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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Summary

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Introduction

This thesis investigates the natural vegetation, human impact on the vegetation and plant subsistence in Dutch wetlands at the time of the Late Mesolithic and the semi-agricultural Early and Middle Neolithic Swifterbant Culture and Hazendonk Group (5500-3400 cal BC). It is part of the research project of the Leiden University, 'The Malta Harvest: from Hardinxveld to Noordhoorn – from forager to farmer', described as 'A new specification of Late Mesolithic and Early Neolithic culture and society of the Lower Rhine Basin, 6000-3500 cal BC, in their North European context'. Parts of this thesis' results are also published in several papers.

Chapter 1 presents the problem, aim and questions of the thesis together with an explanation on the approach and methodology. The neolithisation of Europe involved an extension of the subsistence that was first based on hunting, gathering, fishing and fowling along with animal husbandry and crop cultivation, and changes in mobility, social practices and material culture. The knowledge of the neolithisation process of most parts of the Netherlands is developing though rather fragmented, as is the knowledge on the influence of people on the vegetation and the plant subsistence during this transition. This study provides a new archaeobotanical synthesis of particularly wetland sites, as preservation of organic material including plant remains is usually good at these sites. It should be kept in mind that it remains unclear whether the results of the wetland area are relevant to the surrounding dryland regions, where preservation of organic material is very uncommon.

The aim of this study is to improve the knowledge on the neolithisation process in the Netherlands by focussing on human impact on the vegetation, plant subsistence and cultivation of crop plants. The main questions are: what was the influence of people (and domestic animals) on the natural vegetation, what strategies were used during exploitation of the woodland, which plants were exploited, what is known about the former crop cultivation practices, and were crops cultivated on the scarce dryland terrain in the wetlands? The study represents a renewed synthesis and interpretation of available archaeobotanical literature and unpublished data on pollen, plant macroremains (seeds and fruits), mosses, fungi, roots, tubers and rhizomes, unworked and worked uncarbonised wood, and charcoal from sites that were excavated during the last 30 years. The sites are located in four wetland regions in the Netherlands: the central river area, the coastal region, the Vecht region and the Eem region.

Chapters 2-6: data, background information and interpretation

In the first part of this thesis (chapters 2-6), the individual sites are presented from each region. Each chapter provides information on the palaeogeography of the region, an archaeological introduction for each site, and information on the archaeobotanical methods, results and conclusions for each site. Each chapter ends with a summary of existing and new interpretations on the natural vegetation, human impact and plant subsistence in the region. This first part of the thesis provides extensive background information on the data that are used for comparative analysis later in the thesis.

Chapter 2 presents the data of the central river area that includes the sites Hardinxveld-Giessendam Polderweg, Hardinxveld-Giessendam De Bruin, Brandwijk-Kerkhof and Hazendonk, associated with the Late Mesolithic and the Swifterbant culture. The region is particularly relevant since the sites reflect various phases of the neolithisation process. Part of the source material of chapter 2, including sources that were unpublished until now, is presented in the appendices I-IV (see the end of the summary).

Chapter 3 presents the data of the coastal region that includes the sites Ypenburg, Wateringen 4, Schipluiden and Rijswijk-A4 that are associated with the Middle Neolithic Hazendonk group. These sites were all investigated during the last 15 years and provide a good understanding of the occupation and subsistence in the region.

Chapter 4 presents the data of the Vecht region that includes the sites Swifterbant, Schokland-P14, Schokkerhaven-E170, Urk-E4 and Emmeloord-J97 that correspond with the Late Mesolithic and the Swifterbant Culture.

Chapter 5 presents the data of the Eem region that consists of the intensively investigated site Hoge Vaart, which is Late Mesolithic and Early Neolithic in age. Domestic animals and crop plants were not found at this site.

Chapter 6 presents the data of remaining sites that are not clustered in a concentration of sites that form a region, sites from which data became available only in a later stage of the research, and sites that yielded only fragmentary relevant archaeobotanical data. Some of these sites are located in the western extension of the river area, which are presented as an additional region. The primary data of one of these sites, Bergschenhoek, are presented in appendix V (see the end of the summary).

Chapters 7-11: synthesis of the natural vegetation, human impact on the vegetation and plant subsistence

In the second part of the thesis, the data that are presented in the first part of the thesis are integrated and discussed in order of material group and research theme. The results are compared with data of relevant contemporaneous cultures and regions in Northwestern Europe.

