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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12. Conclusions

12.1 Introduction

This study has aimed to improve the understanding of the neolithisation of the Dutch wetlands by analysis of the human impact on the vegetation, of the exploitation of the vegetation and of the cultivation of crop plants during the period 5500-3400 BC. The study is based on the renewed interpretation and synthesis of available archaeobotanical data on pollen, plant macroremains (primarily seeds and fruits), wood and charcoal from the Late Mesolithic, Swifterbant culture and Hazendonk group. Below, first some methodological aspects will be discussed that have shown to be relevant for the possibilities to answer the research questions. The following paragraph deals with the reconstruction of the natural vegetation. The next paragraph discusses various aspects of human impact and exploitation of the vegetation. Paragraph 12.5 considers how the neolithisation process influenced plant subsistence. The final paragraph presents suggestions for further research.

12.2 Implications on methodology

The study is primarily based on data from sites in the central river area, the Vecht region, the Eem region and the coastal region, supplemented with information from some more isolated sites. The information from the central river area appeared to be the most valuable, since it combines data from Late Mesolithic and Early and Middle Neolithic sites better than any other region, and archaeobotanical material from this region is usually well preserved and dated. In contrast, information from the Vecht region has some restrictions, since the chronological precision is limited at some sites, information on certain botanical materials (pollen, wood and charcoal) is scarce, and the majority of the results is based on excavations executed at a time when some research methods were not commonly applied yet (use-wear analysis, phytolith analyses, the analysis of food crusts, *etc.*). The most important lack of data, however, concerns the sandy regions surrounding the wetlands. Any information on the archaeobotany and plant-based subsistence that can be obtained there, other than hazelnut shells, would increase our understanding of these regions.

The methodological aspects of palynology play an important role in the research on human impact. Relevant aspects are the sample locations and their numbers, the sample intervals (in relation to the deposition rate) and the pollen sum. The sample location, particularly its distance to dry terrain and the distance to the zone of occupation, influences the human impact signal in the pollen deposition. This study shows that the sample location needs to be relatively close to the settlement (within *c.* 25 metres) in order to detect human impact in the period under study. The evidence of human impact at one of the Neolithic sites studied decreases over a distance of 4 metres. This indicates that sampling should preferably occur in the area where refuse layers can still be recognised in a section or pollen core, near the dry surface and near the zone of human activity. It appears that pollen analysis that is not embedded in archaeological research is of restricted use, because it does not offer a clear archaeological context, which strongly restricts the possibility to relate changes in the pollen diagram to human activity. Other strategies to get a better grip on evidence of human impact in pollen diagrams are the analysis of several cores from a single site, and the analysis of pollen from a transect of cores located at increasing distance to the site, in order to disentangle the influence of sample location and distance on the pollen signal and to increase the validity of the results.

Finally, the use of different pollen sums at sites, for which similar vegetation is expected, hampers inter-site comparison. For studies on the development of the vegetation and human impact on the vegetation present at naturally wooded dryland terrain in the wetlands occupied by people of the Swifterbant culture and Hazendonk group, it is advised to apply not only the pollen sum preferred by investigators but also an upland pollen sum (see chapter 1). This pollen sum enables direct focus on the disturbance of dryland vegetation,

where the most intensive human impact is expected. A total pollen sum is advised for environments similar to the coastal region. Alternatively to the use of an additional pollen sum, the original data could be stored in databases such as the European Pollen Database or the electronic archive for Dutch archaeology (EDNA).

Analysis of macroremains should always be based on the analysis of a representative number of samples sieved on a mesh width of 0.25 mm, preferably also in case of sites on dry terrain with poor preservation (although the mesh width could be adapted in the latter case). Macroremains samples are often selected to enable the investigation of material from different periods, locations and contexts. A focus on rich samples sometimes occurs as well, which results in large data sets, but these are usually derived from disturbed contexts, containing mixed assemblages that resulted from various deposition activities instead of a single activity. Such a sample strategy tends to hamper the recognition and reconstruction of single activities, which negatively influences the possibility to answer research questions, and questions related to the vegetation of arable weeds and cultivation practices in particular. For the last subject, it is necessary to have the disposal of a representative number of samples that – be it relatively poor in remains – are likely to represent a single context or activity and to reveal cultivation practices.

