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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4 Vecht region

4.1 Geology and palaeogeography of the Vecht region

4.1.1 Introduction

This paragraph discusses the relevant geology and palaeogeography of the Neolithic sites at Swifterbant (various sites), Schokland-P14, Schokkerhaven-E170, Urk-E4 and Emmeloord-J97, located in eastern Flevoland and the Noordoostpolder. Figure 4.1 shows the location of the sites and the elevation of the Pleistocene subsurface. In the northern part of the Noordoostpolder the Pleistocene subsurface consists of aeolian coversands (Boxtel Formation, *cf.* Schokker *et al.* 2007). In the southern part of the Noordoostpolder and in the northern part of Eastern Flevoland the coversands are generally lacking. In the Pleniglacial, Late Glacial and Early Holocene (*c.* 40.000-8.000 BP) the river Overijsselse Vecht dissected and reworked Pleistocene Rhine deposits (Kreftenheije Formation; Busschers *et al.* 2007). The Geldersche IJssel as a Rhine branch became active only in the Late Holocene. Under the Periglacial climate, the Vecht and the tributaries draining the IJssel valley carried considerable discharge (Huisink 1999; Van Huissteden *et al.* 2001). In contrast to the coversands, the sands of the Vecht are calcareous, contain gravel and have a loamy top. Aeolian inland dunes (river dunes) of Late Glacial age border former channels of the Vecht in the southwestern part of the Noordoostpolder (top at *c.* 4 m -NAP, Kreftenheije Formation). Outcrops of glacial till stand out at Schokland, Urk, Tollebeek and Vollenhove (Gieten Member of Drenthe Formation; Ente 1976; Ente *et al.* 1986; Gotjé 1993; Weerts *et al.* 1998). These Pleistocene deposits were present at the surface in the region during the Late Mesolithic.

The Holocene sequence, consisting of detritus-gyttja, peat and clay (Nieuwkoop Formation and Naaldwijk Formation), buried the Pleistocene subsurface in the last *c.* 7500 years. A gradual rise of the ground water level, owing to sea level rise downstream, resulted in the development of marshes and sedimentation of peat. This started at *c.* 5500-5000 BC at the studied sites at *c.* 8 m -NAP. The Vecht valley became submerged and the river discharged into a lagoon. At short distance from former river channels the marshes were eutrophic, while at larger distance from the rivers the marshes were increasingly oligotrophic. The extent of oligotrophic vegetation increased during the second half of the Holocene. Peat growth was continuous in the north. In the south, it was interrupted locally by periods of clay deposition. Part of the clay was delivered by the rivers Vecht and IJssel, but tidal channels from the west are considered as the main source (discussed below). Deposition of detritus-gyttja mainly took place in the deepest incised submerged river channels (Ente *et al.* 1986; Wiggers 1955).

A tidal inlet was present during the Middle Holocene west of the study area, resulting in marine influence in the region. The inlet connected the fresh to brackish lagoon to the sea. As groundwater level rose and peat formation continued, tidal and salt water influence in the study area decreased. Three phases of marine calcareous clay deposition are registered in the Noordoostpolder. During the first phase at *c.* 5200-4000 BC clay was deposited in the southern and south-central area of the Noordoostpolder (Older Unio clay; see fig. 4.2).[1] During that phase the environment was comparable with a freshwater tidal system, and consisted of levees and backswamp areas. From *c.* 4200-4100 BC onwards, both marine influence and influence of the eutrophic river water decreased, resulting in a mesotrophic freshwater environment. From 3800 BC onwards, river discharge further decreased, resulting in peat formation. A second phase of marine clay deposition occurred at *c.* 3700-3400 BC. It is synchronous with the presence of a lake in the central part of the Noordoostpolder (Younger Unio clay). A third phase of clay deposition occurred in the southern part of the Noordoostpolder at *c.* 2500-1800 BC (Cardium clay). During this phase marine influence appears to be the result of single events (stormfloods) rather

1 This unit probably is diachronic, and as a result the quoted age only applies to its inland limit in the study area.

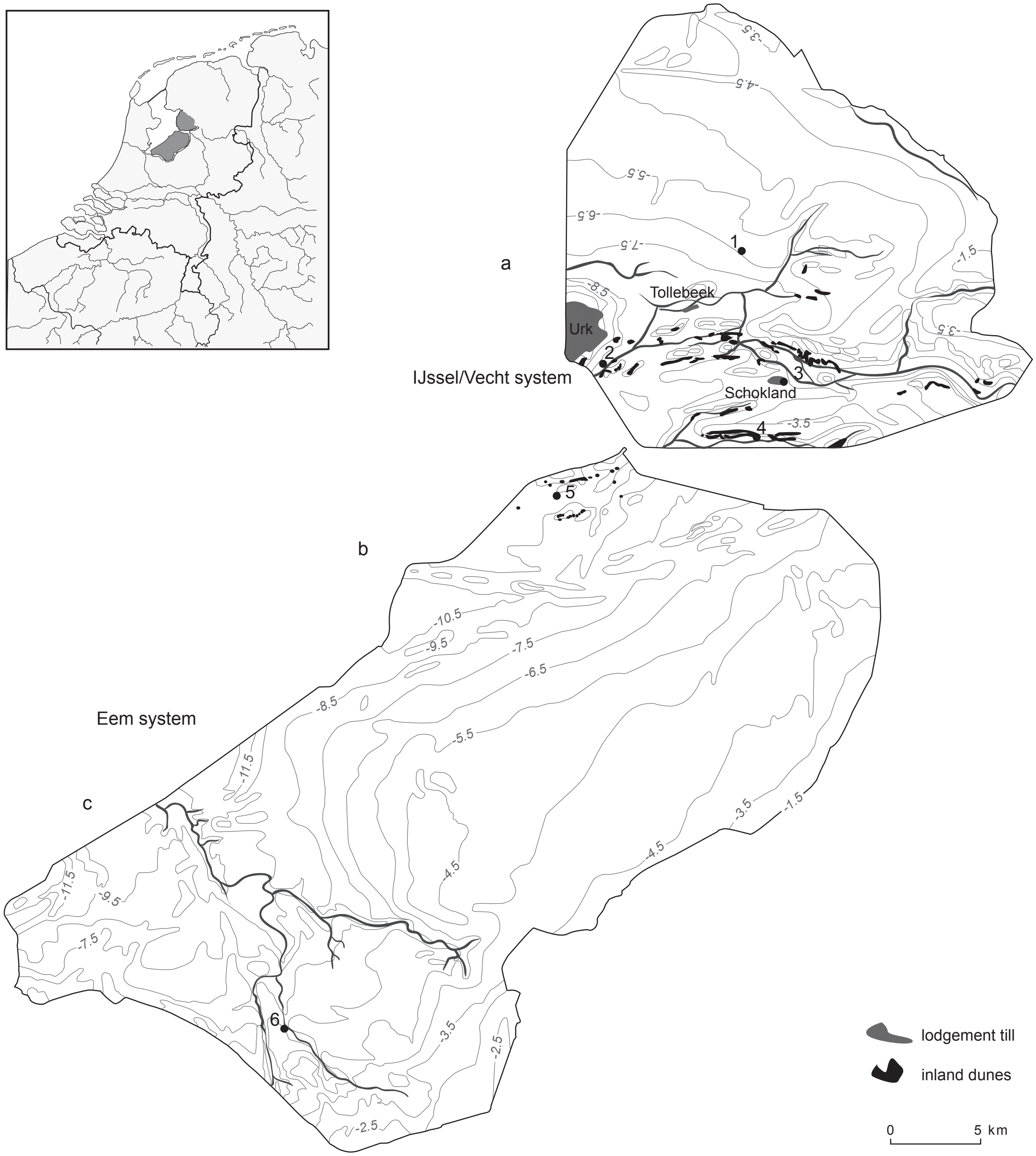

Figure 4.1 The Vecht and Eem region, the Pleistocene subsurface (m –NAP; after Peeters 2007). a = Noordoostpolder, b = Eastern Flevoland, c = Southern Flevoland, 1 = Emmeloord-J97, 2 = Urk-E4, 3 = Schokland-P14, 4 = Schokkerhaven-E170, 5 = Swifterbant, 6 = Hoge Vaart-A27.

than the result of a continuous open connection. The marine connection between the lagoon and the North Sea at this time is sought in the Amsterdam area and the province of Noord-Holland (Oer-IJ and Bergen tidal inlet; *e.g.* De Mulder *et al*. 2003). During this period, marine incursions were of stronger impact than during previous phases (Gotjé 1993). Sedimentation processes continued after the studied period and resulted in partial erosion of the Middle Holocene deposits.

During the Late Mesolithic and Neolithic, islands of relative high topography of various geomorphology stood out in the marshy lagoon and were occupied by people. The highest elevated islands were outcrops of glacial till. These generally shrunk in size through time, but none submerged completely within the timeframe studied here. The Late Glacial inland dunes gradually submerged, becoming unsuitable for occupation during the timeframe of interest. Some of the natural levees along channels may have been suitable for occupation for limited time, depending on their height. These levees developed along the larger and smaller fluvial and tidal channels, especially during the first phase marine clay deposition (*c.* 5200-4000 BC).

The rising ground water table is the main factor controlling the suitability of dryland patches for occupation. A reconstruction of the ground water table rise is therefore an essential element of a reconstruction of occupation history of an archaeological site over time. The ground water level curve available for this region

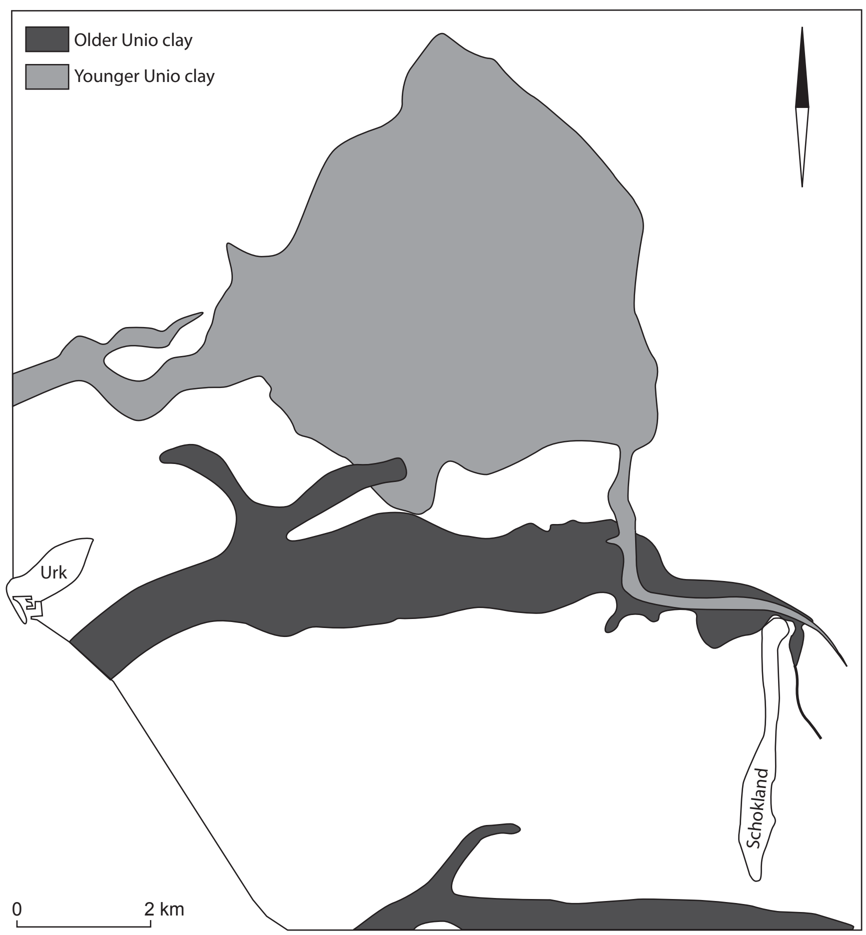

Figure 4.2 Noordoostpolder, Vecht region, palaeogeographic reconstruction showing the distribution of the Older and Younger Unio clays, deposited at *c.* 5200-4000 BC and *c.* 3700-3400 BC respectively (after Gotjé 1993).

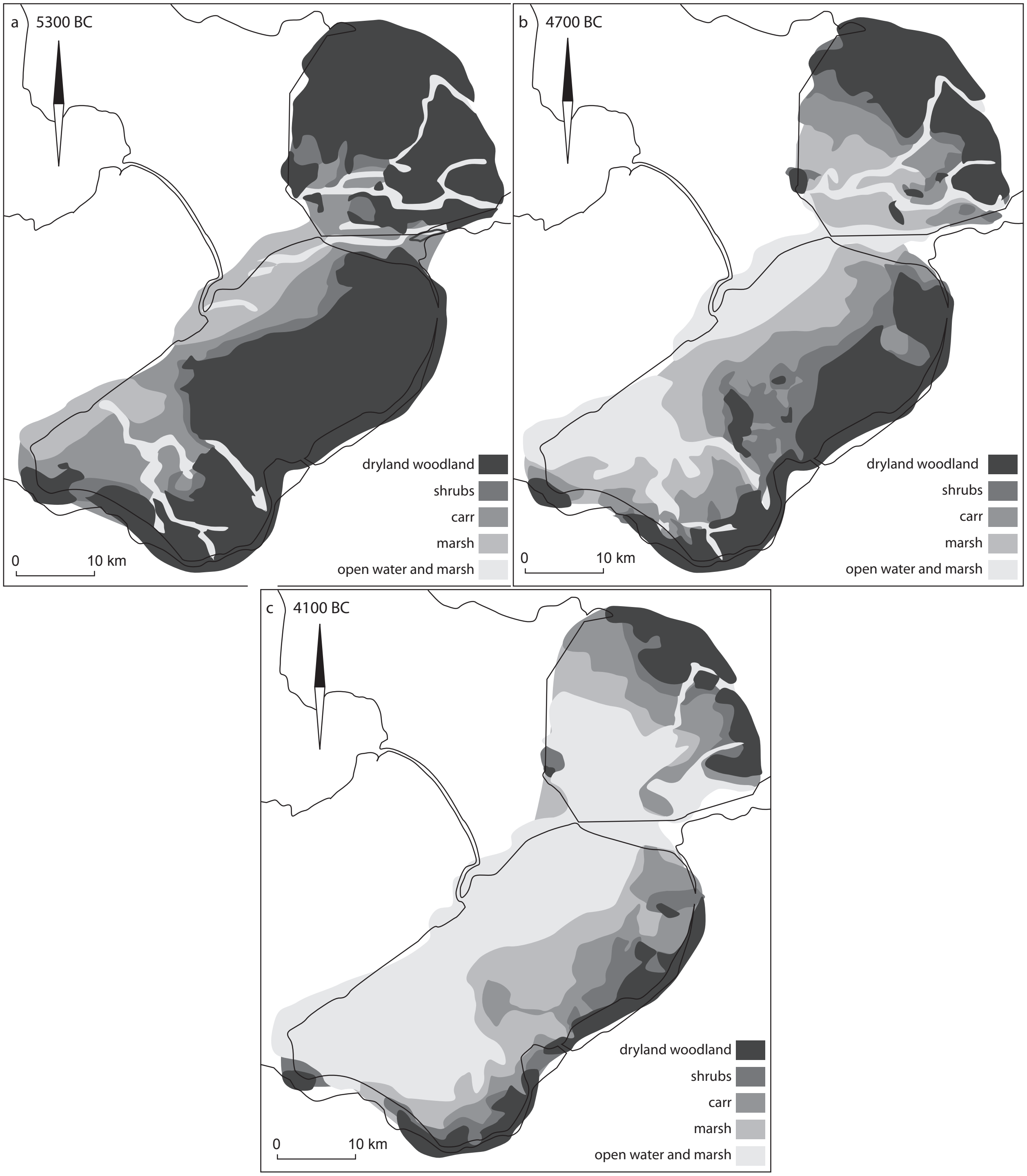

Figure 4.3 The Vecht and Eem region, palaeogeographical reconstruction for a) 5300 BC, b) 4700 BC and c) 4100 BC (after Peeters 2007, adapted by L. Amkreutz).

comes from one single research project (Roeleveld and Gotjé 1993) and is based on peat dates collected at two locations in the southwestern part of the Noordoostpolder. Makaske *et al.* (2003), based on dates from peat, botanical macroremains and charcoal from Hoge Vaart region, suggest that the Roeleveld and Gotjé curve may be decimetres too low. A new study (Van de Plassche *et al.* 2005) however supports the findings of Roeleveld and Gotjé, though this study is based on a small number of samples and needs further research as suggested by the authors. As a result, detailed discussion of results based on estimations of the ground water table is only useful when new data are available. Recently, Peeters (2007, chapter 3) modelled the rise of the ground water level for the Eem region and the Vecht region. Figure 4.3 that is based on a model by Peeters (2007) shows the development of the landscape through time discussed above.

