-	-	-	+	-	-	-	-	-	-	-	+
Bergschenhoek	-	-	-	-	-	+	-	-	-	-	-	-	-
Brandwijk-Kerkhof	-	-	-	-	-	-	-	-	-	-	+	-	-
De Bruin	-	-	-	-	+	-	-	-	+	-	+	-	+
Polderweg	-	-	-	-	+	-	-	-	-	-	+	-	+
Coastal region													
Sion	-	-	-	-	+	+	-	-	-	-	-	-	-
Wateringen 4	-	-	-	-	+	+	cf. +	-	+	+	+	-	+
Schipluiden	-	-	-	-	+	+	+	-	-	-	+	-	+
Ypenburg	+	-	+	-	+	+	+	+	-	-	+	-	+
Northern regions													
Swifterbant-S3	-	+	+	+	-	-	-	-	-	-	+	-	-
Schokland-P14	-	-	-	-	-	-	+	-	-	-	+	-	-
Hoge Vaart-A27	-	-	+	+	+	-	-	-	-	-	+	-	+
Belgium													
Doel Deurganckdok -sector B	-	-	-	-	-	+	-	-	-	-	+	-	-
total (N sites)	1	1	3	2	8	6	3	1	2	1	10	-	7
Late Neolithic													
Hekelingen III	-	+	-	-	-	-	+	-	-	-	+	+	-
Vlaardingen	-	-	-	-	-	-	-	-	-	-	+	-	-

+ = present - = not present

Table 7.3 part 2.

site / taxon	Rhamnus frangula	Salix sp.	Tilia sp.	Ulmus sp.	Viburnum opulus	Viscum album	cf. Sambucus sp.	Sorbus sp.	Sorbus aucuparia	Taxus baccata	Identifications (N or ml)
River area											
Barendrecht 20.125	-	-	-	+	-	-	-	-	-	-	106
Bergschenhoek	-	-	-	+	-	-	-	-	-	-	624 ml
Brandwijk-Kerkhof	-	-	-	-	+	-	-	-	-	-	109
De Bruin	+	+	-	+	+	+	-	-	cf. +	-	607
Polderweg	+	+	-	+	+	+	-	-	-	-	577
Coastal region											
Sion	-	-	-	-	-	-	-	-	-	-	96
Wateringen 4	-	-	-	-	-	-	-	-	-	-	66
Schipluiden	-	+	-	-	+	-	-	-	-	-	1134
Ypenburg	+	+	-	+	+	cf. +	-	+	-	+	1553
Northern regions											
Swifterbant-S3	-	+	+	+	-	-	-	-	-	-	848 ml
Schokland-P14	+	+	-	+	-	-	-	-	-	-	421
Hoge Vaart-A27	-	+	+	+	+	+	-	-	-	-	7633
Belgium											
Doel Deurganckdok -sector B	-	+	+	+	+	+	-	+	-	-	1036 + ?
total (N sites)	4	8	3	9	7	5	-	2	1	1	
Late Neolithic											
Hekelingen III	-	+	-	+	-	-	+	-	-	-	4016 ml
Vlaardingen	-	+	-	+	-	-	-	-	-	-	?

+ = present　　- = not present

Table 7.3 Studied sites and comparable Late Neolithic sites, charcoal. The identifications are provided in millilitres when the number of identifications is unknown, part 3.

site / taxon	*Alnus glutinosa*	*Corylus avellana*	*Fraxinus excelsior*	*Juniperus communis*	Pomoideae	*Prunus* sp.	*Quercus* sp.	*Salix* sp.	*Sorbus* sp.
River area									
Barendrecht 20.125	3	-	2	-	-	-	-	-	-
Brandwijk-Kerkhof	3	2	2	-	-	-	-	-	-
De Bruin	3	1	2	-	-	-	-	-	-
Polderweg	3	1	1	-	-	-	2	-	-
Coastal region									
Sion	3	-	-	3	2	-	-	-	-
Wateringen 4	-	-	-	-	3	-	-	-	-
Schipluiden	3	-	-	-	2	1	-	-	-
Ypenburg	3	-	1	-	-	-	2	-	-
Northern regions									
Schokland-P14	3	-	-	-	-	-	2	1	-
Hoge Vaart-A27	2	-	-	-	1	-	3	-	-
Belgium									
Doel Deurganckdok-sector B	2	-	-	-	-	-	3	-	1
total (sum of dominance)	28	4	8	3	8	1	12	1	1