A final methodological aspect, which has become evident, is the importance of the combination of different sources and approaches, *i.e.* the combination of pollen, macroremains, wood, mosses, molluscs, the analysis of the spatial distribution of botanical remains, morphological and chemical analysis of food crusts, use-wear analysis and the analysis of stable isotopes. The integration of archaeobotanical data with archaeological data on aspects like mobility, site function and seasonality is essential for the critical interpretation of archaeobotanical evidence as well. Future analyses, related to the subject of this study, should preferably be based on a maximal variety of sources. As some parts of this study show, it is equally important to investigate and publish such data from earlier excavations, and to combine and reinterpret already available data.

12.3 Reconstruction of the natural vegetation

Analysis of the archaeobotanical sources shows that the dryland vegetation in most studied regions consisted of *Tilia* and *Tilia/Quercus* woodlands, gradually replaced by *Quercus* woodlands and alder carr due to the rising water level. The surrounding wetlands were dominated by mosaics of open water, reed marsh and alder carr. In the Vecht region, mesotrophic marshes developed as well. In the coastal region, the natural vegetation was relatively open. Salt marshes in this region developed into reed marshes and grassland through time due to the decreasing influence of the sea. Scarce patches of dune shrub vegetation were present on the dunes while patches of alder carr were present on the beach plain behind the beach barrier. Woodland other than alder carr was scarce. The variety of trees and shrubs as attested in the unworked wood and charcoal is nevertheless maximal in the coastal region.

Comparison of the data from the various regions shows that there are some differences between the plant species found at sites in the northern Vecht region (and in lesser degree also the Eem region) and those from southern regions (the central river area and the coastal region). This holds for the data on trees and shrubs on the one hand and ruderals on the other hand. The exceptional position of the Vecht region may relate to restricted representativity of the available data, in which case the difference would disappear with further research. The inter-regional differences may also be related to variation in the natural vegetation between the regions, affecting possibilities and constraints for exploitation. Finally, they may relate to cultural variation in plant exploitation between the regions (also discussed below in relation to human impact). For the moment, it is not possible to distinguish between the three options.

12.4 Human impact

12.4.1 Settlement choice

People selected various environments within the wetlands for occupation, and occupation and exploitation was not restricted to a single type of habitat, as indicated by the differences in the natural vegetation between the regions, as well as the evidence of occupation at various types of dryland terrain (inland dunes, glacial till outcrops and levees). The risk of flooding in the wetlands apparently was no restrictive factor, since people lived at dryland patches that stood out from the marshes sometimes only few decimetres in various regions. This may even have been considered as a benefit since flooding and sedimentation may have functioned as a natural manuring process. The flexibility of people is also shown by the digging of unlined wells at the edge of the occupied dunes in the coastal region in times of shortage of fresh water due to the flooding of the near surroundings.

12.4.2 Evidence of human impact in pollen diagrams

Human impact at the wetland sites of the Swifterbant culture and Hazendonk group, resulting from the presence of people and domestic animals, generally resulted in clearance and disturbance of the woodland on a small to moderate scale, particularly affecting *Tilia* sp., *Quercus* sp. and *Alnus* sp. This resulted in the increased presence of secondary shrub vegetation and an increase in 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%, which is roughly comparable with the percentages known from other Neolithic cultures in Europe. In the central river area and the Eem region, people cleared only a minor part of the woodland of dry terrain. While this scale of disturbance had a restricted impact in densely wooded regions, the same scale of disturbance probably resulted in restricted occurrence of trees and shrubs in the less densely wooded coastal region. The degree of deforestation in the Vecht region remains unclear.

The character of the evidence of human impact in pollen diagrams shows similarity with the evidence of human impact known from the LBK and Rössen culture, and shows considerable similarity to human impact known from the Ellerbek culture, for which is it suggested that leaf-foddering was practised. There is however no evidence of the common practice of leaf-foddering in the pollen diagrams of the sites studied. The evidence of human impact at the sites studied additionally shows similarity with human impact in the Funnel Beaker culture and the Belgian Michelsberg culture, especially concerning the decrease in *Tilia* sp., which suggest that people used the taxon. *Tilia* sp. is however underrepresented in the worked wood and charcoal of the studied sites. The coastal region further provides some indications of burning of dryland vegetation, possibly pointing to the practice of slash and burn techniques, but the purpose of the burning and the relationship with cultivation need further investigation. Overall, the general similarity of the evidence of human impact in pollen diagrams of the studied sites and various other cultural groups and periods must be related to general similarities in vegetation and human impact, and cannot be related to specific agricultural practices.