Chapter 7

Chapter 7 provides a summary of the natural vegetation of each wetland region, a short comparison with the surrounding drylands, and discusses the presence of some individual tree and shrub taxa. The reconstruction of the natural vegetation of the wetland regions is based on pollen, macroremains, unworked wood and charcoal data. The chapter provides an overview of the identifications of unworked wood and charcoal of the sites studied.

Between 5500 and 3400 BC, the natural vegetation in the central river area consisted of scarce patches of deciduous woodland on well drained terrain (*Tilia/Quercus* woodlands) that were surrounded by alder carr, eutrophic marshes and open water. The coastal region was dominated by beach plains, salt marshes, and freshwater reed and sedge marshes, while the dunes, some of which were occupied, were scarcely covered with shrub vegetation. Information on the natural vegetation in the Vecht region is somewhat fragmentary but suggests similarity with the central river area at the beginning of the period studied. The marshes in the Vecht region, however, gradually became increasingly mesotrophic. The natural vegetation at Hoge Vaart consisted of deciduous woodland of dry terrain that was later replaced by birch and alder carr and open marsh vegetation. The documented species richness of trees and shrub in the Vecht region and in lesser degree the Eem region is relatively small compared to the central river area and the coastal region, which may partly be explained by the state of research. In all regions, the scarce dryland patches and their dryland vegetation became considerably smaller or submerged completely due to the gradual rise of the ground water level.

Chapter 8

Chapter 8 discusses the evidence of human impact on the vegetation and plant use derived from pollen diagrams, worked uncarbonised wood and charcoal, and the indications of management of the vegetation. The chapter furthermore includes a short discussion of the restricted indications of symbolic use of wood, and of the artefacts that are made of plant material other than wood.

The pollen diagrams from the sites studied indicate that human impact, caused by the presence and activities of people and domestic animals, generally resulted in clearance and disturbance of the woodland on a small to moderate scale. Trees that were particularly affected were *Tilia* sp. (lime), *Quercus* sp. (oak) and *Alnus* sp. (alder). The disturbance resulted in the increased presence of secondary shrub vegetation and an increase in both dryland and wetland herbs indicative of open patches, disturbance and eutrophic conditions. Pollen diagrams based on an upland pollen sum show NAP values of 5-25%[1].

Due to the extensive data set and the character of the natural vegetation, the pollen diagrams of the central river area provide the most precise information on human impact. These diagrams show an increase of human impact through time, as the evidence at sites with crop plants is stronger than the evidence at sites without crop plants. Further research is necessary to investigate whether there is a causal relationship with the introduction of agriculture and possibly with the introduction of crop plants in particular. The diagrams of other regions do not show strong evidence of human impact or changes through time that may be related to the neolithisation process, which can however partly be explained by the vegetation in those regions and the available data.

In general, the evidence of human impact in pollen diagrams shows similarity with the evidence of human impact known from various other Late Mesolithic and Neolithic Northwest European cultural groups, which can be related to general similarities in the natural vegetation and the character of human impact. The precise similarity is however restricted. For other cultural groups, analysis of palynological data has resulted in hypotheses that people applied specific agricultural practices, such as leaf-foddering or slash- and burn techniques. The pollen diagrams of the sites studied do not support that such techniques were practised.

Subsequently, chapter 8 deals with the use of wood for artefacts, construction wood and fuel at the sites studied. The chapter provides an overview of the taxa used for wooden artefacts for all site together, and additionally provides quantitative overviews of the taxa that were used for specific artefact types. The analysis of uncarbonised wood demonstrates that the availability of taxa in the natural vegetation was the primary factor in the use of wood for artefacts and construction purposes, as is supported by the broad range of taxa that were used. *Alnus glutinosa* (alder) was most commonly used, more or less independent of the purpose. Other taxa that were commonly used for artefact manufacture at many sites are *Fraxinus excelsior* (ash), *Quercus* sp. (oak), *Corylus avellana* (hazel) and *Salix* sp. (willow). The taxa *Juniperus communis* (juniper) and *Prunus* sp. (presumably predominantly *P. spinosa*, sloe) were important wood resources in the coastal region where closed woodland was scarce.

The indications of selective use of wood (the use of a specific species for a specific artefact) has been investigated for fish traps and wattle work, dugout canoes, paddles, bows, hafts and shafts, planks and beams, pointed roundwood other than posts, and posts. In the case of posts, the analysis of selective use of wood concerned various structures. Artefact types that show relatively strong indications of the selective use of wood are bows, canoes, paddles, fish traps and beams. Comparison of wood identifications of fish traps and paddles shows that people in the Eem and Vecht regions used different species than people in the central river area and the coastal region. The selective choice for taxa stayed the same through time during the neolithisation process, with the exception of changes in the choice of wood used for bows and canoes. The change in wood choice for bows and canoes is in accordance with results from other parts of Europe of the same period.