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

Table 7.4 Studied sites, charcoal, the three most important taxa from each site, based on the number of identifications.

site / taxon	Alnus glutinosa	Corylus avellana	Fraxinus excelsior	Juniperus communis	Pinus sp.	Pomoideae	Prunus sp.	Quercus sp.	Rhamnus cathartica	Salix sp.	Ulmus sp.
River area											
Barendrecht 20.125	3	-	2	-	-	-	-	-	-	-	-
Bergschenhoek	3	-	2	-	-	-	-	-	-	-	1
Brandwijk-Kerkhof	3	2	1	-	-	-	-	-	-	-	-
De Bruin	3	-	2	-	-	-	-	-	-	-	1
Polderweg	3	1	-	-	-	-	-	2	-	-	-
Coastal region											
Sion	3	-	1	-	-	2	-	-	-	-	-
Wateringen 4	2	-	-	1	-	3	-	-	-	-	-
Schipluiden	3	-	-	-	-	2	1	-	1	-	-
Ypenburg	3	-	-	-	1	-	-	2	-	-	-
Northern regions											
Swifterbant-S3	3	1	-	-	-	-	-	-	-	1	2
Hoge Vaart-A27	2	-	-	-	-	1	-	3	-	-	-
total (sum of dominance)	31	4	8	1	1	8	1	7	1	1	4

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

Table 7.5 Studied sites, charcoal, the three most important taxa from each site, based on the weight.

7.3 Discussion of some woodland species

7.3.1 *Pinus* sp.

Wood from *Pinus* sp. has been found at the wetland sites Jardinga, Alblasserdam-Nieuw Kinderdijk, Ypenburg, Swifterbant-S3 and Hoge Vaart, dating to the Pre-Boreal and/or Boreal when dated (Bottema-MacGillavry 2003; Casparie *et al.* 1977; Van Haaster 2008; Kooistra and Hänninen 2008; Van Rijn and Kooistra 2001, 17). The wood does not represent the natural vegetation during Late Mesolithic and Early and Middle Neolithic occupation at these sites, since pollen and macroremains do not support (extra-) local presence of *Pinus* sp. For some sites it is suggested that the wood represents material emerging from older deposits present in the studied regions (Bottema-MacGillavry 2003; Kooistra 2008b; Van Rijn and Kooistra 2001).

7.3.2 *Prunus spinosa*

Finds of *Prunus spinosa* are commonly known from the coastal region in the Middle Neolithic (macroremains, waterlogged wood and charcoal) and Late Neolithic (waterlogged wood, charcoal and macroremains), and less commonly known from the river area region (macroremains), the Vecht region (charcoal), and Doel (Bastiaens *et al.* 2005). Pollen identifications from *Prunus* sp. are known from the coastal region and the river area, but these are generally not at species level.

7.3.3 *Prunus padus*

Prunus padus is known from the river area region, the coastal region, Hoge Vaart and Kallo (Belgium). Finds from the river area comprise macroremains and a wooden artefact dating to the Late Mesolithic and Neolithic (appendix III; Bakels and Van Beurden 2001; Bakels *et al.* 2001; Van Beurden 2001). Finds from the coastal region comprise macroremains and possible wood and charcoal identifications (Van Beurden 2008a; Kooistra and Hänninen 2008). At Hoge Vaart, wood from *P. padus* was used in the construction of a fish weir (Van Rijn en Kooistra 2001). A Belgian non-archaeological find at Kallo comprised at least ten stones (lower Scheldt valley, *c.* 4700-4500 BC, Kuijper 2007).