4.1.2 Swifterbant

The various Swifterbant sites were located in a freshwater tidal environment with some minor marine influence, comprising a system of creeks, levees and backswamps (Ente 1976). Occupation took place on dunes and levees. The development of the levee sites is shown in Hacquebord (1976) and De Roever (2004). The top of the levees of the sites S2 and S3 is estimated to be at *c.* 5.00 m -NAP (De Roever 2004, 14). It is assumed that the rise of the ground water level restricted the occupation of the levees after *c.* 3800 BC. The top of the dunes rose to 4.20/4.00 m -NAP, and as a result these submerged later than the levee sites. The extent of individual sites is not published in detail.

4.1.3 Schokland-P14

The site Schokland-P14 is located at the eastern edge of an outcrop of glacial till, covered with Late Glacial coversand. The elevation rises to 2 m -NAP and has an extent of 1400 x 300 metres (42 hectares). The river Vecht ran along the eastern and northern side of the outcrop. The river valley became under influence of the ground water as early as 5200 BC, resulting in sedimentation of fine detritus and peat growth. In the period 4900-3400 BC the water level rose from 7.50 to 4.20 m -NAP. The relative height of the glacial till decreased from *c.* 3.75 metres at 4350-4150 BC to 3.15 metres at 3800 BC (Gehasse 1995, 37-38).

4.1.4 Schokkerhaven-E170

The site Schokkerhaven-E170 in the south of the Noordoostpolder is located on an aeolian dune that is part of a larger inland dune complex, bordering a former Vecht channel. The top of the dune is at *c.* 3.50 m -NAP. The palaeogeography of E170 is not well known since the site was only investigated on a small scale. At the start of occupation a tidal channel with a width of *c.* 800 metres was present next to the dune, resulting in clay deposition. Occupation of the site probably commenced only after the tidal channel had silted up and peat growth had started. The peat grades into humic clay at *c.* 5.40 m -NAP (Palarczyk 1986). The estimations of the ground water level suggest that the top of the dune submerged at *c.* 2600 BC.

4.1.5 Urk-E4

The site Urk-E4 is located on a dune along the former river Vecht, at 1 to 2 km distance of the outcrop of glacial till (16 metres +NAP, the village Urk). The estimated height of the top of the dune is 3.80 m -NAP. The extent of the site approaches 1 hectare but is unknown since only a part of the site could be excavated. Occupation took place during a Mesolithic and a Neolithic phase. Local peat growth outside the channels of the Vecht started after the Mesolithic occupation phase and before the Neolithic occupation phase. There are indications of minor marine influence on the peat vegetation at *c.* 3700-3000 BC. The relative height of the dune was 2.3 metres at 4550-4200/4000 BC and 1.5 metres at 4200/4000-3800 BC, based on an earlier reconstruction of the mean ground water level (Roeleveld and Gotjé 1993). Dating of peat layers on top of the refuse layer indicates that the slopes of the dune became covered with peat and clay in the period 3900-3600 BC. The main channels of

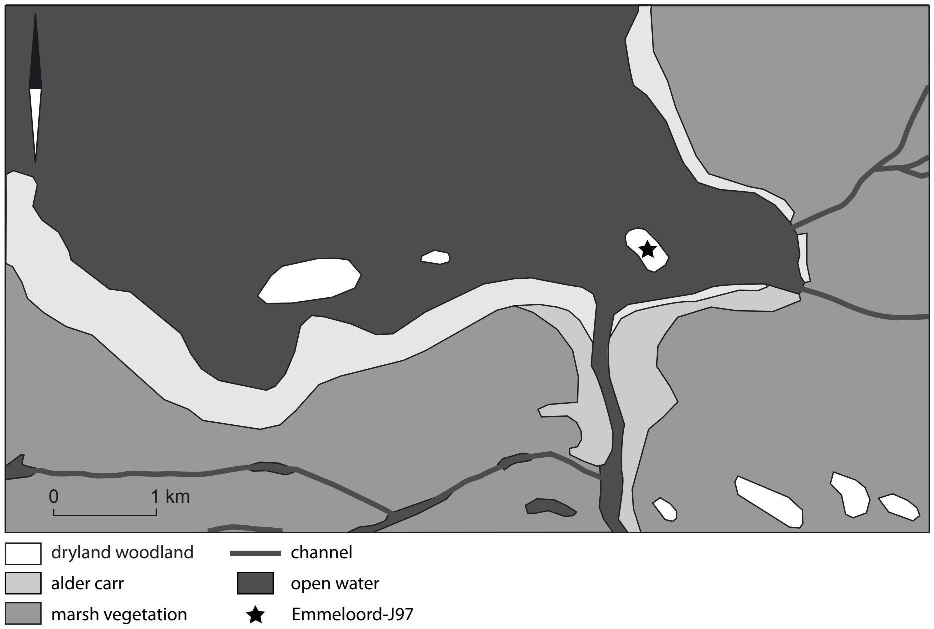

Figure 4.4 Emmeloord, palaeogeographical reconstruction for *c.* 3700-3400 BC (after Van Zijverden 2002).

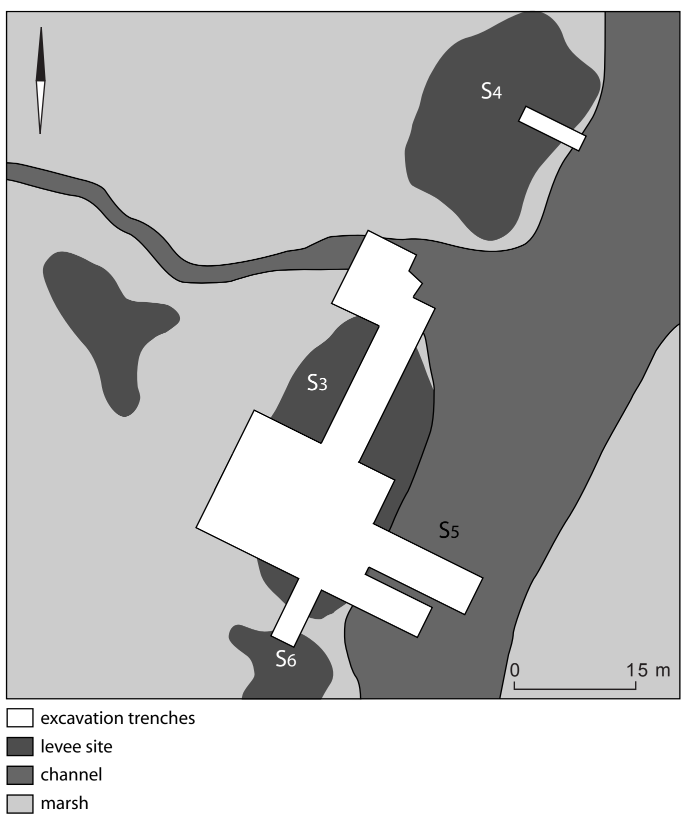

Figure 4.5 Swifterbant, excavation trenches at S3, S4 and S5 (after De Roever 2004, adapted by L. Amkreutz).

the Vecht shifted northwards around the glacial till outcrop at *c.* 3700-3400 BC. As a result peat growth at the locality Urk-E4 became continuous and resulted in decreased accessibility of the site (Peters and Peeters 2001).

4.1.6 Emmeloord-J97

Peat formation at Emmeloord started at 5740-5530 BC. Tidal channels were present in the region from 4330 to 4030 BC, resulting in clay deposition. The main finds from Emmeloord have been found in such a channel. The maximal width of the channel is *c.* 40 metres (Palarczyk 1986). Along the channel, various remains of levees are present. The activity of this channel strongly decreased after 3770-3500 BC, resulting in a decrease in the marine influence and deposition of detritus. From 3370-3000 BC onwards the channel functioned as a drainage channel to transport water from the marshes towards sea, resulting in more oligotrophic conditions. Lakes came into development afterwards around 2000 BC. Figure 4.4 shows a reconstruction of the palaeogeography at Emmeloord at *c.* 3700-3400 BC.

4.2. Swifterbant

4.2.1 Archaeology

A cluster of sites near Swifterbant, eastern Flevoland, were investigated and excavated during 1962-1979. Results of the research of that period have been published in the journals Helinium, Palaeohistoria and in dissertations. The Groningen Institute of Archaeology, the Dutch National Service for Archaeological Investigations and the province of Flevoland have started new research at known sites since 2004. The Swifterbant cluster, spread in an area with a diameter of *c.* 5 km, consists of two types of sites: five Mesolithic/Neolithic sites located on inland dunes (S 11-13, 21-24, 61, 71 and 81) and ten Neolithic sites located on levees (S 2, 3, 4, 5, 6, 31, 41, 42, 43 and 51). Main features and finds found at the sites are hearths, pits, graves, posts, pottery, flint, stone and organic material.

The sites of the Swifterbant cluster were not all contemporaneous and continuously occupied, but details are only known for some sites. Occupation of the region started at *c.* 6500 BC at the dunes. Subsequent occupation at the dunes has been dated to *c.* 6550-5550, 5300-5100 BC and 4350-4000 BC (De Roever 2004, chapter 1), and occupation in between these periods is not excluded but not documented (as yet). Submergence of the dunes made occupation impossible from *c.* 3600-3200 BC onwards. The levees were occupied somewhere between *c.* 4350 and 4000 BC[2] (Raemaekers *et al.* 2005; De Roever 2004). The dates of the sites suggest that the occupation at the dunes could represent the initial colonisation of the area, but data of the dune sites are scarce. De Roever (2004, 161) argues that the pottery shows some influence of the Rössen/Bischheim pottery tradition. The first evidence of domestic animals and crop plants is found at the levee site S3, dating to *c.* 4350-4050 BC (see below). [3]

It is hardly possible to produce a representative reconstruction of site function and seasonality for all sites individually given the scarce evidence and the large number of sites. It has been suggested that dune sites and levee sites had a different function, since the risk of flooding in the winter must severely have restricted possibilities for year-round occupation at levee sites, in contrast to dune sites (Deckers *et al.* 1980; Raemaekers 1999, 117). The pottery analysis supports such a difference between levee and dune sites (De Roever 2004, 41). Early (Mesolithic) occupation at the dunes may have been intensive, possibly characterised by base camps. Later occupation of the dunes (contemporaneous with occupation at the levees) probably reflects special activity sites.

2 Influence of the reservoir effect is however not excluded for all dates (De Roever 2004, 13).

3 The oldest pottery found at the levees dates from 4500-4100 BC (5490 ± 70 BP), possibly indicating occupation of the levees before 4350 BC, but the age range of this oldest pottery is broad and in addition influence of the reservoir effect cannot be excluded.

The sites at the levees are interpreted as intermittently visited base camps (De Roever 2004, 123). Structural analysis of seasonality indicators has only been performed on the basis of zoological data of S3 (Zeiler 1997). This analysis demonstrated presence between spring and autumn, and incidentally in autumn/winter. People apparently incidentally visited this levee site during autumn/winter, despite the risk of flooding.

The site S3 will here be discussed in detail since most published botanical data refer to this site. Swifterbant-S3 is a levee site (15 x 35 metres) with two small elevations at 5.35 m -NAP, bordered to the east by a creek (the location of S5) and north by a side tributary (see fig. 4.5; De Roever 2004, 20). Part of the site has been eroded by activity of the creek (Deckers *et al.* 1980). The width of the levee at the location of S3 is *c.* 80 metres (Cappers and Raemaekers 2008). An area of 760 m^2 was excavated, which yielded a refuse layer of *c.* 70 cm between 6.25 and 5.35 m -NAP. The refuse layer consists of dark clay, deposited by flooding, rich in organic material, representing the use of the site over a period of many decades. The complexity of the layer did not allow distribution maps of archaeological features or finds per sub-layer (De Roever 2004, 41). The overall distribution of finds indicates that occupation was more intensive at the end of the occupation. A house plan with a central hearth has been distinguished in the southern part of the excavation. This house was probably rebuilt several times during later phases of occupation. A second house location is assumed in the northern part of the excavation (De Roever 2004). The subsistence at Swifterbant-S3 was based on hunting, fowling, fishing and gathering, extended with animal husbandry and crop plants over time (Deckers *et al.* 1980). Dominant taxa in the bone assemblage of S3 are pig, beaver and otter; the domestic animals are dog, cattle, pig and sheep/goat (Zeiler 1997).

4.2.2 Archaeobotany

The discussion on the archaeobotany of Swifterbant is primarily based on articles of Casparie *et al.* (1977) and Van Zeist and Palfenier-Vegter (1981), and on published results from the new excavations. The data set consists of data of wood, charcoal, mosses and macroremains from S3, two pollen diagrams, and information on wood remains of S5. The house plans were not known at the time of the botanical analyses.

4.2.2.1 Pollen analysis

The pollen analysis concentrated on peat deposits from two locations, lot H46 and lot G43. The precise sample locations of both cores are not provided, nor are the details of the pollen sum. The sample interval varies between 3 and 10 cm. The diagrams represent a selection of taxa (see Casparie *et al.* 1977, 30).

The peat deposit of H46 represents a channel next to the slope of a dune where sites S21-24 are located. Nearby sampled peat that is comparable with the peat of H46 beneath the clay was dated to *c.* 4560-4330 BC. A sherd from S23 is dated to 4450-3800 BC, indicating that occupation at S23 theoretically may overlap with the pollen diagram of H46. The diagram of H46 shows that *Alnus* sp. dominated the vegetation while *Quercus* sp., *Corylus* sp. and *Betula* sp. may have been present as well. It is difficult to discern which taxa reflect the local vegetation and which do not, and it is not possible to recognise human impact in this diagram with certainty.

The peat deposit of G43 was sampled in the creek next to S3. The middle part of the investigated peat column is dated to *c.* 3800-3650 BC. The upper part therefore represents the development of the vegetation after occupation at S3 (Casparie *et al.* 1977) and is not relevant for the reconstruction of human impact. The lower part may reflect the vegetation during occupation, but it is not possible to recognise human impact. Based on this diagram Casparie *et al.* (1977, 33) suggested that reed vegetation was present on the levee during occupation. The closest woodland of dry terrain was probably present at the dunes, at *c.* 1 km distance. Relevant botanical evidence from the dunes is however hardly available (see paragraph 4.2.3.1).

4.2.2.2 Macroremains analysis
At the time of excavation, the site S3 was selected for analysis of macroremains since it was relatively rich in waterlogged macroremains. The sampling strategy was to sample per square metre in layers of 20-30 cm thick. Sample selection resulted in selection of samples rich in macroremains from various layers and areas. The analysis included 46 samples of 3 litres of soil that were sieved on a 0.2 mm sieve, and macroremains collected from 2.0 mm sieves during excavation (see Van Zeist and Palfenier-Vegter 1981 for details on sampling methods and results).

Most remains were only present in a waterlogged state, which is a result of the site selection. Taxa that were present in more than 50% of the samples are *Urtica dioica*, *Atriplex prostata/patula*, *Chenopodium album*, *Solanum nigrum*, *Phragmites australis*, *Hordeum vulgare* var. *nudum*, *Schoenoplectus tabernaemontani*, *Polygonum aviculare* and *Persicaria lapathifolia*. The frequency of wild food plant such as nuts, apples and berries is of minor importance (*c.* 15% or less). There is a large group of taxa that indicate the presence of marshes and/or alder carr, which could reflect the local or extra-local vegetation. There are three taxa that are representative of saline conditions, and several taxa that tolerate brackish conditions. The group of taxa that is indicative of woodland of dry terrain is small. The presence of waterlogged macroremains of *Alnus glutinosa* and *Betula* sp. may suggest extra-local presence of these taxa, but secondary deposition is not excluded.

The macroremains analysis comprised a study of changes through time, comparing activity areas that were discerned by the presence of unburned flint concentrations with non-activity areas during two phases. The activity areas more or less appear to be concentrated in and around the house, but the precise relationship is unclear. In samples from activity areas, there was no difference between the composition of lower and upper layers. In the samples from outside the activity areas, *P. aviculare* and *P. lapathifolia* were well represented in the lower levels, while *Phragmites australis* and *Scirpus tabernaemontani* were present in a higher frequency in the upper levels (Van Zeist and Palfenier-Vegter 1981).

The macroremains analysis also included a study of the distribution of the overall macroremains frequency at the site. The observed patchy distribution of large quantities of seeds and fruits resulted in the conclusion that people must have been responsible for these patches (Van Zeist and Palfenier-Vegter 1981, 150). It was stated that people were responsible for the deposition of practically all plant material at the site by dumping plant material in order to raise the level of the site (Van Zeist and Palfenier-Vegter 1981, 156). This interpretation appears to be based on field observations. The earlier postulated hypothesis that plants represented by high numbers of macroremains were part of the natural vegetation at the site was explicitly rejected.

The analysis of macroremains of S3 additionally included spatial analysis of single taxa. It was investigated whether it was possible to distinguish a correlation between the distribution of certain taxa and activity areas. The taxa *Urtica dioica*, *Solanum nigrum*, *Chenopodium album* and *Hordeum vulgare* were present in a higher frequency at activity areas. The taxa *Nymphaea alba*, *Atriplex prostata/patula*, *Polygonum aviculare*, *Persicaria lapathifolia*, *Persicaria maculosa*, *Stellaria media*, *Arctium lappa* and *Phragmites australis* were present in a higher frequency outside the activity areas. It was concluded that the occupants of the site preferred certain taxa for raising the level of the levee (those taxa that are found in a high frequency at the site), but the difference between activity areas and the remaining areas remained unexplained (Van Zeist and Palfenier-Vegter 1981, 164).