1 The NAP values represent herbs and spore plants of dry terrain.

The charcoal of all sites, considered to reflect primarily wood collected for fuel, is dominated by *Alnus glutinosa* (alder), *Quercus* sp. (oak), *Fraxinus excelsior* (ash) and Pomoideae (apple subfamily within Rosaceae, the rose family), and comprise a broad range of taxa. Comparison with the natural vegetation indicates that the availability of taxa in the natural vegetation played an important role in the selection of firewood, and in lesser degree also the combustion qualities of wood. There are no explicit indications that taxa were avoided to use them for other purposes. The strategies applied and the taxa selected during fuel collection at the sites studied are generally similar to those that are known from Neolithic cultures in Central Europe.

The final part of chapter 8 concerns the study of forms of management of vegetation, including indications of the practice of fire ecology, the presence of hedges and the practice of pollarding and coppicing. This study hardly provides evidence of management or cultivation of wild plant resources, nor of an increase of management throughout the neolithisation process. Firstly, there is no evidence of burning of wetland vegetation. There are some indications of the burning of dryland vegetation, but the purpose and scale remains unclear. Secondly, there is no evidence that people constructed hedges. Thirdly, the indications of coppicing and pollarding are restricted, which can be partly be explained by the restrictions of the available data sets. Only the scarce studies of wood from structures, mainly fish traps and particularly those from Bergschenhoek, indicate that people probably coppiced trees and shrubs and practised some form of woodland management.

Chapter 9

Chapter 9 aims to reconstruct human impact and plant subsistence by the analysis of gathered (non-cultivated) plants, primarily based on seeds and fruits, and additionally roots, tubers and rhizomes. It is investigated for which taxa there are indications of use and how these taxa were used, with special attention to food plants. The criteria applied to reconstruct the use of plants are the presence of carbonised remains, the presence of taxa in a relative high frequency (in many samples), the presence of plant remains in hearths, the presence of concentrations of single taxa and the spatial distribution of remains at individual sites. In addition, the analysis takes into consideration the relevant results from coprolites and use-wear analysis of artefacts.

The taxa that most likely functioned as a staple food at the sites studied according to the analysis are *Corylus avellana* (hazelnut) and *Trapa natans* (water chestnut). Taxa that also functioned as an important food source are *Prunus spinosa* (sloe), *Malus sylvestris* (crab apple), *Crataegus monogyna* (hawthorn) and tubers of *Ranunculus ficaria* (lesser celandine). Additional plant food sources probably included *Quercus* sp. (acorns), *Cornus sanguinea* (dogwood), *Rosa* sp. (rose hips), *Rubus* species (blackberry, raspberry and dewberry), bulbs, roots, rhizomes and tubers of *Allium* sp. (onion), *Bolboschoenus maritimus* (sea club-rush), *Beta vulgaris* ssp. *maritima* (sea beet), *Typha* sp. (bulrush) and Pteridophyta (ferns), and possibly roots of *Nymphaea alba* and *Nuphar lutea* (white and yellow water-lily). The attested assemblage of probable food plant varies slightly between the regions, being smaller in the Vecht and Eem regions. Surprisingly, *Galium aparine* (cleavers) appears to be an important use plant both in the Mesolithic and Neolithic, possibly representing a food plant, although its precise function is not known.

Overall, the evidence of use, preparation and consumption of gathered plants is restricted as compared with the expected intensity of use of plants and to the expected broad range of taxa available. Compared with the evidence of the consumption of crop plants however, the evidence of the consumption of gathered plants is considerable.

Similar to the wood analysis, the analysis of macroremains hardly gives evidence of intensification of the management of non-cultivated plant resources throughout the neolithisation process. The indications of the use and consumption of wild plants strongly point to the continuation of plant use through time, at least in view of the range of taxa. There is little knowledge on possible changes in the importance of gathered and cultivated food plants in the diet.

The macroremains provide hardly any evidence of a social, ritual or symbolic role of plants and plant food, which correspond with the wood and charcoal data as well. This can partly be explained by the fact that the common finds and their general contexts (refuse layers) do not easily enable the reconstruction of a special role of plants.

Chapter 10

Chapter 10 aims to distinguish the arable weeds of the Swifterbant culture and Hazendonk group, with the goal to use the weeds to reconstruct the cultivation practices. The analysis is primarily based on macroremains. Potential arable weeds are defined as taxa that occur in habitats that could have been transformed into arable land, with exception of trees and shrubs. The range of potential arable weeds is relatively stable through time and is comparable with that of other Neolithic cultures in Northwestern Europe.