Wood analysis of material from sites in the coastal region resulted in the conclusion that it cannot be excluded that wood identifications of *Prunus* sp. at species level other than *Prunus spinosa* at Dutch Mesolithic and Neolithic wetland sites are invalid (pers. comm. Kooistra 2006), representing *Prunus spinosa* instead. Still, the macroremains finds indicate the presence of *P. padus* in the vegetation in small numbers, at least in the southern regions.

7.3.4 *Prunus avium*

Prunus avium (the wild cherry) was presumably absent at the studied sites since there are no indisputable finds from these sites, and since fruits are assumed to be present in Northwestern Europe only from the Roman period onwards. Confusion about the presence of cherries in the Netherlands during the Mesolithic and Neolithic is caused by identifications of both macroremains and charcoal.

Macroremains from “wild cherries” (name in English only, implying *Prunus avium*) have been reported for the site Bergumermeer (Newell 1973; Verhart and Groenendijk 2005). These are however later published as stones of *Prunus* sp. (Odell 1980, 416), suggesting that it does not necessarily concern *Prunus avium*. Similar confusion seems to exist in other Northwestern European countries. German Mesolithic finds from Kempen near the Niederrhein published by Bertsch (1947, 112) are cited by various authors (Renfrew 1973; Knörzer 1973, 94; Maes 2006). More northern Late Mesolithic or Neolithic finds are reported from lake Dümmer (Pfaffenberg 1947, 76). However, Knörzer *et al.* (1999, 148) state that *Prunus avium* is found in the German Rhineland from the Roman Period onwards only; at this time it concerns the cultivated cherry (see also Kroll and Willerding 2004, 146). Wild *Prunus avium* may have occurred in the Neolithic already in more southern parts of Germany but this discussion focuses on the northern part of Germany that is better comparable with the Netherlands. Rowley-Conwy (1984) reports amongst others cherries as a common food source of the Ertebølle culture, although stones of *Prunus avium* of that age are not found in Denmark as far as known to the author, while *Prunus spinosa* (sloe) is often found. At the Belgian Late Mesolithic site Opglabbeek-Ruiterkuil five waterlogged stones of *Prunus avium* were reported (Vermeersch *et al.* 1974, identification Heim), but these have been rejected later since it concerned not subfossil but recent macroremains (Bakels 1991, 280; pers. comm. Vermeersch 1989[4]). A Mesolithic find is reported at the French site Noyen-sur-Seine (Marinval-Vigne *et al.* 1989). This site is located much more southern in direction than the Netherlands and the German regions discussed above and the climate may have been more suitable. Dietsch (1997) however does not report any finds at all for the Neolithic in the Paris Basin.

Charcoal remains of *Prunus avium* have been identified at the Dutch Mesolithic site Hardinxveld-Giessendam De Bruin and at the Middle Neolithic site Wateringen 4 (Bakels *et al.* 2001; Raemaekers *et al.* 1997), but these results must be questioned due to the absence of stones at all studied Dutch wetland sites (see paragraph 7.3.3). Charcoal from *Prunus avium* is also known from Neolithic Luxemburg (Damblon *et al.* 2006), which is difficult to discuss without further detailed information from that region.