The available results of the macroremains analysis do not answer the question in which degree taxa where imported by people to the site. However, the botanical data do not need to be explained by anthropogenic efforts to raise the levee with plant material only, although this conclusion may be based on field observations. According to the current interpretation, the site S3 was not occupied year-round (De Roever 2004, 29). The levee could therefore have become covered with herb vegetation naturally when the site was not occupied. The vegetation presumably consisted of patches of wet meadow vegetation, forb vegetation and reed and bank vegetation. The character of the changes of the vegetation through time tentatively support the presence of vegetation. The importance of *Persicaria* species in lower levels and marsh taxa in higher levels (outside activity areas, thus representing natural vegetation) can be interpreted as the result of the increasing water level and submergence of the site. Disturbance of the local vegetation and possibly plant processing around the house and at activity zones could explain the difference between activity zones and non-activity zones. The interpretation that natural vegetation was present at the levee implies that most macroremains represent the natural vegetation. Only a part of the macroremains assemblage may represent non-local vegetation, *e.g.* plant material deposited by creek activity as drift litter and plant material imported by people (cereals and possibly other taxa).

4.2.2.3 Carbonised macroremains of non-cultivated plants

Van Zeist and Palfenier-Vegter (1981) suggest consumption of ten taxa including nuts, berries, herbs and a water plant. Indeed all relevant taxa have edible parts and are commonly mentioned as potential food plants, but the evidence of collection of some of the taxa mentioned at S3 is restricted. A new analysis of potential food plants has been based on the preservation status of taxa, the frequency analysis, and spatial distribution. Remains of wild plants found in a carbonised state are shown in table 4.1. The carbonised state supports handling and possibly consumption of *Corylus* sp., *Malus* sp. and *Crataegus*. Macroremains of *Galium aparine*, *Oenanthe* sp., *Phragmites australis* and *Ceratophyllum submersum*, which were also found in a carbonised state, are however not known as food plants and may represent use plants or natural vegetation that was burnt during human activities instead (though see chapter 9). One species mentioned in table 4.1, *Claviceps pupurea*, is a parasitic fungus of wild grasses and cereals that is toxic for humans and animals. The frequency analysis is discussed above; taxa that are found in a high frequency are herbs that may represent the natural vegetation of the site and do not necessarily represent food plants. Spatial analysis indicates that the distribution of *Urtica dioica*, *Solanum nigrum*, *Chenopodium album* and *Hordeum vulgare* corresponds with the distribution of activity areas. The first three taxa could represent arable weeds, but were also found in a high frequency at the site and can therefore also be interpreted as part of the local vegetation. There is no information on the possible content of the hearth, while information on the spatial distribution of plant remains in relation to the house is absent since the house was not distinguished at the time of the macroremains analysis. In conclusion, the carbonised state of certain taxa is the only indication of gathering and consumption of plant food. People must nevertheless have used a variety of plants in many ways. It moreover remains a question why only a small number of taxa was found in a carbonised state.

taxon
Ceratophyllum submersum
Claviceps purpurea
Corylus avellana
Crataegus monogyna
Galium aparine
Malus sylvestris
Oenanthe aquatica
Phragmites australis, stem fragments

Table 4.1 Swifterbant-S3, carbonised macroremains of non-cultivated taxa (Van Zeist and Palfenier-Vegter 1981).

4.2.2.4 Crop plants

The crop plants found in the macroremains assemblage of S3 are six-rowed, predominantly lax-eared *Hordeum vulgare* var. *nudum* (naked barley) and *Triticum dicoccon* (emmer wheat). In particular the sieve residues contained carbonised cereal remains (Van Zeist and Palfenier-Vegter 1981, 141). The preservation state of the cereals is not published in detail. There were many chaff remains of *Hordeum vulgare* var. *nudum* including a small concentration in a carbonised state, and a small number of chaff remains of *T. dicoccon*. One grain identified as

Triticum cf. aestivum was found as well. This can be interpreted as a grain of *T. dicoccon* deformed during carbonisation (see Braadbaart 2008), since it is a single grain and since *T. aestivum* is not commonly present at contemporaneous Dutch wetland sites. Carbonised grains of *Hordeum vulgare* var. *nudum* were also found during recent excavations at S4 (Raemaekers *et al.* 2005).

Van Zeist and Palfenier-Vegter (1981) concluded that there is no relationship between the distribution of cereal concentrations and the distribution of activity areas and/or distinctive features such as hearths and ash patches. The recent distinction of the house structure however leads to the conclusion that the cereal remains are distributed around the house.

There is no palynological evidence of the presence of crop plants at any of the Swifterbant sites. The presence of Cerealia-type pollen grains in the province of Flevoland contemporaneous with occupation at Swifterbant is only documented in two unpublished pollen diagrams from Lelystad and Tollebeek (Flevoland). The Cerealia-type pollen is supposed to date to 4100/4000 BC onwards and possibly also to 5400-4700 BC. The presence of pollen of Cerealia-type corresponds with a decrease in *Ulmus* sp. and the presence of *Plantago lanceolata* (De Roever 2004, 11-12). These pollen grains do however not prove or support local crop cultivation. Firstly, the unpublished diagrams date from 1971 and 1973 or earlier and were produced for geological research purposes. Secondly, there is no direct archaeological context and there is no direct link with the Swifterbant sites, although agricultural activity would probably be related to the Swifterbant culture. Thirdly, there are no finds of macroremains known from these sample locations. Furthermore, confusion with large pollen grains of Poaceae is not excluded since identification criteria of the cereal type pollen grains are not known (*cf.* De Roever 2004). Finally, the relationship with other changes in the pollen diagrams has no meaning since *Ulmus* sp. is strongly dependent on changes in the ground water level, while *Plantago lanceolata* may represent the natural vegetation at river banks and levees rather than vegetation indicative of human activities. Therefore, more information and new pollen analysis is necessary to enable further discussion of these diagrams.

4.2.2.5 Arable weeds

The analysis of arable weeds of Swifterbant is hampered by excavation methods. The sampling strategy at S3 did not focus on the association between carbonised cereals and other taxa that were mostly preserved in a waterlogged state, and relevant details are scarce. The macroremains assemblage contains a large variety of taxa that may represent arable weeds. Van Zeist and Palfenier-Vegter (1981, 141) argue that typical field weeds are hardly present and that only *Bromus hordeaceus/secalinus (B. mollis/secalinus)* may represent a true field weed. There is however no reason to exclude that some of the remaining taxa found at S3 functioned as arable weeds as well. Table 4.2 shows the taxa that were frequently present in the 27 standardised samples that contained cereal remains. Most taxa are found frequently in all samples, independent of the presence of cereals. This suggests that most taxa may have been part of the natural vegetation and do not necessarily represent arable weeds (this holds true even for *Urtica dioica*, *Solanum nigrum* and *Chenopodium album* that were present in a higher frequency in activity areas together with *Hordeum vulgare*). Only *Stellaria media* is found in a remarkably higher frequency in samples that contain cereal remains (78% in samples with cereals *versus* 24% in all samples). This is an indication that this species represents an arable weed.

taxon	freq. (%)
Urtica dioica	98
Atriplex prostata/patula	85
Chenopodium album	83
Solanum nigrum	83
Phragmites australis	72
Schoenoplectus tabernaemontani	63
Polygonum aviculare	59
Persicaria lapathifolia	59

freq. = frequency

Table 4.2 Swifterbant-S3, waterlogged macroremains, taxa that occur in a high frequency in the 27 standardised samples that contained cereal remains (based on Van Zeist and Palfenier-Vegter 1981).

4.2.2.6 Wood analysis

The published wood identifications consist primarily of wood remains from S3 and S5 of the excavations in 1975 and additionally posts, pegs and sticks from S3 and S5 of 1972-1974. The sampling in 1975 involved an area of 39 m^2 next to the house, where charcoal was collected as well. The number of excavated wood remains at S3 is *c.* 750 but not all remains were investigated/identified (Casparie and De Roever 1992; Deckers *et al.* 1980). The number of pieces collected at S5 (channel next to S3) is very small and their anthropogenic context is not assured. *Malus*-type represents *Crataegus* sp*.*, *Malus* sp., *Pyrus* sp. and possibly *Prunus* sp. (Casparie *et al.* 1977).

The wood remains can be divided into unworked and worked wood. The results are shown in tables 4.3 and 4.4. It is argued that "most wood was brought in by Neolithic man", and that these men "exploited the alder-rich deciduous woodland in the neighbourhood" without severe selection (Casparie *et al.* 1977, 37). The absence of woodland at the levee is supported by the absence of the remains of trunk or root systems at S3. The indications of import imply that the wood assemblage may represent a selection of taxa from the natural vegetation. The identifications of unworked wood (N = 92) consist of twigs, chips/bits and remaining pieces. It has been suggested that a bundle of twigs of *Ulmus* sp. supports the practice of leaf-foddering at Swifterbant (Casparie *et al.* 1977). Although such a function of the twigs cannot be excluded, leaf-foddering is not demonstrated here because there is no supporting information on the context of the find that could give information on the specific use or function of this bundle of twigs.

The worked wood remains consist of posts, pegs and sticks, and a minority of other remains. The published data contain information on 142 posts, mostly pointed. *Alnus* sp., *Corylus* sp. and *Fraxinus* sp. dominate the spectrum of posts. *Fraxinus* sp. appears to have been selected for posts (Casparie *et al.* 1977). Comparing the various wood and charcoal assemblages, it can be added that *Salix* sp. is underrepresented in the assemblage of posts, and was probably avoided during the building of structures. There is no information on identifications from single structures.[4]

4 Recognised structures are houses and series of posts. A series of posts at S3 consisted of 14 posts at the southern side of the levee at a distance of 0.4 metres of each other. At S2 a similar series of eight stakes was excavated along the eastern side of the ridge of the levee (diameter posts: 3-5 cm, distance: 0.4-0.5 metres) (Van der Waals 1977).

taxon \ category	twigs	chips	other	total (N)
Alnus sp.	-	24	9	33
Betula sp.	-	1	2	3
Corylus sp.	-	1	11	12
Fraxinus sp.	-	-	2	2
Malus-type	-	4	-	4
Populus sp.	-	-	1	1
Quercus sp.	-	3	2	5
Salix sp.	-	9	5	14
Ulmus sp.	17	1	-	18

- = not present

Table 4.3 Swifterbant-S3, unworked wood (Casparie *et al.* 1977).

	N			%	N	
taxon \ category	posts 1	posts 2	posts total	posts total	other	function
Alnus sp.	47	10	57	40	1	paddle
Betula sp.	4	3	7	5	-	
Corylus sp.	27	6	33	23	2	1 haft
Fraxinus sp.	11	8	19	13	1	haft
Malus-type	5	1	6	4	1	'bow'
Populus sp.	-	1	1	1	-	
Quercus sp.	7	3	10	7	1	paddle
Salix sp.	7*	2	9	6	2	haft and 'wattlework'
total	108	34	142		8	

posts 1:S3 en S5 (excavation 1975)

posts 2: excavation 1972-1974

* = four pieces with distinct gnaw marks of beaver

- = not present

Table 4.4 Swifterbant-S3, worked wood (Casparie *et al.* 1977).

Details on worked wood remains other than posts (see table 4.4) are scarce. The assemblage comprises three hafts, a paddle of *Alnus* sp. and a paddle of *Quercus* sp. (Casparie and De Roever 1992). The authors furthermore mention a bow of *Malus*-type and wattle-work, both written down between quotation marks that suggest that the authors do not exclude alternative interpretations. In contrast to most other studied sites, the paddles and the bow do not support selective use of wood based on the quality of the wood since paddles were usually made of *Fraxinus excelsior* and bows of *Ulmus* sp. or *Taxus baccata* (see chapter 8). *Fraxinus* sp. and *Ulmus* sp. were found in the wood and charcoal assemblages and were presumably available in the exploitation area. This indicates that the uncommon choice of wood for artefacts at S3 cannot be related to unavailability of the most suitable taxa.

4.2.2.7 Charcoal analysis

The available information on charcoal identifications of Swifterbant represents the results of the excavation of a part of S3 in 1975 (N = *c.* 848, max. *c.* 2 cm). Combining information on the investigated area and the location of the houses, it appears that the charcoal was collected in the corner of the house, where four hearths were present. Information from single contexts is however not available. Table 4.5 shows the charcoal identifications (based on Casparie *et al.* 1977). *Alnus* sp. strongly dominates the spectrum (51%). *Ulmus* sp., *Corylus* sp., *Salix* sp. and *Quercus* sp. are present with substantial values (7-12%), and *Fraxinus* sp., *Tilia* sp., *Betula* sp., *Populus* sp., *Pinus* sp. and *Malus*-type are of minor importance (< 4%). The charcoal assemblage indicates that both dryland and wetland vegetation was exploited for the collection of fuel. It can be assumed that the taxa that dominate the charcoal assemblage were easily obtainable in the exploitation area of S3. *Ulmus* sp. is overrepresented in the charcoal assemblage compared with the wood assemblage and may have been selected as fuel because of the qualities of the wood. *Fraxinus* sp. may have been avoided for fuel in order to save it for use as timber (posts). *Pinus* sp. was probably not present in the region and may represent reworked wood (see also chapter 7).

taxon	ml	%
Alnus sp.	436	51
Betula sp.	14	2
Corylus sp.	83	10
Fraxinus sp.	34	4
Malus-type	7	1
Pinus sp.	1	0
Populus sp.	6	1
Quercus sp.	62	7
Salix sp.	78	9
Tilia sp.	20	2
Ulmus sp.	107	13
total	848	

Table 4.5 Swifterbant-S3, charcoal (Casparie *et al.* 1977).

4.2.2.8 Moss analysis

The moss remains originate from the samples selected for macroremains analysis (for a list of taxa see Van Zeist and Palfenier-Vegter 1981). The number of taxa is large compared with most other Dutch wetland sites (though see Bergschenhoek, appendix V), which may be related to the research strategy. The assemblage contains many epiphytic taxa that grow on (old and rotten) trunks of *e.g. Fraxinus* sp., *Ulmus* sp., *Quercus* sp., *Tilia* sp., and *Salix* sp. Human collection of the wood may have resulted in the import of mosses from the exploitation area towards the site, and the mosses therefore do not demonstrate the local presence of dryland woods. The mosses may also have been imported intentionally for the use of the mosses themselves. Additional taxa are indicative of moist conditions, marsh vegetation, running water and ombotrophic bog vegetation. It is suggested that the ombotrophic taxa are of secondary origin (Van Zeist and Palfenier-Vegter 1981, 117), which could be related to secondary deposition or to import.

4.2.2.9 Other sources

The identifications of wild animals of S3, studied in detail by Zeiler (1997), are dominated by pig/wild boar, beaver and otter. These species are indicative of a marshy wetland environment. Roe deer is absent while red deer is mainly represented by antler fragments rather than bones, which can be related to the scarcity of dry terrain. Aurochs, elk and horse were of minor importance. It was suggested that the woodland around Swifterbant was too dense for these species (Zeiler 1997, 33), while it can be added that dry, accessible terrain may moreover have been too scarce.

4.2.3 Discussion

4.2.3.1 Reconstruction of the natural vegetation

For the exploitation area of all Swifterbant sites together, Van Zeist and Palfenier-Vegter (1981) suggested the presence of deciduous woodland on the higher levees and the dunes, alder carr at the edges of the levees and in the backswamps, and willow carr, marsh and reed vegetation, grassland and meadow vegetation, aquatic vegetation, and anthropogenic vegetation characteristic of disturbed, trodden and ruderal places rich in nitrate at occupied locations. The authors assume that the highest parts of levees along the main creeks were covered with woodland vegetation that tolerated some flooding (Alno-Padion). For the dunes they assume vegetation of a different character due to the different soil conditions and the absence of flooding.

The original publications did not offer a detailed reconstruction of the vegetation of S3 since it was not possible to reconstruct the vegetation before, during and after occupation, and since it was argued that all wood remains and macroremains were brought in from elsewhere. It is however more probable to suppose that many of the macroremains simply represent the vegetation on the levee, consisting of moist grass and reed vegetation, with some willow and/or alder trees present before/at the start of occupation. Occupation must have resulted in an increase in taxa indicative of disturbance. At the end of occupation, the low levees submerged and became overgrown by marsh vegetation and indicators of disturbance. The available wood data do not allow distinction between natural and anthropogenic wood remains, but scarcity of the macroremains of trees and shrubs indicate that most wood was probably indeed brought in from elsewhere in the exploitation area. Taxa that were probably present on the high levees are *Quercus* sp., *Fraxinus excelsior*, *Corylus avellana*, *Ulmus* sp., *Populus* sp., *Alnus* sp. and *Salix* sp., *i.e.* hardwood alluvial woodland and softwood alluvial woodland vegetation. The lower levees were probably only grown with softwood alluvial vegetation and at these levees *Quercus* sp., *Corylus avellana*, *Fraxinus excelsior* and *Ulmus* sp. must have been scarcer. *Tilia* sp. was probably not present on the levees (though see the discussion on the natural vegetation on levees in paragraph 2.8.2).