In order to discern the arable weeds of the regions studied, it has first been investigated which taxa have been found in a carbonised state in concentrations of carbonised crop products. Finds of concentrations are however only known from the Hazendonk and furthermore, these seem to represent a mixed assemblage resulting from more than one deposition process instead of a single assemblage that represents the flora of an arable field, which hampers the identification of the arable weeds. Secondly, it has been investigated which taxa were found in a carbonised state in samples that contain carbonised cereal remains. Thirdly, it has been investigated whether there is a pattern in the presence and absence of potential arable weeds at sites with and without cereals, and between regions (statistical analysis was not applied). Carbonised macroremains finds received more attention in the analysis than waterlogged finds since their carbonised state suggests handling by people.

The combined results of the three approaches indicate that *Bromus secalinus*-type (rye broom), *Hordeum marinum* (sea barley), *Fallopia convolvulus* (black bindweed), *Malva* sp. (mallow), *Persicaria maculosa* (red shank) and *Solanum nigrum* (black nightshade) are most likely to have functioned as arable weeds at agricultural sites. The restricted number of taxa indicates that there must have been more weeds. The group of probable weeds shows some differences between regions. Firstly, *Hordeum marinum* and *Malva* sp. are only known from the coastal region. Secondly, none of the weeds listed above are found in a carbonised state in the Eem and Vecht regions, and *Fallopia convolvulus* appears to be completely absent in those two regions. This second regional difference may relate to the possibly restricted representativity of the data sets of the Vecht and Eem regions, to differences in the natural vegetation or to differences in cultivation practices between regions.

The preliminary distinguished group of probable weeds enables to make some first conclusions on cultivation practices of the Swifterbant culture and the Hazendonk group. The conclusions remain to be tested by future research, and remain to be refined for single periods, region's and crops. As most of the probable weeds are annuals, the weed analysis firstly indicates that shifting cultivation was generally not practised. Secondly, the height of most probable weeds indicates that in most regions only the upper half of the cereal plants was harvested, with the exception of the coastal region for which there are indications of harvesting lower on the culm. This implies that small weeds that only reach a limited height may be poorly distinguished by the weed analysis. Finally, the probable arable weeds represent primarily summer annuals, indicating that summer cultivation is most likely for most sites.

The distinguished probable arable weeds of the Swifterbant culture and Hazendonk group have been compared with the weeds of comparable Neolithic cultural groups in order to investigate which group could have played a role in the introduction of crop plants into the Dutch wetlands. This comparison however does not provide information on the introduction process, since the commonly found weeds of the other cultural groups are rather similar. For these other cultures the distinction between potential arable weeds and true weeds is furthermore difficult, hampering a sound comparison with the weeds of this study.

Chapter 11

Firstly, chapter 11 presents the finds, the importance and the role of crop plants in the Dutch wetlands, and the dating of the introduction of crop plants to the region. The main crop plants are *Triticum dicoccon* (emmer wheat) and *Hordeum vulgare* var. *nudum* (naked barley), while *Papaver somniferum* ssp. s*etigerum* (opium poppy) and *Pisum sativum* (pea) are occasionally found as well, particularly in the central and western river area. The presence and importance of *Triticum monococcum* (einkorn) in the Vecht region remain to be assessed.

The combined evidence of pollen and macroremains demonstrates the first presence of cereals between 4220 and 3940 BC in the central river area and between (4400/)4300 and 4100 BC in the Vecht region. This implies that the introduction occurred at least between (4400/)4300 BC and 4100/4000 BC, while an earlier introduction cannot be excluded. These dates indicate that the Michelsberg Culture played an important role in their introduction in the Swifterbant Culture. There is some evidence of the absence of crop plants before 4400 BC, but the period of introduction needs further refining, especially for the Vecht region. The common presence of emmer wheat and naked barley from the reconstructed introduction period onwards and the context of the finds suggest quick incorporation of crop plants in the subsistence. However, the development of their importance in the diet remains difficult to assess, as well as their social role.

An important point of debate is whether local arable farming was practised at wetland sites of the Swifterbant culture and Hazendonk group. The best indications of local cultivation are available for sites in the coastal region, dating to the Middle Neolithic (Hazendonk Group). The data from earlier sites in the Vecht region are fragmentary but do not argue against local cultivation, and local cultivation is additionally supported by new results from Swifterbant-S4. For the central river area, the crops and weeds provide some indications of the import of crop plants, but many finds and research results can be interpreted in various ways. As a result it is not possible to exclude the practice of small-scale local cultivation or a combination of import and local cultivation for this region.