7.3.5 *Sorbus aucuparia*

Macroremains identifications of *Sorbus aucuparia* are rarely known from Dutch prehistory and identifications of pollen and wood up to species level are scarce. Weeda *et al.* (1987) state that the species was present in the Netherlands from the Early Holocene onwards, while Maes (2006) doubts its presence in prehistory due to the absence of finds of macroremains. The studied sites show pollen identifications (Hoge Vaart, Spek *et al.* 2001b), charcoal of *cf. Sorbus aucuparia*/*Sorbus* sp. (Bakels *et al.* 2001; Bastiaens *et al.* 2005; Kooistra and Hänninen 2008), rope from bark of *cf. Sorbus* sp. (Van Rijn and Kooistra 2001) and waterlogged wood of *Sorbus aucuparia* (Van Beek 1990; Groenman-van Waateringe 1978, see also appendix VI for comments on this identification). At the site Schokland-P14 a seed or fruit of *Sorbus cf. aucuparia* has been found (Luijten 1986), probably dating to the Bronze Age or Iron Age. In Denmark, macroremains are known from the Mesolithic site Bökeberg III (Regnell *et al.* 1995; Robinson 2007). Examples of pollen identifications from dryland regions in the Netherlands dating to the Atlantic comprise finds of pollen of *Sorbus*-type in various diagrams from the Haterse Vennen in the eastern part of the Dutch river area (Theunissen 1995) and finds of *Crataegus*-type (*Sorbus*) pollen in the diagram Moerkuilen I of the Dommel Valley, Noord-Brabant (Janssen 1972). The combined evidence suggests the presence of *Sorbus aucuparia* in the Netherlands during the Mesolithic and Neolithic, although it was presumably scarce at the wetland sites studied. The explanation of the apparent absence of macroremains may be related to the distribution of the species, preservation or possibly a symbolic meaning.

7.3.6 *Taxus baccata*

Until recently, finds of *Taxus baccata* from the studied area were mainly known from Late Neolithic bows. The selection of *Ulmus* sp. instead of *Taxus baccata* for bows in the Late Mesolithic suggests that the species immigrated into the Netherlands (especially the Dutch wetland regions) only in the Neolithic. Archaeobotanical research from the last ten years has resulted in more precise data on the species' presence in the Neolithic. Middle Holocene finds of *Taxus* suggest that the species belonged to the natural vegetation in the coastal region and in the lower valleys of the rivers Rhine, Meuse and Scheldt (Deforce and Bastiaens 2007; Maes 2006, 309). Finds in the coastal region date to the Middle and Late Neolithic (Van Beek 1990; Kooistra 2006b; Kooistra and Hänninen 2008; Zeiler 1997). In the central river area the species is found as pollen during the Early and Middle Neolithic and as a wooden artefact in the Late Neolithic. These finds indicate that the species may have become

4 Letter from P.M. Vermeersch to C.C. Bakels, 16.8.1989, Leuven.

part of the vegetation in the central river area between 5500 and 3400 BC, but the chronological details of this process are poorly understood. Botanical finds of *Taxus baccata* in the lower Scheldt valley date to the Late Atlantic or Sub-Boreal (Neolithic and Bronze Age) but not to later periods. *Taxus baccata* disappeared in the deltaic/coastal regions from the second half of the Sub-Boreal onwards due to the development of oligotrophic peat (Deforce and Bastiaens 2007; Maes 2006). At Emmeloord in the Vecht region, a staff made of *Taxus baccata* dates to the Late Neolithic or Bronze Age (Van Rijn 2002). The species may have been part of the natural vegetation in the exploitation area of this site but was probably not present at the wetland location itself (see chapter 4).

7.4 Reconstruction of the natural vegetation on a regional level

7.4.1 Central river area

The natural vegetation in the river area is relatively well known due to the large number of palaeoecological and archaeobotanical studies that have been carried out. Dryland vegetation formed a minority of vegetation cover in the region during occupation, present on inland dunes and levees. Only dune vegetation has been studied in detail. On relatively high and dry dunes, mixed *Tilia/Quercus* woodland was present. This vegetation was formerly known as *Quercetum mixtum*, but this name seems to underestimate the importance of *Tillia* sp. in this vegetation (*cf.* Greig 1982; Hommel *et al.* 2002, 33). Several herbs, mosses and fungi indicate that the dryland vegetation on the dunes consisted of old, dense woodland. The vegetation on the lower slopes of the dunes and on levees probably consisted of woodland vegetation on eutrophic moist soils without peat accumulation and with constant or changing water tables, including hardwood alluvial woodland vegetation. Alder carr and softwood alluvial woodland vegetation was present on even lower parts of the landscape, such as relatively low dunes, levees and dry patches in the marshes. Open patches were naturally present in all woodland types. The major vegetation components of the wetlands in the river area were eutrophic marsh vegetation (reed and sedge fen) and open water vegetation, present everywhere where the absence of running water allowed the development of vegetation and where the groundwater level prevented the development of woodland vegetation. Marine influence was negligible in the river area.