The age of the woodland vegetation in the exploitation area was the subject of discussion in early publications on Swifterbant. The rather small mean diameter of posts and pegs found at S3 was interpreted as being indicative of young woodland and was thought to contradict the identifications of the mosses and the variety of taxa indicative of old woodland (Van Zeist and Palfenier-Vegter 1981, 135). A possible scenario is that old woodland was present on the dunes while the relatively thin posts from S3 represent taxa from certain high levees. The use of posts with a limited diameter then can logically be explained by the principle of least effort, *e.g.* collection of wood as nearby as possible. The presence of the mosses can be explained by import from the dunes. Alternatively, it can be questioned whether the wood had a young age, since information on the number of annual rings is not available, and since the diameter of the posts from Swifterbant may be not so small after all in comparison with posts of contemporaneous sites in other regions.

There are no data available on the vegetation of the dunes other than the pollen diagram of H46 (discussed above) and the remark on the common presence of the remains of *Quercus* sp. in the clay around the dunes (Casparie *et al.* 1977, 42). Especially for these dryland patches one can assume the presence of varied deciduous woodland vegetation of dry terrain, similar to the dunes in the central river area. Taxa that are rare at S3, such as *Tilia* sp., Pomoideae, *Betula* sp. and *Rosa* sp., may have grown primarily at the dunes.

The creek system at Swifterbant was primarily a freshwater system. The assemblages of fish remains, mammals, and botanical macroremains all show the dominance of freshwater taxa, but also a very minor presence of taxa that tolerate brackish or marine conditions (Brinkhuizen 1979, 85; Zeiler 1997; Van Zeist and Palfenier-Vegter 1981). The pollen diagrams are not informative since only a selection of taxa is shown. Interestingly, the diatoms indicate fresh-brackish conditions (Cappers and Raemaekers 2008; Ente 1976, 21; De Roever 2004, 120). The presence of very weak marine influence can be interpreted as being indicative of sporadic events that resulted in the import of brackish water into the creek system as far as S3. The frequency of such events must have been lower than once a year. The creek system was connected with the North Sea coast by a large lagoon, which reduced the direct impact of the sea. The reconstruction of the environment does not suggest the nearby presence of salt marshes. Casparie *et al.* (1977, 47) stated that the difference of water depth due to tidal activity was maximal 10 cm. The presence of any daily tidal activity is however questionable considering the distance to the open coast and the absence of more indicators of brackish conditions.

4.2.3.2 Human impact on the vegetation

The pollen diagrams do not provide information on human impact on the vegetation (see paragraph 4.2.2.1), but this does not mean that (small) arable fields were absent at all Swifterbant sites, since the available data set is restricted (*contra* Bakels and Zeiler 2005, 317; *contra* Gehasse 1995, 202). The high number of taxa indicative of open patches and disturbance in the macroremains assemblage supports that disturbance of the vegetation occurred. The number of taxa of which macroremains have been found in a carbonised state is relatively small compared with some other contemporaneous sites. This is remarkable when taking into consideration the presence of a house that points to more than accidental occupation. The assemblage of posts shows some selective use of wood based on the qualities of the wood, but the assemblage of other wooden artefacts shows remarkably little evidence of the selective use of wood.

4.2.3.3 Local cultivation

Arable farming at Swifterbant has been a topic of discussion. The levee sites seem rather unsuitable for local cultivation because of the moist to wet conditions and because the sites were already used for occupation, resulting in the presence of domestic animals. On the other hand, local cultivation may have been possible after all.

Based on the absence of *in situ* concentrations of cereal remains it was concluded that "most if not all" cereal remains found at S3 represent dumped refuse (Van Zeist and Palfenier-Vegter 1981, 148). This interpretation corresponds with the distribution of the cereal remains clustered around the house, indicating that the remains of crop plants at S3 can be interpreted as the results of (daily) crop processing before consumption. Van Zeist and Palfenier-Vegter (1981) argued that the presence of chaff remains of naked barley is nevertheless indicative of local crop cultivation. They suggested that crop cultivation took place at the high levees of relatively large creeks and possibly the dunes, *i.e.* not at S3 itself. The presence of chaff remains does not however necessarily imply local cultivation since crop products could be transported in the ear from elsewhere in the exploitation area (see chapter 11). The original excavations did not show any indications of tillage marks or culms, but not all levees and dunes were investigated in detail. Use-wear analysis did demonstrate the working of plants and wood (Bienenfeld 1986) but did not positively proved the working of cereals since the methodology did not allow the distinction of such traces at that time yet.

Cappers and Raemaekers (2008) have suggested local cultivation based on the pollen evidence from Lelystad and Tollebeek, the presence of chaff remains of naked barley, the presence of querns and the use-wear analysis by Bienenfeld. These arguments can all be rejected (see discussion above) and do not demonstrate local cultivation. More recent use-wear analyses has moreover not resulted in the evidence of the presence of sickle gloss indicative of cereal cutting in a longitudinal direction that is comparable with the evidence from the coastal region (pers. comm. Van Gijn 2004), but this may be related to the possibility that cereals were harvested without sickles, or with deposition processes (see chapter 11). In my opinion, the data from the excavation at S3 do not demonstrate local cultivation, and the presence of the house seems to exclude cultivation at the time of occupation. The minor changes in the macroremains assemblage through time do not indicate local cultivation either. It remains however to be investigated how the remaining parts of the levee at S3 were used.

The new excavations at S4 have interestingly provided more or less regular features and micromorphological analysis that demonstrate some form of disturbance of the soil that is interpreted as the result of a form of soil tillage (Huisman and Raemaekers 2008). Details from the analysis of these features were not published yet when this study was finished.

A new argument for cultivation near Swifterbant is the ratio of naked barley *versus* emmer. Naked barley, which tolerates saline conditions better than emmer (Bottema *et al.* 1982), is clearly dominant at Swifterbant. Interestingly, some minor marine influence has been attested for Swifterbant (see paragraph 4.2.3.1). As a result, the dominance of naked barley may be explained by cultivation in a slightly brackish environment, *e.g.* at or near Swifterbant. The ratio of naked barley and emmer furthermore indicates that it is unlikely that the cereals were cultivated in the sandy dryland regions east of Swifterbant.

In conclusion, local cultivation may have taken place in the cluster of sites at Swifterbant, while cultivation at S3 during occupation seems unlikely until evidence proves otherwise. Cultivation on higher levees or on dunes seems more probable, although the indications of local cultivation at S4 may indicate that all levees may have been in use.

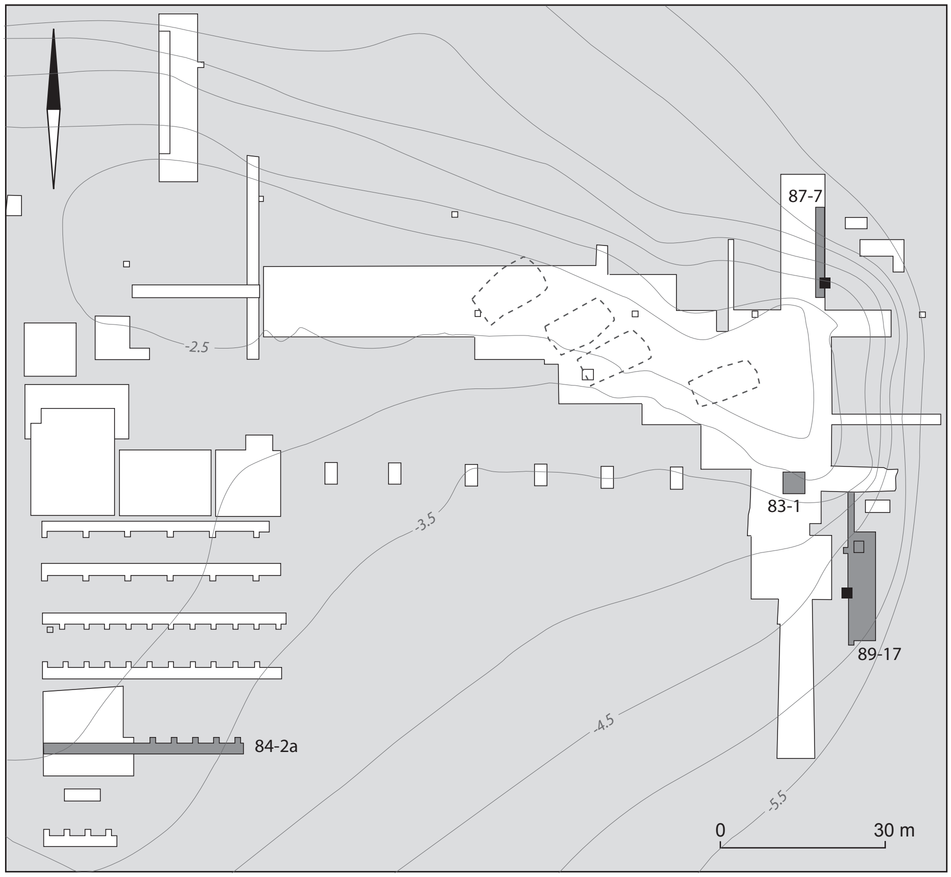

Figure 4.6 Schokland-P14, the Pleistocene subsurface (m -NAP), the excavation trenches, the presumed houses, and a part of the archaeobotanical sample locations indicated with dark grey and squares (after Ten Anscher 2001 and Gehasse 1995).

layer	date (yrs cal BC)	cultural phase	deposit
E	3600-3300	SW 4	31**
D	3600-3350	SW 4	32
C	3800-3600	SW 3/4	part of 200*
B	4100-3800	SW 3/4	part of 200*
A	4900-4100	SW 1/2/3	201 and part of 200*

SW = Swifterbant
* division of deposit 200 based on the distribution of pottery
** includes Swifterbant, Funnel Beaker and Single Grave pottery

Table 4.6 Schokland-P14, trench 89-17, the layers and related interpretation of the dates (Gehasse 1995).

4.3 Schokland-P14

4.3.1 Archaeology

The site Schokland-P14 (coordinates 181.580/518.000) was discovered in 1957 and partly excavated by the Institute for Prae- and Protohistoric Archaeology, University of Amsterdam (now the Amsterdam Archaeological Centre), between 1982 and 1991. The discussion below is based on Gehasse (1995). A site report that may contain new interpretations (concerning chronology amongst others) is expected in the future (Ten Anscher in prep.).

The site revealed indications of occupation from the Late Palaeolithic until the Early Iron Age, but the majority of the finds date to the Neolithic. The discussion below will focus on the Neolithic (Swifterbant) occupation until *c.* 3300 BC. Archaeological remains from this period were found on the outcrop and on the slopes (refuse layers), partly mixed with younger material. Figure 4.6 shows a map of the excavation trenches and some features.

The most detailed information was retrieved from trench 89-17 (20 x 5 metres; 5.00 to 3.19 m -NAP). In this trench, five strata with Swifterbant pottery were distinguished (layers A-E, see table 4.6). The ^{14}C dates however show considerable overlap, probably as a result of the mixture of material from different occupation periods. The stratigraphy can therefore only be used for dating with extreme caution (Lanting and Van der Plicht 2000). Occupation is argued to have occurred from 4900 BC onwards (Gehasse 1995). The material from the deepest layer (layer A) can however mainly be placed in the period 4400-4100 BC. The two oldest dates of layer A may furthermore indicate periods that are too old in age due to the reservoir effect resulting from dating food crusts that may have contained fish remains (pers. comm. Ten Anscher 2007). In all other trenches where Swifterbant material was found, only one 'GSW' layer (mixed Swifterbant) was distinguished.

The subsistence was based on animal husbandry, hunting, fishing and fowling, crop cultivation and gathering. The stone assemblage contained a fragment of a quern (Gehasse 1995, 60). The bone assemblage comprised both wild and domestic animals (dog, cattle, pig and goat/sheep) and was rich in wild/domestic pig, beaver and red deer (antler). The fish remains comprised freshwater taxa and anadromous taxa (Raemaekers 1999).

The features of Schokland-P14 related to the occupation before 3300 BC comprises graves dating to the middle phase of the Swifterbant culture, postholes and hearths. Ten Anscher (2001) distinguished four house structures (6 x 12 metres) that probably date to the late phase of the Swifterbant culture. Diatom analysis has demonstrated that at least part of the pottery was produced locally. The presence of houses, burials and the practice of a broad spectrum of activities including local pottery production indicate that the site functioned as a permanent settlement (Gehasse 1995, 67). The zoological remains mainly indicate summer and autumn occupation while there are a few indications of spring and winter occupation. Year-round occupation as well as occupation during the summer half-year only are both possible. The similarity of the fauna spectrum through time indicates continuity of site function (Gehasse 1995, 59, 67). Gehasse however argued that the site may have functioned as a temporary hunter-gatherer camp during a questionable first occupation phase until 4600 BC, since bones of domestic animals and pollen of cereals have not been found in the earliest part of layer A, and the number of sherds in this sub-layer is relatively low (Gehasse 1995, 67-68). The flint assemblage mainly consists of flint that was probably collected at or near the site itself, but it also contained small numbers indicating contact with the south. The pottery, stone axes and flint are said to indicate influences of the (epi-) Rössen culture (Gehasse 1995, 197).

4.3.2 Archaeobotanical materials and methods

The archaeobotanical research included the investigation of diatoms, pollen, macroremains and charcoal. The botanical data discussed here are samples from sections, samples collected for botanical (macroremains) analysis, samples from postholes, material from sieve residues obtained from the processing of non-botanical samples on 2 and 4 mm sieves, and handpicked material. The macroremains from samples other than the section samples and the charcoal data are presented below. For the results of the section samples I refer to the original publication. The majority of the botanical data were derived from trench 89-17 (see fig. 4.6).

Pollen analysis was applied to section samples. The sample interval of section samples varied between 2 and 10 cm. The calculation of percentages is based on a tree pollen sum including dryland trees, wetland trees and *Corylus* sp. (pers. comm. Troostheide 2006). Concentration calculations are available for some diagrams. The macroremains analysis is based on samples of 2 litres (number and location unknown; at least including samples from features) and samples from sections with a volume of 0.1 litres. Both sample types were sieved on a mesh width of 0.25 mm. Most features on top of the outcrop where occupation took place did not contain (carbonised) macroremains, except for a single posthole (dated between 4900 and 3300 BC). Charcoal was collected by hand and from the sieve residue (mainly 4 mm), resulting in 72 samples. There is no information on sample selection, sample size and context of the charcoal samples. More details on material and methods of botanical material are provided in Gehasse (1995).

Table 4.7 provides information on the relevant sections of which only a selection of relevant deposits will be discussed here, associated with the middle and late phase of the Swifterbant culture. The age of the oldest deposits that are represented by the sections is unclear, but may be around *c.* 4000 BC (based on the groundwater curve of Roeleveld and Gotjé 1993). There are no samples from sections that reflect the development of the vegetation from the suggested start of occupation (4900 BC) onwards.

Analysis of the evidence of human impact in pollen diagrams from the central river area has shown that the distance between the sample points and the refuse layers (settlement area) is relevant to explain the results on human impact. The extent of the refuse layers at Schokland-P14 is however not known. The distance between the sample point and the distinguished late Swifterbant houses is minimal 22 metres (trench 83-1 and 87-7) and maximal 100 metres (trench 84-2a).

trench	deposit	depth (m -NAP)	age (yrs cal BC)	layer	sediment
89-17	31	4.35-4.09	after 3600	E	detritus-gyttja
89-17	32	4.51-4.35	3700-3600	D	clay
89-17	200	4.63-4.51	before 3700	C (A/B/C)	sand
89-17	201	4.71-4.63	before 3700	C (A/B/C)	sand
83-1	7010	3.35-3.24			sand
84-2/2A	7010	3.50-3.47/2.95-2.87			sand
87-7	402	5.20-5.18	before 3700		sand

Table 4.7 Schokland-P14, overview of the section samples (Gehasse 1995).