12.4.3 Use of wood

Comparative analysis of the wood of the studied sites indicates that the availability of taxa in the natural vegetation was the primary factor in the use of wood, since the wood of *Alnus glutinosa* (alder) was most commonly used, more or less independent of the precise purpose. Moreover, the range of taxa used for the manufacture of wooden artefacts is relatively broad. Taxa other than *Alnus glutinosa* that are found in the artefact assemblage of many sites are *Fraxinus excelsior*, *Quercus* sp., *Corylus avellana* and *Salix* sp. The taxa *Juniperus communis* and *Prunus* sp. (*Prunus spinosa*) were important wood resources in the coastal region where woodland was scarce. The range of wood and charcoal identifications in the northern regions is slightly smaller than in the central river area.

In addition to the use of wood based on availability, people selected wood of specific taxa for specific purposes as well because of the quality of the wood and the function of the artefact, but generally only if these taxa were present in the exploitation area, and only on a small to moderate scale. There are little indications of the import of wood from outside the exploitation areas. Artefact types that show relatively strong indications of a selective choice of wood based on the qualities of the wood and the function of the artefact are bows, dugout canoes, paddles, fish traps and beams. Comparison of wood identifications of fish traps shows that people in the Eem and Vecht regions used different species than people in the south. Furthermore, the comparison shows that there are no indications of the selective use of wood for paddles in the two northern regions, which is in contrast to the southern regions as well. This result cannot be explained by poor preservation or research methodology, and may indicate differences in the natural vegetation and/or different selective choice.

The charcoal assemblages of all sites, primarily reflecting the gathering of fuel, are dominated by *Alnus glutinosa*, *Quercus* sp., *Fraxinus excelsior* and Pomoideae. This indicates that the availability of taxa in the natural vegetation played an important role in the selection of firewood, and to a lesser degree also the combustion qualities of wood. The taxa selected for fuel are similar to those that were selected in Neolithic cultures in Central Europe.

12.4.4 Food plants and use plants

The finds of macroremains were subjected to various analyses in order to investigate which non-cultivated plants were used and consumed. The analyses indicate that *Corylus avellana* and *Trapa natans* most likely functioned as staple foods at the sites studied. Taxa that also functioned as an important food source are *Prunus spinosa*, *Malus sylvestris*, *Crataegus monogyna* and *Ranunculus ficaria*. Additional plant food sources probably included *Quercus* sp., *Cornus sanguinea*, *Rosa* sp., *Rubus* species, bulbs, roots, rhizomes and tubers of *Allium* sp., *Bolboschoenus maritimus*, *Beta vulgaris* ssp. *maritima*, *Typha* sp. and Pteridophyta, and possibly roots of *Nymphaea alba* and *Nuphar lutea*. The attested assemblage of probable food plant varies slightly between the regions, being smaller in the northern regions (see paragraph 12.3). Although import cannot be excluded, the macroremains do not provide any indications of exchange of food plants or use plants between 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 plants is restricted as compared with the expected intensity of use of plants and to the expected broad range of taxa available. The evidence of the consumption of gathered plants is, however, considerable compared with that of the consumption of crop plants.

12.4.5 Social role of plants

The botanical material gives hardly any evidence of a social, ritual or symbolic role of plants, plant food and artefacts made of plant material. Some scarce evidence is presented by the wooden artefacts. This scarcity of relevant data should probably not be interpreted as proof that plants did not have such a role. It is more likely that the finds and the contexts that are most commonly represented at sites do not easily enable the reconstruction of the social role of plant material. The study of various aspects of flint artefacts that are related to plant processing appears to shed more light on this aspect (Van Gijn in press). The analysis of stable isotopes of human skeletal material may reveal a social differentiation in the role of food, including plant food, as well (Smits *et al*. in prep.). Further integration of approaches seems promising here.