7.4.2 Coastal region

The coastal region differs from the other regions due to its location directly behind the coast, resulting in the presence of unique vegetation. During early occupation phases, tidal flats and salt marshes formed major elements in the landscape, resulting in a very open landscape dominated by taxa that tolerated saline or brackish conditions. During later occupation phases, these salt marshes developed into beach plains and finally into freshwater marshes covered with reed, sedges and patches of alder carr. While parts of the region may have been relatively dry during the initial stages of occupation, the coastal dunes in the former beachplain that formed major locations for occupation also submerged through time. The combination of the various biotopes resulted in maximal taxon diversity in the waterlogged wood and charcoal assemblages from this region (see paragraph 7.2).

The dunes were covered with dune shrub vegetation, containing a variety of shrubs and small trees including *Juniperus communis*. Dune shrub vegetation was however rather scarce during occupation, resulting in an almost complete absence of trees and shrubs, at least at the occupied dunes, despite the presence of some herb taxa indicative of shaded conditions.

Woodland vegetation of moist and eutrophic soils comparable with hardwood alluvial vegetation may have been present in the region (Kooistra in press; Kooistra and Hänninen 2008) although this type of vegetation was probably uncommon. Well-developed woodland vegetation of dry, not too eutrophic soils was scarce or absent in the region, resulting in the scarcity of finds of *Tilia* sp., *Quercus* sp. and *Corylus avellana*.

7.4.3 Vecht region

In the Vecht region, dryland patches such as till outcrops, dunes and levees formed a minority of the landscape during the best known occupation phases. There is little precise information on the development of the dryland vegetation near archaeological sites due to the scarcity of archaeobotanical data and the absence of data of separate phases. The best data available, from Schokland-P14, indicate the presence of a *Tilia/Quercus* woodland gradually developing into alder carr. The precise species composition of this vegetation is however unknown.

Van Zeist and Palfenier-Vegter (1981) questioned the presence of old, well developed woodland vegetation in the area around Swifterbant, with the argument that the diameter of many wood remains is rather small, suggesting that only young forest would have been present. The restricted data set currently available does not allow for the answering of this question, although the mosses found at Swifterbant-S3 indicate the presence of well-developed and relatively old softwood alluvial woodland in the region. The vegetation of occupied levees is well documented at Swifterbant-S3, showing the presence of vegetation of moist, marshy and ruderal terrain (Van Zeist and Palfenier-Vegter 1981). There is however no detailed information on how the vegetation of levees would have looked in absence of occupation.

In the relatively low parts of the landscape, initially the gradual rise of the ground water level resulted in the development of eutrophic reed peat. Later on, mesotrophic and oligotrophic peat developed. There was some weak marine influence in the region.

The analysis of wood and charcoal presented above, the indications of selective use of wood (chapter 8), the analysis of gathered plants (chapter 9) as well as the analysis of potential arable weeds (chapter 10) suggest that the dryland wood and herb vegetation in the Vecht region was less varied than the vegetation in the river area and in the coastal area. Taxa of woody vegetation that are scarce or absent in the Vecht region are *Cornus sanguinea*, *Prunus spinosa*, *Quercus* sp., *Sambucus nigra* and *Viburnum opulus*. The data set from the Vecht region is however not large enough to make firm conclusions, since the amount of data is relatively small compared with the two other regions and since preservation may have been less optimal.