4.3.2.1 Pollen and diatoms analysis from sections

A specific focus in the reconstruction of the natural vegetation is the presence of dryland vegetation. On the one hand the reconstruction of the height of the outcrop and the water levels support the presence of such vegetation, but on the other hand it can be questioned whether the archaeobotanical data support this. Unfortunately, the use of a different pollen sum than applied at most other sites studied hampers a comparison with the interpretation of other sites. In most relevant spectra, pollen of dryland trees and shrubs are present, but only in low values (*Quercus* sp. up to 20%, *Corylus* sp. mainly up to 30%, *Tilia* sp., *Fraxinus* sp., *Ulmus* sp. and *Betula* sp. below 5%). The dryland trees and shrubs do not show major fluctuations that support local presence. The relevant deposits of each section will be discussed separately. In the relevant samples of the section of trench 89-17 (4.70 to 4.50 m -NAP) values of dryland trees are not high, and instead *Alnus* sp. is dominant (40-60%), combined with *Dryopteris* sp. and Poaceae, and macroremains of marsh taxa. The relevant spectra of trench 83-1, a trench that is located higher on the outcrop than the samples of trench 89-17, are highly similar to the spectra of trench 89-17 despite the considerable difference in height (3.40 to 2.50 m -NAP instead of 5.10 to 4.60 m -NAP). Surprisingly, this section from a location higher and closer to the western top of the outcrop does not show a higher percentage of dryland trees. The relevant spectra of trench 84-2, located somewhat higher on the outcrop and closer to the main body of the outcrop, show a slightly higher percentage of *Quercus* sp. than the spectra of trench 89-17 and 83-1. The difference between the percentages of dryland taxa of the two trenches is however limited. In a single spectrum of section of trench 87-7 (5.17 m -NAP) the percentage of *Quercus* sp. is remarkably high compared with the spectra of trench 89-17 (*c.* 40%). Furthermore, *Tilia* sp. is relatively high compared with the next sample and the percentage of *Alnus* sp. is lower than the percentage of *Quercus* sp. This section of trench 87-7 represents a location north of the outcrop. Only the results of this single sample convincingly demonstrate the presence of woodland of dry terrain at the eastern part of the outcrop.

The discussion above illustrates that the pollen diagrams do not give clear information on the dryland vegetation at the eastern side of the outcrop where occupation took place. The presence of dryland vegetation can nevertheless be assumed when considering the large surface of the outcrop of glacial till and the age of the outcrop, allowing development of climax vegetation. The absence of evidence of the presence of deciduous woodland of dry terrain may have been caused by poor preservation, and the relatively large sample interval that restricts distinction of fluctuations that support local presence. Furthermore, alder vegetation present in between the dryland vegetation and the sample locations may overrule the signal of woodland of dry terrain.

Analysis of diatoms from deposit 200, representing the environment before 3700 BC, indicates that the environment was a eutrophic freshwater environment. There are furthermore indications of regular changes of the water table that may represent flooding and/or erosion of sand in the marsh at the edge of the outcrop. There is only very scarce evidence of highly occasional marine influence, for example during very high water levels or storms. The marine influence increased after 3700 BC. There are no indications of the local presence of plants that prefer brackish conditions (Gehasse 1995, 39).

It is hardly possible to detect human impact in the dryland vegetation based on the data from the sections since the reconstruction of the vegetation is already difficult, since the amount of detailed information on occupation (permanent or intermittent) is restricted, and since the sample interval does not allow distinction of short-term changes. Erosion and colluviation may have played a role as well. Certain pollen diagrams show changes that may be related to human impact, but it is not possible to exclude natural disturbance as a cause of the changes. Analysis of human impact in the wetland vegetation is restricted by the variable conditions in the extra-local environment (variable activity of channels and changes in the rate of the rise of the water level) that appear to be the primary factor causing changes in the wetland vegetation. Only the pollen grains of cereals (presented below) indicate distinct human presence.

4.3.2.2 Macroremains analysis

The macroremains of the sections indicate a eutrophic freshwater wetland environment (vegetation of open water, bank zone, marshes and alder carr) and did not contain carbonised remains or remains of crop plants. The botanical macroremains from all other contexts are shown in table 4.8. The remains are preserved in waterlogged and carbonised states, and as impressions. The total number of remains is very low due to poor preservation (and possibly to other factors such as deposition and taphonomy) and can therefore not be considered as representative. The identifications contain three important groups of plants: potential wild food plants, remains of crop plants and taxa that are indicative of disturbance (ruderals and pioneers of dry terrain). Crop plants and disturbance indicators are discussed below.

The taxa that probably represent wild food plants are *Quercus* sp., *Corylus avellana*, *Rubus fruticosus* and *Trapa natans*. Of all these taxa some macroremains were present in a carbonised state, thus supporting handling by humans and indicating occupation during autumn, except for *Rubus fruticosus* that was only preserved in a waterlogged state. Nevertheless a carbonised fruit of *Rubus* sp. was present, supporting handling of this taxon. Macroremains of other trees and shrubs were not found in the presented contexts.

4.3.2.3 Crop plants

All relevant parts of sections contained pollen grains of cereals including *Hordeum*-type and Cerealia-type dating to the period before 3700 BC (see table 4.9). Macroremains from cereals were preserved in a carbonised state and as impressions in pottery. The assemblage contained grains and chaff remains of *Triticum dicoccon* (emmer), and grains of *Hordeum vulgare* var. *nudum* (naked barley), corresponding with the pollen identifications. Concentrations of carbonised cereals were absent. True absence of chaff remains of naked barley was not demonstrated since the number of samples other than section samples sieved on a 0.25 mm sieve is unknown. The assemblage of crop plants also contained a single waterlogged seed of *Papaver somniferum* ssp. *setigerum*. The age of this seed is Neolithic (Gehasse 1995, 103).

trench	89-17	89-17	89-17	83-1	84-2a	87-7
deposit	200	32	31	7010	7010	402
number of samples	2	1	1	1	1	1
taxon						
Triticum-type	+	-	-	+	+	+
Hordeum-type	+	-	-	+	-	+
Cerealia-type	+	-	-	+	-	-
Poaceae > 40 µm (wild grasses)	+	+	+	-	-	+
Poaceae > 40 µm (indet.)	-	-	-	-	-	+

\+ = present - = not present

Table 4.9 Schokland-P14, cereal and grass pollen from sections (Gehasse 1995).

4.3.2.4 Arable weeds

Table 4.8 shows various macroremains identifications of potential arable weeds found at Schokland-P14. Gehasse (1995, 63) suggests that the waterlogged remains from the posthole sample may be of recent age (not further explained;). The only disturbance indicator (of moist to wet terrain) that is found in a carbonised state is *Chenopodium glaucum/rubrum*.

trench layer/feature taxon	GSW+ ABCDE	87-? GSW	89-? GSW	89-17 A	89-17 B	89-17 C	89-17 E	posthole 90-64
Woodland vegetation of dry terrain								
Corylus avellana	271, 63 c	-	-	-	-	-	-	-
Quercus sp.	2, 1 c	-	-	-	-	-	-	-
Rubus sp.	1 c	-	-	-	-	-	-	-
Rubus fruticosus s.l.	3	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
Ruderals and pioneers of dry terrain	-	-	-	-	-	-	-	-
Chenopodium ficifolium, r?	-	-	-	-	-	-	-	4
Ranunculus acris/repens, r?	-	-	-	-	-	-	-	2
Rumex acetosella, r?	-	-	-	-	-	-	-	1
Solanum nigrum, r?	-	-	-	-	-	-	-	1
Stellaria media, r?	-	-	-	-	-	-	-	2
Crop plants								
Hordeum vulgare	-	-	-	-	-	-	-	1 c
Hordeum vulgare var. nudum	-	-	1i	1i	1 c	1 c	-	2 c
Hordeum vulgare, juvenile	-	-	-	-	-	-	-	1 c
Triticum dicoccon	-	2i	-	-	-	-	-	-
Triticum dicoccon, rachis internodia	-	1i	-	1c	-	-	-	-
Triticum dicoccon, spikelet forks	-	1i	-	-	-	-	-	-
Wetland pioneer vegetation								
Chenopodium glaucum/rubrum	-	-	-	-	-	-	-	1 c
Open water vegetation								
Trapa natans, spines	3, 2 c	-	-	-	2 c	1 c	1 c	-

GSW = Swifterbant layer in other trenches than trench 89-17   i = impression in pottery
c = carbonised   r? = possibly recent
x, yc = x macroremains including y carbonised macroremains   - = not present

Table 4.8 Schokland-P14, macroremains from botanical samples, a posthole sample, the archaeological 2 and 4 mm sieve residues and handpicked finds (Gehasse 1995).

Concentrations of carbonised remains of crop plants were absent and it is therefore not possible to distinguish arable weeds. The potential arable weeds were furthermore not preserved in the same state as the cereal remains. As a result, it is not certain whether potential arable weeds represent taxa indicative of general disturbance or true arable weeds. General disturbance can be related to human impact, activities of domestic and wild animals, and river activity or zones with drift litter along the river Vecht.

4.3.2.5 Charcoal analysis

The results of the charcoal analysis from the layers A-E are shown in table 4.10 (N = 421). The layers D and E may be contaminated with material from older layers while layer E may be contaminated with younger material as well. *Alnus* sp. and *Quercus* sp. are dominant in layer A, B and C while *Alnus* sp. combined with *Salix* sp. dominates the later phases, which can be interpreted as being indicative of the increasing ground water table (Gehasse 1995). The presence of *Rhamnus frangula* in four of the five layers indicates that this species was present in the natural vegetation around the outcrop. The number of identified taxa is maximal in layer C. The uneven distribution of charcoal quantities through the layers corresponds with the general distribution of archaeological material (Gehasse 1995). Therefore, the dryland taxa that are scarcely present in layer B and C are probably underrepresented in the material of layer A. Analysis of the organic remains of postholes in trenches other than 89-17 resulted in the identification of charcoal of *Quercus* sp. (87%), *Alnus* sp., *Ulmus* sp. and *Corylus* sp. There is no further information on these identifications. Gehasse (1995, 63) suggests the functional selection of wood based on wood qualities for posts.

Gehasse (1995, 62) concludes that the charcoal spectra indicate the selection of taxa for fuel based on availability in the vegetation, qualities of the wood, and other functions of taxa, with emphasis on the first factor. This implies that the wood was collected at the outcrop. It can be added that the evidence of the selective use of fuel based on the qualities of the wood is restricted, because of the moderate burning qualities of some of the attested taxa on the one hand and the restricted information on the composition of the vegetation on the other hand. In addition, the apparent absence of some taxa that Gehasse interpreted as possible avoidance of taxa may be explained by the number of identifications that appears to be rather small in view of the number of samples and the time range of the investigated layers.

4.3.2.6 Other sources

Gehasse (1995, 64) discusses the zoological data of the Swifterbant occupation at Schokland-P14 in relation to the landscape. The dominant wild animals are pig, beaver and red deer, confirming the marshy character of the landscape as suggested by the dominance of wetland taxa in the botanical data set. Other important mammals are moose, roe deer, otter and marten. Roe deer prefer an open landscape as well. Another indication of open landscape is the presence of wild horse in layer D and E.

4.3.3 Discussion

4.3.3.1 Reconstruction of the natural vegetation

Gehasse has described the vegetation on top of the outcrop during the Swifterbant period as mixed deciduous woodland including *Tilia* sp., *Quercus* sp., *Ulmus* sp., *Fraxinus* sp., *Corylus* sp.and *Rubus fruticosus*, while the slopes were covered with alder carr including *Betula* sp. and *Salix* sp., and eutrophic marsh vegetation and sedge vegetation. The wetlands are described as a combination of carr, marshes and small channels, with only very minor marine influence as demonstrated by the diatoms.

	N							%						freq. (%)				
layer	A	B	C	D	E	total		A	B	C	D	E		A	B	C	D	E
number of samples														10	10	25	12	15
taxon																		
Acer campestre	-	-	1	1	-	2		-	-	1	2	-		-	-	4	8	-
Alnus sp.	9	43	67	46	56	221		33	45	59	71	47		60	70	64	100	80
Corylus sp.	-	4	10	3	2	19		-	4	9	5	2		-	40	28	25	13
Fraxinus excelsior	-	1	1	-	-	2		-	1	1	-	-		-	10	4	-	-
Prunus spinosa	-	-	1	-	-	1		-	-	1	-	-		-	-	4	-	-
Quercus sp.	13	28	17	4	23	85		48	29	15	6	19		50	90	44	25	67
Rhamnus frangula	4	7	4	3	-	18		15	7	4	5	-		20	40	16	25	-
Salix sp.	1	7	8	8	34	58		4	7	7	12	29		10	40	28	33	73
Ulmus sp.	-	6	5	-	4	15		-	6	4	-	3		-	40	12	-	13
total	27	96	114	65	119	421												

freq. = frequency   - = not present

Table 4.10 Schokland-P14, trench 89-17, charcoal (Gehasse 1995, 62).

Presence of woodland of dry terrain as natural climax vegetation at the outcrop can be assumed despite the limited evidence, at least for the early occupation phases. The charcoal provides the best indications of this, suggesting the presence of woodland of dry terrain comprising of *Tilia* sp., *Quercus* sp., *Ulmus* sp., *Corylus avellana*, *Rubus* sp., and possibly *Fraxinus excelsior*, *Acer campestre* and *Prunus spinosa*. It is probable that other trees and shrubs were present as well. There is no detailed information on the spatial distribution of the vegetation on the outcrop; all pollen diagrams show approximately the same result except for a single diagram sampled north of Schokland-P14. It remains unknown whether the reconstruction of the vegetation is representative of the total outcrop (also since human impact remains unclear). The wetland vegetation along the slopes of the outcrop consisted of *Alnus glutinosa*, *Myrica gale*, *Salix* sp. and *Rhamnus frangula* (and possibly other taxa), combined with wetland herb vegetation. Farther away from the outcrop, the landscape was dominated by reed and sedge marsh vegetation (discussed in Gotjé 1993).

The limited chronological information on the sections and the mixed stratigraphy restricts the reconstruction of the development of the vegetation through time. Changes in the natural dryland vegetation can hardly be demonstrated. Gehasse (1995) suggested that woodland of dry terrain was present from 3800 BC onwards only above 4.95 m -NAP, based on the reconstruction of the ground water table. The archaeobotanical evidence that supports the presence of dryland vegetation after 3600 BC is however restricted since the variety and number of dryland taxa in the charcoal assemblage decreases after layer C.

4.3.3.2 Human impact on the vegetation

The lack of a detailed reconstruction of the vegetation through time does not allow for a precise analysis of human impact. Absence of more information on the spatial distribution of archaeological remains further hampers interpretation of the ecological data. The only indications of human impact are registrations of crop plants, taxa that indicate disturbance and the presence of carbonised macroremains and charcoal. The number and variety of taxa of macroremains found in a carbonised state at Schokland-P14 is rather small and is presumably not representative due to poor preservation and possible other factors such as deposition, taphonomy and sampling strategy. Indications of the handling of plants are scarce for the same reason. There is no evidence of the selective use of wood, but the small data set and absence of information on artefacts does not exclude selective use either. Absence of evidence of human impact as discussed above does not imply evidence of absence and therefore the absence of deforestation is not attested.

4.3.3.3 Local cultivation

Firstly, it can be questioned whether the landscape at the site Schokland-P14 was suited for local crop cultivation. Gehasse states that the surface of the outcrop was large enough (42 hectares). The subsoil of a glacial till with a sandy layer on top seems very suitable for crop cultivation. Flooding or inundations in winter may on the one hand have threatened fields on the slopes of the outcrop and may on the other hand have resulted in natural fertilisation. The suitability of the location for local crop cultivation is confirmed by presence of ard marks from the Late Neolithic occupation period, demonstrating crop cultivation at that time (Gehasse 1995, 100).

Gehasse (1995, 60-61) discusses the arguments concerning local crop cultivation, including the presence of cereal pollen and the distribution of this pollen, the presence of grains and chaff remains of cereals, the possibility of import of both emmer and naked barley in the ear, the absence of ard marks, the methods of crop cultivation including the use of the digging stick, a find of a presumed digging stick and the presence of a fragment of a quern. She concludes that it is not possible to make a final conclusion on the practice of local crop cultivation but tends to conclude positively (Gehasse 1995, 266). Most arguments are indeed non-indicative: the presence of cereal pollen, the fragment of the quern and the macroremains including chaff of emmer can all be explained by consumption alone but do not necessarily exclude local crop cultivation. The absence of other indications of local crop cultivation does not mean evidence of absence. The remaining argument of

Gehasse (1995, 60) is that the sporadic presence of cereal pollen at different locations (at different section locations) corresponds better with sparse release of pollen during harvesting rather than abundant release of pollen during processing (threshing) of cereals; this argument is used to argue in favour of local crop cultivation. Intepretation of the number of pollen is however a tricky subject and there are additional arguments that do not support the hypothesis of local crop cultivation based on this pollen evidence:

- Preservation of the organic remains at Schokland-P14 was not optimal and hampers quantitative analysis.
- The cereal pollen was present in refuse layers and this indicates that the pollen is a waste product of households rather than representing a field (*cf.* Bakels 1986).
- Details on the process of crop processing at Schokland-P14 such as the location of crop processing are unknown. Crop processing may have occurred at various locations at Schokland-P14 and crop processing by separate households might additionally have resulted in the same scattered distribution.
- Houses were present at the eastern part of the site during the late Swifterbant phase and occupation of the same spot during earlier occupation can be assumed since refuse layers are present. It is unclear whether the cereal pollen grains are contemporaneous with the houses since both are not dated precisely (the pollen grains date to the period before 3700 BC, while the houses date to the period after 3950 BC). The presence of a field in front of the houses at a relatively large outcrop where space is readily available would be questionable and needs further evidence.

These arguments do not support local crop cultivation at the excavated site as suggested by Gehasse based on the pollen evidence, but do not exclude local cultivation at (another part of) the site either. Interestingly, the available surface makes the site more suitable for local crop cultivation than most other Early and Middle Neolithic wetlands sites.