Chapter 12

Chapter 12 summarises the main conclusions of chapters 7-11 concerning the natural vegetation, human impact, plant use and neolithisation, and discusses the implications for methodology and future research. Comparison of the natural vegetation with the evidence of human impact and plant use shows that people used mainly those taxa that were present in the surroundings. The wood and macroremains hardly provide evidence of import of plant material from outside the regions or of exchange of plant material between regions. Differences in human impact and plant use between regions can primarily be explained by differences between the natural vegetation. Changes in plant use through time, if present, can primarily be related to changes in the vegetation as well. The results on human impact on the vegetation and plant subsistence generally correspond with what is known from contemporaneous cultural groups in other parts of Northwestern Europe.

This archaeobotanical study demonstrates that there are few changes in human impact in the Dutch wetlands during the transition from the Late Mesolithic to the Early and Middle Neolithic. Apart from the slightly increasing evidence of human impact in the pollen diagrams from the central river area, the results primarily indicate continuation in the way people used plants for food, fuel and artefact manufacture during this period. This result corresponds with the observed uniformity and continuity within the Swifterbant Culture and supports that neolithisation in the Dutch wetlands was a gradual process. An important suggestion for future research is to extent the investigated period to the Late Neolithic and Bronze Age and to compare this overview of the Dutch wetlands with comparable data of other regions in Northwestern Europe in further detail.

Appendices (available online)

Appendix I concerns a summary of the archaeobotanical data and interpretations of the publications on the Late Mesolithic/Early Neolithic sites Hardinxveld-Giessendam Polderweg and De Bruin in the central river area. This makes the data accessible for an international public. Apart from data that were already available, the appendix also presents new data. The evidence of human impact on the vegetation at Polderweg and De Bruin is restricted, and crop plants were absent.

Appendix II concerns the reconstruction of the natural vegetation, human impact and plant subsistence at the Early Neolithic site Brandwijk-Kerkhof in the central river area, based on new data of macroremains, uncarbonised wood and charcoal from the excavation. It concerns an addition to the analysis of pollen and macroremains from a core transect of the site that was published earlier as part of this study. Occupation at Brandwijk-Kerkhof took place during various phases, of which intensive occupation during a late phase provides the best evidence of human impact and use of plants. Uniquely, the investigated occupation phases show the transition from absence to presence of crop plants, which is an important aspect of the neolithisation process.

Appendix III concerns the reconstruction of the natural vegetation, human impact and plant subsistence at the Neolithic site the Hazendonk in the central river area, based on not previously published data of pollen, macroremains and uncarbonised wood. Botanical data from this site were already available, but these were primarily derived from sample locations at some distance from the site, which enabled the reconstruction of the natural vegetation but not of human impact and plant subsistence. This appendix provides for the first time a complete overview and interpretation of the botanical remains from the excavation, and of unique cores and sample series from locations near the excavation. The new pollen, non-pollen palynomorphs and seed diagrams provide clear evidence of human impact during the various occupation phases. Crop plants were present from the start of the (known) occupation onwards.

Appendix IV compares the results of appendix III with other, earlier published data of the Hazendonk from locations at various distances from the site. This concerns particularly the reconstruction of the vegetation and human impact based on pollen diagrams. Comparison of the various sources confirms the conclusions on human impact of appendix III. The comparison furthermore shows that sample series located near the site provide precise information on human impact, and that the evidence of human impact is strongly influenced by the distance between the sample location on the one hand and dry terrain and the activity area on the other hand.

Appendix V concerns the reconstruction of the natural vegetation, human impact and plant subsistence at the Early Neolithic site Bergschenhoek, located in the western part of the river area. The main features at the site are a platform of planks, a hearth and several fish traps, located on a fragment of peat. The reconstruction is based on the analysis of pollen, macroremains, mosses, uncarbonised wood, charcoal and molluscs. The analysis of pollen and macroremains concerns a sample series from the hearth and a sample series from the clay directly next to the site. Comparison of the pollen and macroremains on the one hand and the wood and charcoal on the other hand indicates that all the wood must have been brought in to the site. Investigation of the wood of the fish traps demonstrates selective use of dogwood and strongly indicates that that people coppiced dogwood on a considerable scale elsewhere in the river area. These indications of coppicing represent the best evidence of coppicing of all sites that were part of this study.

Appendix VI concerns the reconstruction of the natural vegetation and human impact at the Late Neolithic site Vlaardingen, located in the western part of the river area. Not earlier published macroremains data are presented as part of a short synthesis of the earlier published archaeobotanical data.