7.4.4 Eem region

The sand ridge at Hoge Vaart formed a border between higher and lower located terrain. The natural vegetation at the higher located sand ridge developed during occupation from *Tilia/Quercus* vegetation into varied *Quercus* vegetation with open patches (Spek *et al.* 2001a, b). The *Quercus* vegetation submerged at *c.* 4500-4300 BC quite suddenly due to the gradual rise of the ground water level, which reached a critical point, affecting the vegetation of the major part of the site's local surroundings. A eutrophic freshwater marsh dominated by *Phragmites australis* developed afterwards, with some patches of wetland trees. In the lower parts of the landscape peat growth began at *c.* 7000 BC. A detailed vegetation reconstruction of these lower parts of the landscape is not available. A channel, part of a freshwater tidal system, was active at the border of the sand ridge between *c.* 5000-4900 BC and during *c.* 4450-4300 BC. This channel resulted in occasional weak marine influence at the site from *c.* 4450 BC onwards. The available data on the vegetation suggest that the vegetation in the region of Hoge Vaart shows both similarities and differences with the river area. The differences comprise a smaller attested variety of trees and shrubs in the Eem region, the development of birch carr during the later occupation phases indicative of relatively mesotrophic to oligotrophic conditions, the development of *Pteridium aquilinum* in reaction to human impact (not clearly corresponding with changes in curves of other taxa that are likely to be related to human impact), and the presence of taxa indicative of brackish conditions. The differences may be related to a combination of factors such as the presence of a unique type of Pleistocene subsurface (coversands) at Hoge Vaart, its location at the edge of dry terrain and the geomorphologically and geographically unique location of Hoge Vaart (located in an area that was partly different from the central river area). Further study in the region may show more varied vegetation.

7.5 Comparison with macroregions

7.5.1 Scheldt Basin

The natural vegetation in the Scheldt Basin during the second half of the fifth millennium and the first half of the fourth millennium BC consisted of deciduous woodland vegetation dominated by *Tilia* sp. and *Corylus avellana*, while *Quercus* sp., *Ulmus* sp., *Fraxinus excelsior*, *Alnus* sp. and Pomoideae were additionally present as well (Vanmontfort 2004, 324). The precise composition of course depended on local conditions. Analyses of individual sites have shown a large variety of taxa and vegetation types that are comparable with the Dutch wetland sites (*e.g.* Bastiaens *et al.* 2005; Vanmontfoort *et al.* 2004). The similarity in vegetation between the Scheldt Basin and the studied wetland regions can be explained by similarity in geomorphological conditions and processes.

7.5.2 Pleistocene sand soils

It is presumed that (some) people of the Late Mesolithic communities, the Swifterbant culture and the Hazendonk group that occupied and visited the studied wetland sites spent part of the year in the surrounding dryland region. A general reconstruction of the vegetation of the Pleistocene sand soils that bordered the wetlands is not available. Instead, reconstructions of various regions will be presented below. Differences in the abiotic factors between the dryland soils and the wetlands were presumably the absence of direct influence of groundwater and the absence of marine influence at the sandy soils.

Reconstruction of the regional vegetation on Pleistocene sand soils in Drenthe during the Late Atlantic (Bakker 2003, 213-214) presents dense woodland vegetation with *Quercus* sp., *Ulmus* sp., *Tilia* sp., *Fraxinus excelsior*, *Corylus avellana* and some *Pinus* sp., comparable with present *Quercus*-*Carpinus* and *Quercus*-*Fagus* woodland (without *Carpinus betulus* and with only possibly small quantities of *Fagus sylvatica*), as well as more open woodland comparable with present *Quercus-Betula* woodland that is less rich in species. *Alnus* sp. and *Betula* sp. were only present at local wetland patches. In the Sub-Boreal the importance of *Tilia* sp. and *Fraxinus excelsior* increased while the importance of *Ulmus* sp. decreased.