The available data from Schokland-P14 that are relevant for the introduction of crop plants may give information on the introduction of cereals at the wetland sites of the Swifterbant culture. The introduction of cereals at the site is however not precisely dated.[5] It was suggested that the people who visited or occupied Schokland-P14 from 4900 BC onwards were farmers, although agriculture was possibly not practised at the site yet, and that agriculture including crop cultivation was practised at Schokland-P14 from 4600 BC onwards (Gehasse 1995, 67, 196). Brinkkemper *et al.* (1999) already rejected this hypothesis, due to the absence of dated cereals grains, the limited possibilities at Schokland-P14 to use the stratigraphy for dating (see paragraph 4.3.1), and the absence of domesticates in the lower part of layer A. As most pottery from layer A dates to4400-4100 BC and since the earliest dates of that layer are probably too old due to the reservoir effect (see paragraph 4.3.1), it can be argued that the introduction of crop plants at Schokland-P14 probably occurred between 4400 and 4100 BC.

5 The first evidence of crop plants at the site is found in layer A (4900-4100 BC) that consists of deposit 201 (lower part of layer A) and a part of deposit 200 (upper part of layer A). Both deposits did not contain pollen of crop plants. Deposit 201 did not contain macroremains of cereals (pers. comm. Gehasse 2007, *cf.* Brinkkemper *et al.* 1999), while the lower level of deposit 200 contained a charred internodium of emmer and an impression of a grain of naked barley in a sherd (Gehasse 1995, 59)

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4.4 Schokkerhaven-E170

4.4.1 Archaeology

Schokkerhaven-E170 has been investigated by the Dutch National Service for Archaeological Investigations under the responsibility of J.W.H. Hogestijn in 1988 (see also Van Heeringen *et al.* 2004 for an overview). The site was located on the slope of an elongated east-west oriented inland dune complex along a former Vecht channel and was repeatedly occupied from the Neolithic until the Middle Ages (Hogestijn 1991). Only the Neolithic occupation will be discussed here. A refuse layer was mapped over a distance of 75-100 metres, oriented in a northwest-southeast direction, producing hearths, flint, Swifterbant pottery, artefacts and organic material. A fence made of a double row of oak posts is dated between 3500-3100 BC[6] (Hogestijn 1990), implying that it was built by people of the Swifterbant culture or Funnel Beaker culture. The small bone assemblage contained remains of dog, domestic and wild cattle and pig, and wild animals. Bones of wild animals dominate the spectrum (Gehasse 1995). The botanical research presented below is based on the investigation of sections. The stratigraphy of one of the sections is shown in table 4.11, showing the presence of archaeological remains in the layers. The discussion of layers in the text below refers to this section.

A single date from the refuse layer (GrN-14122: 5035 ± 30 BP) and pottery characteristics point to an age of 3950-3700 BC. Hogestijn (1990) estimated that the occupation lasted at maximum 400 years. Gehasse (1995) suggested continuous occupation based on the similarity with Schokland-P14 and the possibility of local crop cultivation. The research activities at the site did however not result in an analysis of site function. More information on the site is available in Hogestijn (1990, 1991), Palarczyk (1986) and Raemaekers (1999).

layer	depth (m -NAP)	sediment	arch. remains	notes
1	4.55-4.30	plough soil		
2	4.90-4.55	peat		
3	5.00-4.90	sand (secondary deposition)	+ (base of layer)	
4	5.40-5.00	disturbed layer of peat, clay and sand with thin layers of sand and ash	+	^{14}C date (base of layer 4)
5	5.50-5.40	humic clay (Younger Unio clay)	+	
6	5.65-5.50	clay (Older Unio clay)	+ (top of layer)	

+ = present

Table 4.11 Schokkerhaven-E170, section between lot E170 and E171, stratigraphy (Gehasse 1995, 69).

6 Dates of the fence: GrN-16708: 4550 ± 40; GrN-16709: 4550 ± 40; GrN-16710: 4580 ± 35.

4.4.2 Pollen analysis

The discussion of pollen is based on Palarczyk (unpublished report University of Amsterdam 1986; see also Gehasse 1995). The pollen analysis is based on the analysis of 16 samples (peat, sand and clayey sediment) from four sections at E170 that are estimated to date to the Atlantic and Sub-Boreal. Most of the samples correspond with layer 4 of the section presented above. The pollen sum, based on a tree pollen sum including *Alnus* sp., is for most samples too low for representative results. The pollen analysis indicates the presence of a combination of deciduous woodland of dry terrain, alder carr, eutrophic marshes and open water. The dune was probably covered with some woodland of dry terrain since the results indicate the presence of *Tilia* sp., *Quercus* sp., *Fraxinus* sp., *Corylus* sp. and some dryland herb and fern vegetation. The samples do not contain indicators of marine influence in layers that are potentially contemporaneous with occupation, except for Hystrichosphaeridae (marine organisms). The Hystrichosphaeridae may be indicative of the primary deposition of marine sediment or, more likely, secondary deposition. The best indicator for human activity in the pollen data is a pollen grain of *Hordeum*-type in a peaty layer at the northern side of the dune, contemporaneous with the Swifterbant occupation phase (Gehasse 1995; Palarczyk 1986). In view of the presence of cereal macroremains, this probably represents *Hordeum vulgare* var. *nudum*, although it cannot be excluded that it concerns a pollen grain of a wild grass species. The sample that contained the cereal grain is based on a rather high pollen sum but does not show taxa indicative of arable fields.

4.4.3 Macroremains analysis

The discussion of six macroremains samples is based on Luijten (1987). All samples were collected in layer 4, corresponding with the Swifterbant occupation, except for sample 9017 that was collected in layer 2. All samples contained charcoal, bone and/or fish remains, pottery remains (except for samples 1917 and 1901) and flint (except for samples 1917 and 1918). Two of the six samples, samples 9020 and 9001, were collected in a specific anthropogenic context consisting of a concentration of refuse dominated by hazelnut shells and an ash layer respectively. The ^{14}C date of layer 4 is based on this concentration of hazelnuts. Luijten (1987) suggests that sample 9001 is contaminated with material from the higher parts of the dune.

The sample volume varied between 0.2 and 7 litres. The samples were sieved on a 0.25 mm sieve. Sample (9020) has a large volume (*c.* 7 litres) and was probably sieved on a coarser sieve. The order of the samples in the presented macroremains diagram corresponds with the depth of the samples, although the samples were not collected from a monolith. The diagram shows the total number of macroremains for 750 ml. Fruits of *Galeopsis bifida*-type represent *G. bifida/speciosa/tetrahit*. Fruits of *Polygonum* sp. (old nomenclature) represent *Fallopia* sp., *Persicaria* sp. and/or *Polygonum* sp. Seeds originally identified as *Veronica anagallis-aquatica* are here reported as *Veronica beccabunga*-type.

The results of the macroremains analysis are shown in figure 4.7. Similar to the pollen analysis, the macroremains diagram shows a combination of woodland of wet terrain, marshes combined with grassland (meadows), disturbed terrain and open water. The diagram shows scarce evidence that supports the presence of dryland vegetation at least in the lower part of the diagram (finds of macroremains of *cf. Tilia* sp. and *Corylus* sp.). The diagram shows a decrease in *Alnus* sp., a decrease in woodland herbs that are indicative of partly shaded terrain (*Galeopsis bifida*-type, *Galium aparine* and *Lapsana communis*), an increase in marsh taxa (*Persicaria hydropiper*, *Alisma plantago-aquatica* and *Typha latifolia/angustifolia*), and an increase in pioneers and taxa indicative of disturbance (*e.g. Chenopodium album*, *Chenopodium ficifolium*, and *Persicaria maculosa*).

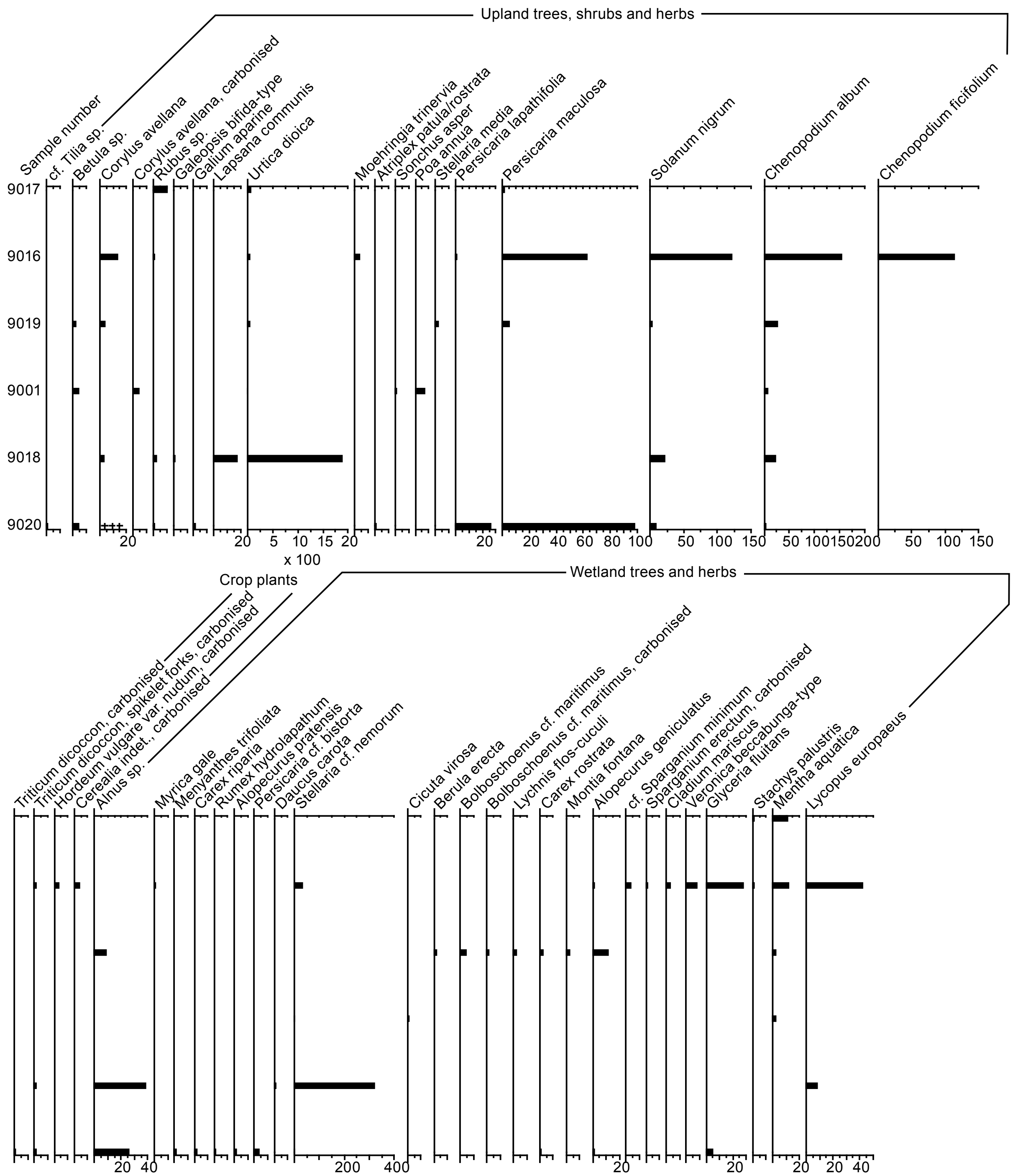

Figure 4.7 part 1.

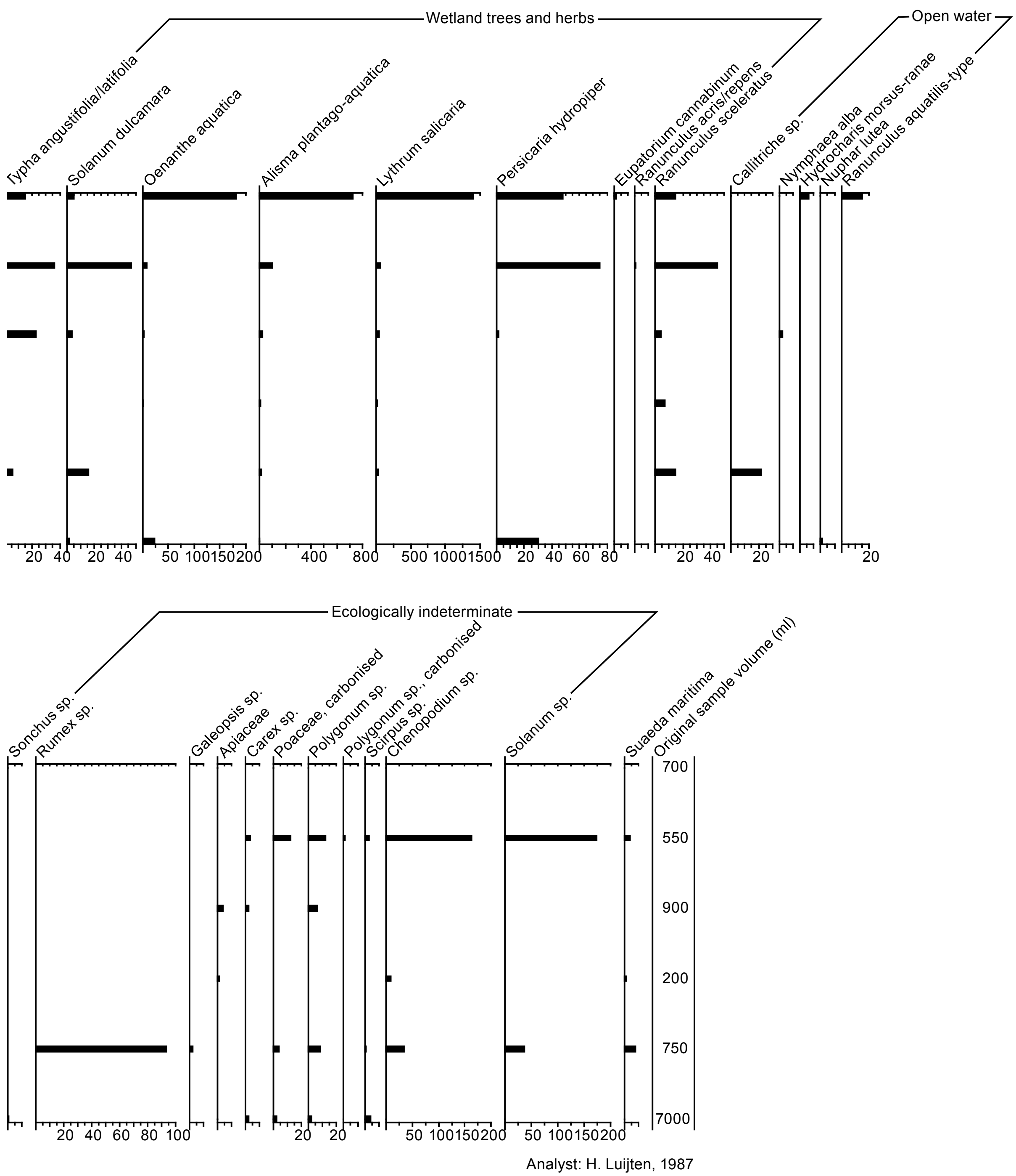

Figure 4.7 Schokkerhaven-E170, macroremains from the section between lot E170 and E171 (after Luijten 1987), +++ = many tens (50-99). The results are multiplied for a sample volume of 750 ml. The samples were not collected from a monolith, part 2.

This last group of taxa can be indicative of human impact or may represent the natural vegetation along the water edge. Remains of crop plants are presence in small numbers in various samples. They are however especially common in sample 9016 that also contains a variety of disturbance indicators. The disturbance indicators therefore probably represent indicators of human impact, and possibly arable weeds.

The macroremains samples contain taxa of the halophilous taxa *Bolboschoenus maritimus* (high salt marsh) and *Suaeda maritima* (salt marsh). The first species is only present in the younger samples but *Suaeda maritima* is present both in old and young samples, as well as in sample 9001 that represented an ash layer. These salt marsh taxa may represent drift litter deposits. The presence of *Suaeda maritima* in sample 9001 however indicates that an anthropogenic context cannot be excluded (see also paragraph 3.7.4).

There are several indications of human impact in the macroremains data set. The taxa that have been found in a carbonised state are *Corylus avellana*, *Bolboschoenus cf. maritimus*, *Sparganium erectum*, *Polygonum* sp., Poaceae and Cerealia. These taxa form a combination of potential food plants and marsh plants. The attested cereal remains are carbonised grains and spikelet forks of *Triticum dicoccon* and a carbonised grain of *Hordeum vulgare* var. *nudum*. They were present in samples collected in a good anthropogenic context (sample 9020 and 9001) and in samples that were not collected from a pure anthropogenic context. The presence of carbonised remains of hazelnut indicates the presence of people at the site during autumn or possibly winter, although use after storage cannot be excluded. Gehasse (1995, 70) mentions the fruits of *Rubus* sp. as well in relation to collected plant food. Although collection and consumption of *Rubus* sp. is possible, the data from E170 do not demonstrate this since there are no indications of consumption and there is no association with archaeological remains.