12.5 Neolithisation

Neolithisation generally involves changes in ideology, social practices, mobility, subsistence and material culture, of which the cultivation of crop plants is only one aspect. The archaeobotanical data set of the study, derived from Late Mesolithic and Early and Middle Neolithic sites, enables investigation on whether the neolithisation process resulted in changes in the use of plants. Theoretically, changing use patterns can be expected from the very beginning of the neolithisation process onwards, that is, from the first known contact with fully Neolithic cultures (LKB) onwards.

12.5.1 Wild plants

Only the data set of the central river area enables the comparison of the evidence of human impact in pollen diagrams between non-agricultural and agricultural sites and phases. This comparison shows a trend that the strength of human impact in the central river area increased after the introduction of crop plants. The distinction of the precise role of the introduction of crop plants is, however, complicated since the size of the catchment basin, research methodology, occupation intensity, the introduction of domestic animals and site function may also play a role in the increase of the evidence of human impact.

Analysis of pollen diagrams shows that the character of the changes in the vegetation within most regions remained relatively similar through time during the period studied (see paragraph 12.4.2). This continuity in the character of human impact can be related to the continuity in the composition of the vegetation, the cultural continuity within the communities studied, and to continuity of site function.

The analysis of wood and charcoal indicates continuity of the use and selection of wood resources throughout the neolithisation process. The selective use of taxa stayed the same through time, with the exception of changes in the choice of wood used for bows and dugout canoes that is in accordance with results from other parts of Europe. There is only a single wooden artefact that is interpreted as an artefact possibly used for cultivation practices. Despite the increased number of finds and increased attention for wood, a variety of wooden artefacts without a known function indicates that our knowledge about the activities involving wooden artefacts and use of wood is still restricted.

In addition to the wood data, the indications of the use and consumption of wild plants also strongly point to the continuation of plant use through time, at least in view of the range of taxa. The information on the importance of gathered food plants compared with crop plants is restricted.

The study hardly provides evidence of the intensification of collection, management or cultivation of non-cultivated plant resources throughout the neolithisation process *(cf.* Rowley-Conwy 2004, 86, who concluded the same for other parts of Northwestern Europe). The data do not enable the distinction of increasing control over the vegetation either. Only the scarce studies on wood from structures, mainly fish traps, indicate that people probably practised some form of woodland management for optimal production of withies. This is especially supported by the evidence from Bergschenhoek, while the restricted sample size hampers to make strong conclusions for other sites. The current results indicate that more extensive sampling programs of fish traps can improve the validity of the evidence of vegetation management in the period concerned.

Apart from the evidence of slightly increased human impact after the introduction of crop plants in the pollen diagrams from the central river area, the results from the Late Mesolithic and the Early and Middle Neolithic primarily indicate continuation in the way people used plants for food, fuel and artefact manufacture. This continuity corresponds with the observed uniformity and continuity within the Swifterbant culture as discussed by Raemaekers (1999, 189 and further). The pattern additionally supports that neolithisation in the Dutch wetlands was a process of gradual acculturation.

12.5.2 Arable weeds

The study of potential arable weeds has shown that it is difficult to distinguish which taxa represent field weeds of the Swifterbant culture and Hazendonk group, since there are hardly any samples that are derived from closed contexts and that represent single deposition events, thus not assuring association between crop plants and weeds. Furthermore, many taxa that developed into arable weeds after the introduction of crop cultivation were already present in the vegetation earlier. The range of potential arable weeds is relatively stable through time and is comparable with those from other Neolithic cultures in Northwestern Europe.

This study has aimed to analyse which taxa represent arable weeds at the sites studied, based on three methods. Firstly, the small number of samples that represents pure assemblages from closed contexts was analysed. Secondly, it was investigated which taxa are present in a carbonised state in samples that contain carbonised cereal remains. Thirdly, it was compared which potential arable weeds are present in a carbonised state at agricultural sites. The combination of these methods shows that *Bromus secalinus*-type, *Hordeum marinum*, *Fallopia convolvulus*, *Malva* sp., *Persicaria maculosa* and *Solanum nigrum* most likely represent arable weeds. It is expected that some other taxa also functioned as weeds. *Hordeum marinum* and *Malva* sp. have only been attested in the coastal region where the natural vegetation differed from the vegetation in other regions. The suggested field weeds indicate that the arable plots had a permanent character.

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 regional difference may relate to differential preservation and (non-) representativity of the data sets of the northern regions, to differences in the natural vegetation or to differences in cultivation practices between regions that may relate to the neolithisation process.