The reconstruction of the natural vegetation in the Dommel Valley in the eastern part of the province of Noord-Brabant during the Middle Holocene (Janssen 1972) describes the presence of woodland of dry terrain dominated by *Quercus* sp., *Betula* sp. and *Pinus* sp., combined with *Tilia* sp., *Ulmus* sp., *Fraxinus excelsior*, *Corylus avellana*, *Pteridium aquilinum* and *Calluna vulgaris*, suggesting relatively poor soils. *Alnus* sp. and *Salix* sp. occurred in the lower parts of the landscape. The transition of the Atlantic to the Sub-Boreal is characterised by a decline of elm, the decline of mesic woodland types, and the development towards more acidophilous vegetation types.

Theunissen (1995) studied the development of the vegetation in the eastern part of the Rhine/Meuse river area near Nijmegen. This study was based on palynogical analysis of cores collected in small fens in the middle of sandy dry terrain. In this region, deciduous woodland vegetation was present in the Middle Atlantic, with *Tilia* sp., *Quercus* sp., *Ulmus* sp. and *Corylus avellana* as important elements and *Pinus* sp. and *Betula* sp. as minor elements. The importance of *Quercus* sp. and *Tilia* sp. increased through time. During the Late Atlantic, *Fraxinus excelsior* became present as well. Eutrophic fens came into development due to the gradual rise of the ground water table, resulting in the increasing importance of *Alnus* sp. During the Early

Sub-Boreal, the values of *Tilia* sp., *Ulmus* sp. and *Corylus avellana* decreased, and later also those of *Quercus* sp., while *Betula* sp. became more important. The changes in the Sub-Boreal are related to the combination of the deterioration of the sand soils and human impact.

Kooistra (2008a) summarised the information on the vegetation development of the southern sandy soils in the province of Noord-Brabant, located directly south of the river area. In the Mesolithic, the woodlands in the more western parts of the province were dominated by *Pinus* sp., combined with *Corylus avellana*, *Betula* sp., *Quercus* sp. and *Salix* sp. During the Neolithic the western woodland consisted of fairly closed deciduous woodland vegetation with a variety of shrubs. The Neolithic woodland in the northeast part of the province was dominated by *Quercus* sp., *Tilia* sp., *Fraxinus excelsior*, *Ulmus* sp. and *Betula* sp. The presence of *Corylus avellana* and *Pteridium aquilinum* indicate the occurrence of open patches (Kooistra 2008a, based on Bakels (2002) and Van Beurden (2002)).

Several authors suggest the presence of *Pinus* sp. during the Atlantic and Sub-Boreal at the dryland soils surrounding the wetlands, mostly based on palynological evidence, although Janssen does not explicitly conclude the presence of the taxon in the Dommel Valley. However, the local presence of *Pinus* sp. may be questioned since local or regional pollen rain of pine could possibly be confused (regional pollen rain may increase as the result of increased openness of the vegetation), and it is not always clear how much pine trees it would have concerned and in which parts of the landscape the trees would have grown. Additional botanical evidence should be preferably obtained, such as macroremains or wood data. The data from the dryland site Marienberg (Verlinde and Newell 2006) indicate the presence of *Pinus* sp. during the Mesolithic (corresponding with the Boreal), but not during the Neolithic (corresponding with the Atlantic). A find of a needle of *Pinus* sp. is known from the site Maastricht-Randwijck in Limburg, occupied by people of the Rössen culture (Bakels *et al.* 1993, 42), but this site is not located in the dryland regions that surrounded the studied wetland sites.

Comparison of the Pleistocene sand soils and the studied wetlands shows a general trend that the sandy drylands that surrounded the wetlands were dominated by mesotrophic woodland of dry terrain. Compared to woodland of dry terrain in the wetlands, these dryland woodlands contained relatively much *Betula* sp. and possibly *Pinus* sp. that are characteristic of poor and slightly acid soil. The absence of direct influence of the ground water level made the drylands generally much dryer, less frequently flooded and less eutrophic than the wetlands, except for those zones along rivers and gullies.