Figure 4.7 shows various potential arable weeds found at Schokkerhaven-E170 (grouped as upland herbs). The number of taxa is large when considering the number of samples (compare with Schokland-P14). Most taxa were however found in a waterlogged state only. As discussed above, particularly the relevant taxa in sample 9016 that was rich in cereal remains may represent arable weeds. This remains however unknown since most taxa were not found in a carbonised state (in contrast to the cereal remains). Taxa found in a carbonised state other than *Polygonum* sp. and Poaceae (discussed above) are unlikely to represent arable weeds since their ecology does not correspond with the environment that is most suitable for arable fields.

4.4.4 Conclusions

The data from Schokkerhaven-E170 suggest the presence of woodland of dry terrain on top of the dune complex near the location where people lived. Alder carr, marsh and meadow vegetation surrounded the dune while open water was present nearby. The data do not allow a more precise reconstruction of the vegetation or a reconstruction of the vegetation through time. Both the pollen and macroremains analysis indicate weak marine influence during occupation. The high number of taxa characteristic of disturbance that is identified despite the small number of collected samples suggests that people disturbed the natural vegetation on a considerable scale, by their presence and daily activities, by animal husbandry and possibly by local cultivation. Emmer and naked barley were at least consumed at the site. Local crop cultivation must theoretically have been possible since the site was located on an inland dune. The scarcity of archaeological data does not however allow a final conclusion on local cultivation.

4.5 Urk-E4

4.5.1 Archaeology

The site Urk-E4 is located on a dune near the village of Urk in the Noordoostpolder (coordinates 170.420/518.750). A part of the dune (880 m^2) was excavated in 1997 under the responsibility of the Dutch State Service for Archaeological Investigations. The discussion of the site below is based on Peters and Peeters (2001). The excavation covered the partly eroded top of the dune and the slopes of the dune (see fig. 4.8).

A ^{14}C date of the base of a peat covering the refuse layer gives a *terminus ante quem* of 3950-3630 BC (4950 ± 60 BP). The refuse layer, consisting of a humic sand layer rich in charcoal, comprised the mixed material of at least two occupation periods. The first phase is dated to the Mesolithic, with ^{14}C dates between *c.* 7000 and 5060 BC. The second phase is dated between *c.* 4250 and 3500 BC. There are no indications of later occupation.

The excavation revealed deep hearths, surface hearts, pits, postholes, flint, stone, pottery, organic remains including human skeletal remains of ten individuals, and features tentatively interpreted as ard marks (discussed below). Some of the deep hearths, considered as Mesolithic, contained some pottery, to be considered as intrusive. Figure 4.8 shows the main features of the site. The pottery assemblage was dominated by Swifterbant pottery. The flint assemblage contained mainly flint of northern origin that was probably collected locally, and some flint of southern origin (1.5%) and unknown sources. The bone assemblage comprised bones of domestic animals (dog, cattle, sheep/goat and possibly pig), a large proportion of bones of wild animals (large mammals including domestic pig/wild boar) and small quantities of birds and fish. The research did not include the analysis of charcoal and wood remains.

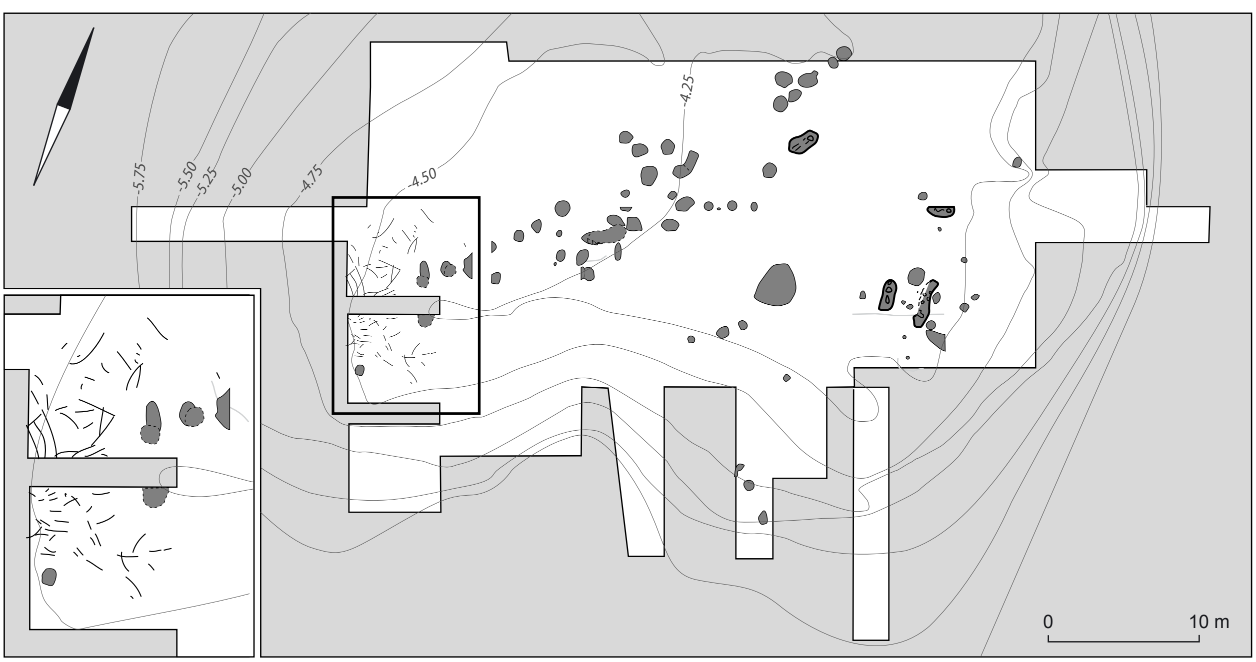

Figure 4.8 Urk-E4, the Pleistocene subsurface (m -NAP), the excavation trenches and the main features (after Peters and Peeters 2001, adapted by L. Amkreutz).

The material of the refuse layer is not assigned to the separate phases. It is assumed that the organic remains are mostly related to the Neolithic phase, in view of the changing preservation conditions through time. The variety of the bone and macroremains assemblages indicates that Neolithic subsistence was based on hunting, gathering, fowling, fishing and agriculture. There is not much information available on seasonality. Altogether the site may have had a base camp function and even may have been occupied permanently.

4.5.2 Archaeobotanical materials and methods

The archaeobotanical data consist of pollen samples from the presumed ard marks and macroremains samples. D. van Smeerdijk and T. Vernimmen were responsible for the pollen and macroremains analysis respectively. The pollen analysis consisted of three samples from sandy features that were interpreted as ard marks. Of each sample, a single line of a single slide was counted while the remaining lines were scanned for new taxa; of one sample two lines were counted. Three slides were studied for the identification of pollen grains of cereals.

The analysis of macroremains was based on single finds from sieve residues, handpicked samples, samples from the presumed ard marks, samples from deep hearths, a sample associated with a grave, and samples from the refuse layer. The sieve residue samples were collected from sieves with various mesh widths (mainly 2 mm). The samples from the presumed ard marks were sieved dry on a mesh width of 0.25 mm. The samples from the hearths and the grave were sieved on a 1 mm sieve. The treatment of the samples of the refuse layer was based on the sediment of the samples (0.25 mm mesh width for organic sediment and 1 mm mesh width for sand). More details are given in Van Smeerdijk (2001) and Vernimmen (2001).

4.5.3 Reconstruction of the natural vegetation

The material available for the reconstruction of the natural vegetation consists of pollen analysis from the ard marks and macroremains from the refuse layer. The ard marks are supposed to date to the Neolithic period. The AP/NAP ratio in the three investigated samples varies between 0.3 and 0.55 (Van Smeerdijk 2001), suggesting open vegetation. The number of unidentified pollen grains is however relatively high. The number of wetland taxa (Cyperaceae included here) tends to be larger than the number of dryland taxa. The data do not demonstrate the presence of woodland of dry terrain or large patches of open water. In the local and/or extra-local vegetation, alder carr vegetation may have been present comprising *Alnus* sp., Poaceae, Cyperaceae, Asteraceae and ferns. Several of the microfossils indicate the presence of shallow pools. The presence of ruderals indicates the presence of open, disturbed terrain.

Five samples of macroremains collected in and just above the refuse layer were more or less suitable for reconstruction of the natural vegetation, but only two samples contained considerable numbers of macroremains. The assemblage was contaminated with recent macroremains and neophytes (especially ruderals). The results of this analysis are shown in table 4.12. Most remains were preserved in a waterlogged state. The assemblage is dominated by taxa from eutrophic alder carr, marsh and bank vegetation, suggesting the presence of somewhat open alder carr vegetation. The available data of macroremains do not allow the answering of the question on whether deciduous woodland of dry terrain was present on the dune during occupation (the large number of hazelnut shells could represent natural vegetation or collected hazelnuts). The number of taxa that indicate woodland vegetation of dry terrain is rather limited. This could either mean that the vegetation was very open during all occupation phases or that the assemblage represents only the wetland vegetation during the period of submergence of the dune.

In addition to wetland taxa, the assemblage shows a considerable variety of taxa indicative of open, disturbed terrain rich in nutrients. Some of these taxa clearly represent contamination since they were introduced in the Netherlands only after the period studied, for some taxa this remains unclear (*e.g. Sonchus* sp.), while several other taxa are regularly present at comparable sites in the Vecht region and can tentatively be interpreted as valid finds (*e.g. Atriplex patula/prostrata*, *Solanum nigrum* and *Stellaria media*).

taxon	freq.	cont.	taxon	freq.	cont.
Ruderals and pioneers of dry terrain			*Carr and marsh vegetation (cont.)*		
Aethusa cynapium	1		Mentha aquatica/arvensis	1	
Anagallis arvensis	1		Menyanthes trifoliata	1	
Atriplex patula/rostrata	3		Oenanthe aquatica	2	
Chenopodium album	1		Potentilla palustris	1	
Persicaria lapathifolia/maculosa	2	r, s	Ranunculus sceleratus	2	
Polygonum aviculare	1		Schoenoplectus lacustris/ tabernaemontani	2	
Solanum nigrum	3		Sium latifolium	2	
Sonchus arvensis	1		Solanum dulcamara	2	r, s
Sonchus asper	2	r, s	Sparganium erectum	1	
Sonchus oleraceus	1		Stachys palustris	2	
Stellaria media	4		Typha sp.	1	
Urtica urens	1		Urtica dioica	4	
			Lemna sp.	1	
Crop plants					
Cerealia indet. (cf. Triticum sp.)	2c		*Ecologically indeterminate*		
			Apiaceae	1	
Carr and marsh vegetation			Galeopsis bifida/speciosa/tetrahit	1	
Alnus glutinosa	2		Poaceae, stem fragments	1c	
Alnus glutinosa, cones	2		Ranunculus acris/repens	4	
Rubus fruticosus	1		Senecio sp.	2	
Alisma sp.	1		Veronica beccabunga-type	1	
Carex appropinquata/paniculata	1		Cenococcum geophilum, sclerotia	1	
Carex hirta/riparia	1				
Carex rostrata	1		*Contamination*		
Carex rostrata/vesicaria	1		Chenopodium ficifolium	3	r
Carex cf. vesicaria, perigynium	1		Cirsium arvense/vulgare	1	r
Cicuta virosa	1		Lactua serriola	2	r
Eupatorium cannabinum	2		Descurainia sophia	2	
Iris pseudacorus	1		Erysimum cheiranthoides	1	
Lycopus europaeus	2				
Lythrum salicaria	2				

1 = present in one of five samples
2 = present in two of five samples, *etc.*
c = carbonised

cont. = contamination
r = recent
s = subfossil

Table 4.12 Urk-E4, mostly waterlogged macroremains, frequency in five samples (Vernimmen 2001).

This last group may represent general indicators of disturbance or true field weeds. It is not possible to establish whether disturbance indicators represent arable weeds since concentrations of carbonised cereal remains were absent. Taxa that indicate saline or brackish conditions are absent in the macroremains assemblage, except for *Cladium mariscus* that tolerates brackish conditions. This absence of indicators of marine influence corresponds with the assemblage of fish remains that indicates the presence of a freshwater environment and the assemblage of other animal remains that indicate a freshwater environment, marshes and possibly open woodland vegetation (Peters and Peeters 2001). Marine influence or occasional marine influence can however not be excluded for the complete occupation period of the dune.[7]

4.5.4 Evidence of human impact from the macroremains

This paragraph discusses the evidence from the macroremains assemblage for the handling and consumption of gathered plants as well as the range of potential food plants. The samples of the ard marks did not contain macroremains. The sample associated with the grave contained a single carbonised fruit of *Cladium mariscus* (great sedge). It is unclear whether the fruit is truly associated with the grave. A tentative though intriguing comparison can be found in Ambrona, Spain, where carbonised macroremains of *Cladium mariscus* were found in an ashy layer of a grave-mound dating to the early part of the fourth millennium BC. In this context it is suggested that "this reed might have been used for embedding the dead bodies" (Stika 2005).

Table 4.13 shows the results of analysis of the hearth samples. Table 4.14 shows the results of the handpicked samples and the samples from the sieve residues. Most taxa found in both groups of samples were found in a carbonised state. The samples from the hearths, the sieve residue and the handpicked samples provide information on the plants that were used and/or consumed by people. Potential wild food plants that have been found in a carbonised state are *Corylus avellana*, *Malus sylvestris, Crataegus monogyna* and *Quercus* sp. Remains of *C. avellana* were dominant in the macroremains assemblage. The assemblage of macroremains from the refuse layer additionally contained a waterlogged fruit of the food plant *Rubus fruticosus*. Taxa found in a carbonised state with an unknown function are *Galium aparine* and *Vicia hirsuta/tetrasperma*.

4.5.5 Crop plants

The finds of crop plants, mostly handpicked or collected from sieve residues, included 12 carbonised cereal grains including grains of *Triticum dicoccon/monococcum* and *Hordeum vulgare* var. *nudum*. The small number of remains of crop plants may be related to the mesh width that was used during sieving at the excavation (generally 2 mm). Two *Triticum* grains were identified as *Triticum monococcum*.[8] These could however represent grains from the top of ears of *Triticum dicoccon* since single grains are sometimes present in the top of the ear of *T. dicoccon*. Vernimmen (2001) argues that *T. monococcum* was common at Dutch Neolithic sites but this is not the case for other Early and Middle Neolithic Dutch wetland sites. The excavation furthermore yielded a carbonised spikelet fork of *Triticum* sp. (*T. dicoccon/monococcum*). The finds of *Hordeum vulgare* var. *nudum* consisted of carbonised grains including a grain that was hulled in chaff. It is suggested that the barley was harvested in a not completely ripe state (Vernimmen 2001, 66). The cereal remains are expected to date to the Neolithic occupation period (*c.* 4250-3500 BC). A single grain of *Hordeum* sp. of Urk-E4 was dated to 4250-3960 BC. The mesh width generally applied during excavation was too large to retrieve cereal chaff if present.

7 Gotjé (1993) concludes that there was some marine influence at the glacial till outcrop of Urk from 4600 BC until the end of the Neolithic occupation of the dune site Urk-E4. This marine influence probably reached Urk-E4 as well since the site was located near the river Vecht. In addition, dune Urk-E4 had a lower height than the glacial till of Urk.

8 According to the current state of knowledge the grains of *Triticum monococcum* represent grains of *Triticum monococcum*-type, pers. comm. Brinkkemper (2005).

taxon	N
Corylus avellana	2
Quercus sp., cupulae	1
Triticum sp., spikelet forks	
cf. Vicia sp.	1
Indet.	5

Table 4.13 UrkE4, macroremains from hearths, all carbonised (Vernimmen 2001).

taxon	N
Corylus avellana	235, 199 c
Crataegus monogyna	4c
Malus sylvestris	1c
Quercus sp., cupulae	1
Cerealia indet.	2c
Hordeum vulgare var. nudum	8c
Hordeum vulgare	1c
Triticum monococcum-type	2c
Galium aparine	1c
Iris pseudacorus	1
Vicia hirsuta/tetrasperma	1c

c = carbonised

x, yc = x macroremains including y carbonised macroremains

Table 4.14 Urk-E4, macroremains that were handpicked and collected from the sieve residues (Vernimmen 2001).

4.5.6 Presumed ard marks

Features have been found that are interpreted as ard marks on the slope of the dune (see fig. 4.8). The sediment that embedded the marks (below the refuse layer) consisted of grey sand below a brown humic layer of sand with particles of charcoal. The site report is unclear on the character of this layer (old surface?). The marks were up to several metres long, 2-8 cm broad, and had a depth of several cm. There is no information on the distance between marks, probably related to the absence of a dominating orientation. Some of the marks were oriented horizontally while others were oriented vertically or sloping (it is unclear whether they run parallel to the old surface). The site report does not give the size of the area with marks, but its minimal size can be roughly estimated from figures in the original publication as *c.* 75 m^2. Overall, the absence of a good description of the field observations of the ard marks hampers discussion and interpretation. The map presenting the features of the site does not show all ard marks. Some of the apparent marks were interpreted as marks while some were not (Peters and Peeters 2001, 118) but this is not further explained.