12.5.3 Crop cultivation

This study provides an updated overview and interpretation of the finds and the age of finds of crop plants from the wetland sites of the Swifterbant culture and Hazendonk group. The crop plant assemblage is highly uniform through time, with emmer wheat and naked barley as the main crops. Possible differences in the crop plant assemblage, if any, can be mainly observed on a regional scale. In the Vecht region, the importance of einkorn remains to be investigated. In the river area, opium poppy and pea were additionally present, which can be related to active exchange and a developed stage of neolithisation in the southern regions, although the intensity of research could play a role as well. In the Vecht region opium poppy was present during the Neolithic as well, but the available finds are not precisely dated.

The evidence on local cultivation at the wetland sites has been investigated in detail and compared for all agricultural sites. The discussion on this subject, based on both archaeobotanical and archaeological arguments, requires a high level of evidence, arguments and detail in this developed stage of the discussion, and is further complicated by the uncertainty about the cultivation practices and the scale of the arable plots. The best evidence of local cultivation is available for sites in the coastal region, dating to the Middle Neolithic (Hazendonk group). The information from Early Neolithic sites in the Vecht region is fragmentary but does not argue against local cultivation, while new results from Swifterbant-S4 support local cultivation. For the central river area, the crops and weeds provide some indications of the import of crop plants for the Early Neolithic (Hazendonk phase 1), although small-scale local cultivation may also have been practised. Assuming that local cultivation was practised in the Vecht region, the start of cultivation in the wetlands was contemporaneous with the introduction of crop plants.

The date of the introduction of crop plants on the sandy soils that surround the wetlands remains unknown due to a lack of data, which means that the wetland sites reveal only a part of the evidence of the introduction of crop plants in the Swifterbant culture. The available data on crop plants from the wetland sites indicate that the introduction of crop plants took place between (4400/)4300 BC and 4100/4000 BC. There is

scarce evidence of the absence of crop plants before 4400 BC, but the period of introduction needs further refining, especially for the Vecht region. The scarcity of well-documented sites and assemblages from the period 4400-4100 BC does not allow a finer chronology yet. As a result, more detailed information is needed on the very initial stage and the rate of the process of crop introduction. 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. It would be relevant to compare the rate of introduction of crop plants with the rate of introduction of pottery and domestic animals in the wetlands.

The dates of the crop plants indicate that the Michelsberg culture played an important role in their introduction in the Swifterbant culture, confirmed by the considerable correspondence between the crop assemblages. The hypothesis that the Rössen culture played a major role in the introduction of crop plants in the wetlands can be rejected for the southern regions, and tentatively for the Eem and Vecht region as well. It can, however, not be excluded that other cultural groups (like the Bischheim group) were relevant as well, in view of the time range, the restricted information from the Eem and Vecht region and the lack of information on subsistence in the sandy regions that surrounded the wetlands.

12.6 Suggestions for further research

In addition to the specific comments added at the end of some of the chapters, some suggestions for further research are discussed here. Future studies would benefit from continuation of the application of the full range of available archaeobotanical methods and approaches, in combination with the study of archaeological sources, both on site level and on a regional scale. Important focus points for archaeobotany are the number of samples and control samples (possibly from non-archaeological locations) in order to improve the validity of the conclusions on human impact. The extended micro-wear and residue analysis of artefacts appears to be promising for the study of plant use throughout the neolithisation process. A combined archaeobotanical and zoological approach can be useful in order to study the influence of domestic animals on the vegetation.

Comparison of the information on the development of the vegetation indicates that particularly the Vecht region needs further attention, as well as the Pleistocene sandy dryland regions that surround the wetlands. It would be useful to obtain more detailed information on human impact for the dryland regions and the coastal region. The better determination of the period of introduction of crop plants can be improved by the further study of sites from this period available in the central river area (Alblasserwaard). The study of the subject of crop cultivation indicates that cultivation practices and the presence and location of fields needs further study, including the investigation of tillage marks.

The continuity of the relationship between people and plants as discussed in the conclusions about neolithisation indicates that the research would profit from a wider scope, both in geographical and chronological sense. Comparison with the Vlaardingen group is expected to give similar results, while incorporation of other Late Neolithic cultural groups as well as earlier Mesolithic groups will probably enable the distinction of long-term trends.