Micromorphological investigation of the marks was based on two small sections. Details relating to the methods of this investigation are not published (number of samples and control samples?). Both sections contained a sandy layer that was very rich in small-sized particles of charcoal from herbaceous vegetation, equally distributed through the sand. Fine particles of charcoal were present around the particles of sand. The mixture of sand and charcoal is interpreted as the result of burning of vegetation, resulting in the presence of burned herbaceous plant matter. This herbaceous plant matter would have been mixed into the sand soil by tillage of the soil.

The pollen analysis of the ard marks contained several pollen grains that were identified as pollen grains from large grasses and cereals (identification based on the criteria of Küster 1988, see original publication for details). Some of the pollen grains are interpreted as grains of *Triticum* sp. A single pollen grain is interpreted as a grain of *Avena* sp., which probably represents a weed (see also paragraph 3.5.3). The pollen grains of cereals collected in the features represent the best botanical evidence of the interpretation of the ard marks. The evidence would however have been more convincing if more features had been sampled and if the analysis had included control samples from outside the marks. The pollen analysis further demonstrates the presence of ruderals and potential arable weeds, which are argued to support the interpretation of the features as ard marks. These taxa might represent arable weeds but may however also simply represent disturbed vegetation indicative of human activity. The presence of *Trichuris* sp., an intestinal parasite of mammals, is argued as being indicative of the practice of manuring. Intentional manuring of the plot is however not demonstrated by this single find.

The assumed field was presumably present between *c.* 4200 and 3700 BC.[9] If the features are indeed ard marks and indeed date to the Swifterbant culture, the features represent the oldest known ard marks of the Netherlands if not the oldest of Northwestern Europe (Louwe Kooijmans 2006a). The spatial distribution and lay-out of the features does however not correspond to accepted ard marks known from Northwestern Europe. Importantly, the use of the ard is not known yet for the Swifterbant culture. Therefore, the amount of information and hard evidence is too limited to allow a final conclusion. The interpretation of the features as ard marks must therefore be rejected, and especially the use of the description 'ard marks'.

Summarising, the tillage features are an important discovery in view of the discussion on local cultivation within the Swifterbant culture, but have been investigated and documented insuffiently to make a final conclusion. The remaining evidence makes it difficult to prove or reject local cultivation. Use-wear analysis was not included in the analysis of flint and therefore information on sickles is not available. Cultivation at Urk-E4 is further discussed in paragraphs 4.7.4.4 and 11.6.13.

4.5.7 Conclusions

The environment at Urk-E4 during occupation was probably a freshwater environment. It is unclear what kind of vegetation grew on top of the dune during occupation due to the absence of sufficient data. For the Mesolithic phase, the presence of woodland vegetation of dry terrain can be assumed in view of the ground water level. Alder carr and marsh vegetation were certainly present in the near surroundings of the site during Neolithic occupation. It is not possible to further reconstruct the development of the vegetation through time or to reconstruct human impact on the vegetation. The features on the slope of the dune interpreted as ard marks are questionable due to restricted documentation and sampling. Therefore, local cultivation between *c.* 4200 and 3700 BC is not demonstrated, but cannot be rejected either.

4.6 Emmeloord-J97

4.6.1 Archaeology

The site Emmeloord-J97 is located in the Noordoostpolder in a channel that was part of the former river Vecht (coordinates 179.200/522.100). After small-scale investigations (see Gehasse 1995), the ADC Amersfoort excavated the site in 2000-2001. The discussion below is based on the resulting site report (Bulten *et al.* 2002). Dating of *in situ* preserved fish weirs (N = 10) and fish traps (N = 46) indicates that the site was used during two periods, 3370-3000 BC (Middle Neolithic) and 2470-1700 BC (Late Neolithic and Early Bronze Age). The relative large number of fish weirs and fish traps in the channel and the absence of structures has resulted in

9 Although not explicitly stated in the publication, it can be assumed that the presumed ard marks date to the Neolithic phase. It is argued that the cultivation of the slope must have taken place before 3700 cal BC based on the depth and the reconstruction of the ground water level (Peters and Peeters 2001, 114).

the interpretation that the site functioned during a long period as a fishing site (Bulten *et al.* 2002; Gehasse 1995). The Middle Neolithic use phase of the fish weirs is assumed to be related to the Swifterbant culture (Bulten *et al.* 2002, 124). Redeposited sand that contained archaeological remains including some Swifterbant pottery (Raemaekers 2004) suggests occupation close to the fishing station. The exact location and details of the Swifterbant occupation are however unknown. There is no contextual relationship between the fish weirs and the reworked finds in the sand.

The finds in the reworked sand, that probably predominantly date to the post-Swifterbant (Beaker) phases, comprise pottery, flint, stone including querns and organic remains. The flint was mainly of northern origin, probably collected in the glacial till outcrops in the region. The stones could have been collected at comparable locations as well. The bone assemblage indicates the presence of domestic cattle, pig and goat/sheep.

4.6.2 Archaeobotanical materials and methods

This study aims to investigate the botanical remains of the Swifterbant phase, although the amount of data is restricted. There are samples of pollen and macroremains collected around the site but outside the sandy layer. The pollen analysis, published by Gehasse (1995) will not be discussed since the samples are not dated. The analysis of macroremains is based on some single samples collected in the channel at different depth levels, and a core sampled in the channel. W.J. Kuijper (Leiden University) analysed the data. Details on the context of the samples are scarce and the association of the samples with the Swifterbant occupation period is weak. One of the single samples probably corresponds with the Swifterbant occupation period in view of the character of the sediment (volume 1 litre; mesh width 0.25 mm; sample depth and location unknown). The length of the investigated core is 3.25 metres (9.05 to 5.80 m -NAP). The samples from this core are 5 cm high and have a diameter of 6 cm (mesh width 0.25 mm, see also Van Zijverden 2002). Palaeogeographical maps suggest that the core was collected next to the border of a levee. In addition to the pollen and macroremains samples, there are two fish weirs and three fish traps dating to the Swifterbant occupation period. P. van Rijn identified the wood of the weirs and traps. The identification of the wood of the fish weirs dating to the Swifterbant phase included only a part of the posts (18 of 70 and 26 of 100). A total of ten identifications were made of the wood of the fish traps, all of which relate to a single trap.

taxon	N
Alnus glutinosa	++
Urtica dioica	+
Anagallis sp./Lysimachia sp.	1
Alisma sp.	+
Carex sp.	+
Mentha aquatica/arvensis	+
Menyanthes trifoliata	+
Oenanthe aquatica	++
Rumex hydrolapathum	+
Schoenoplectus lacustris	+++
Najas marina	1
Nuphar lutea	++
Nymphaea alba	++

+ = few (1-9)

++ = few tens (10-49)

+++ = many tens (50-99)

Table 4.15 Emmeloord-J97, macroremains of a single sample collected from the channel, all waterlogged (Kuijper, unpublished data).

4.6.3 Macroremains analysis

The macroremains identifications of the single sample of botanical macroremains are shown in table 4.15. The taxa present in this sample mainly indicate freshwater conditions, which are confirmed by the absence of molluscs that are indicative of brackish conditions (unpublished data Kuijper). The long core used for the analysis of macroremains theoretically offers better possibilities to reconstruct the vegetation before, during and after occupation and also to reconstruct anthropogenic influence on the vegetation (see the original publication for the results). The parts of the core correlated with Swifterbant occupation are the top of the Younger Unio clay and the coarse detritus. The top of the Younger Unio clay is relatively poor in macroremains and is dominated by *Alnus glutinosa* and *Oenanthe aquatica*. The clay does not contain indicators of marine influence. Taxa that are well represented in the macroremains assemblage of the detritus are *Schoenoplectus lacustris*, *Schoenoplectus tabernaemontani*, *Nuphar lutea*, *Nymphaea alba*, *Alisma* sp., *Oenanthe aquatica* and *Alnus glutinosa*, while additional taxa are *Menyanthes trifoliata*, *Carex pseudocyperus*, *Eleocharis palustris* s.l., *Solanum dulcamara*, *Cladium mariscus*, *Rumex hydrolapathum*, *Urtica dioica* and *Salix* sp. The identifications from the core indicate eutrophic alder carr and marsh vegetation. Some of the taxa tolerate slightly brackish conditions, and minor marine influence can therefore not be excluded completely. Taxa indicative of the presence of woodland vegetation are *Alnus glutinosa*, *Myrica gale*, *Betula* sp., *Salix* sp. and *Viburnum opulus*. These taxa can all grow in softwood alluvial woodland or alder carr. There is no evidence of the presence of dryland vegetation during occupation.

Human impact in the core samples is indicated by the presence of charcoal in the detritus, especially at 6.85 to 6.75 m -NAP (assuming that the charcoal does not represent reworked material). The sample from 6.80 to 6.75 m -NAP shows an increase in *Schoenoplectus tabernaemontani* and *Ranunculus repens-type*, and a decrease in *Alnus glutinosa*, *Urtica dioica* and *Lythrum salicaria*. These changes may indicate the clearance of alder vegetation or may be related to some brackish influence on the environment. It probably concerns human impact since not all glycophytic taxa decrease. There are no finds of carbonised macroremains that can be related to the Swifterbant occupation period.

4.6.4 Wood analysis

The discussion of the results of the wood investigation is based on Van Rijn (2002). The identified wood of the two fish weirs that date to the Swifterbant period consists of *Alnus* sp. (71%), *Salix* sp. (15%), *Betula* sp. (9%) and *Ulmus* sp. (5%). The range of taxa does not indicate the selective use of wood based on the quality of the wood since the dominance of *Alnus* sp. probably represents its importance in the natural vegetation. The characteristics of the wood from one of the weirs indicated bad growing conditions for old *Alnus* trees. Only three fish traps date to the Swifterbant culture. The wood of longitudinal withies of one of these was identified as *Salix* sp.

4.6.5 Conclusion and discussion

The natural vegetation at Emmeloord-J97 during the Swifterbant occupation period can only tentatively be reconstructed. The vegetation in the exploitation area probably consisted of soft wood alluvial woodland, alder carr and eutrophic marsh vegetation. The data do not support the presence of woodland of dry terrain. The macroremains assemblage and the wood identifications indicate a disturbance of alder carr vegetation. The indications of the absence of hardwood alluvial woodland or woodland of dry terrain (botanical remains and height of the levees) indicate that local crop cultivation was not possible at Emmeloord.

4.7 Synthesis Vecht region

4.7.1 Occupation and neolithisation

The studied sites in the Vecht region are interpreted as being of a relatively permanent character (seasonal or year-round occupation by complete households), and as special activity sites of a more temporal character and with a more specific function. The long-term and repetitive occupation at many sites and the erosion and restricted preservation of organic remains however prevent a more detailed assessment of site function and occupation history. The subsistence of the Swifterbant culture in the Vecht region was based on hunting, fishing, fowling and gathering, combined with agriculture in the course of time. The quantitative reconstruction of the subsistence of most sites is however problematical. Firstly, the botanical data do not give information on the relative importance of crop plants. Secondly, the publications of Schokkerhaven-E170, Urk-E4 and Emmeloord do not present conclusions on the importance of domestic animals. The importance of domestic and wild animals (in bone weight) is estimated to be roughly equal for Swifterbant-S3, while the importance of domestic animals increased through time at Schokland-P14 (Gehasse 1995, 34, 53; Raemaekers 1999, 100; Zeiler 1997).

Figure 4.9 shows the occupation periods of the main archaeological sites known from the Vecht region. The data of Hoge Vaart-A27, situated in the Eem region, are added for comparison, together with the phasing of the Swifterbant culture according to Raemaekers (1999). The data set of the Vecht region shows a lack of information for the period 5100-4350 BC. Occupation during a part of this period is suggested for Schokland-P14, but data of this period are scarce and do not enable reconstruction of the subsistence. The Swifterbant culture continued in the northern part of the Netherlands until 3400-3300 BC (Raemaekers 2004). The final phase of the Swifterbant culture is however poorly documented; relevant data of Schokland-P14, Schokkerhaven-E170 and Emmeloord-J97 are scarce. The table nevertheless indicates that the Vecht region was probably occupied and/or visited continuously during the Late Mesolithic and Early and Middle Neolithic. Some additional sites are moreover known in the Vecht region: a dune at lot J89 (flint and pottery of the Swifterbant culture and Funnel Beaker culture), a dune at lot J112 (flint and pottery of the Mesolithic and Swifterbant culture, and a post of alder wood dated to 5635 ± 40 BP: 4550-4360 BC), a dune at lot J125 (hearths, flint and pottery) (Hogestijn 1991) and several other sites/finds including sites of the late Swifterbant phase (Raemaekers 2004). These additional sites are however not included here since there are no published archaeobotanical data.

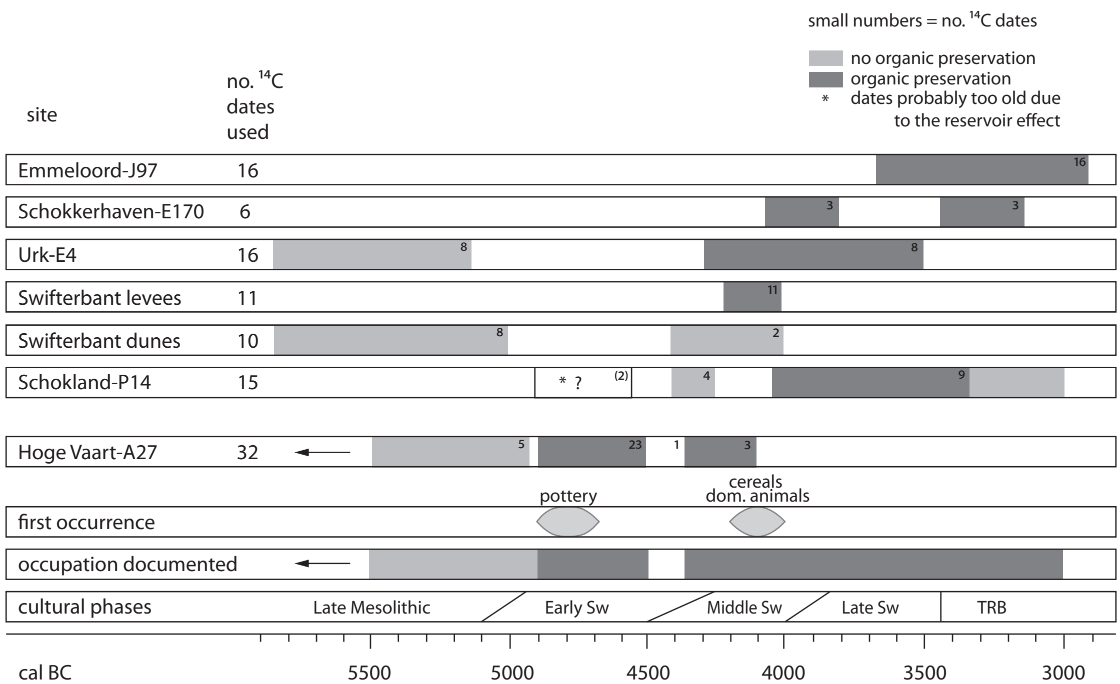

Figure 4.9 The Vecht and Eem region, the range of the known occupation periods of the main archaeological sites and the reconstructed introduction of pottery, domestic animals and crop plants. The various occupation periods of most sites are not precisely dated and may have been shorter than suggested in the figure. The figure is based on a new interpretation of dates (L.P. Louwe Kooijmans 2009). SW = Swifterbant.

The occupation phases before the gap in the data set as presented above, before 5100 BC (see fig. 4.9), can be considered as Mesolithic while the occupation phases after the gap can be considered as Neolithic. For the period before 5100 BC, the Mesolithic phase, there is no evidence of the presence of pottery, domestic animals and crop plants (see the early phases of Schokland-P14, Urk-E4 and Swifterbant). The period from 4400 BC onwards can in contrast be characterised as Neolithic since pottery, domestic animals and crop plants were all present (see the late phases of Urk-E4 and Schokland-P14, and Swifterbant-S3). Because of the scarcity of data for the period 5100-4350 BC as well as restricted chronological precision in the later periods, the precise moment of the introduction of domestic animals and plants remains unknown, as well as other details of the neolithisation process. The presence of crop plants from at least 4250-3960 BC onwards suggests that crop cultivation was introduced or inspired by the Michelsberg culture. A role of the preceding Rössen culture can however not be excluded in view of the absence of information on crop plants before this phase.

There is restricted material evidence on contact between people living in the Vecht region with people of other cultures who may have played a role in the neolithisation process. Flint was locally available in the outcrops of glacial till. At Schokland-P14, Urk-E4 and Emmeloord-J97 only a small part of the flint assemblage is indicative of contact with the south. At Emmeloord-J97 a single artefact of Helgoland flint indicates contact with the North Sea coast. A Rössen Breitkeil has been found at Swifterbant (Deckers 1982). The pottery of the sites in the Vecht region is primarily characteristic of the Swifterbant culture, though the pottery is said by some authors to indicate also some influence of the Rössen culture/Bischheim group and Funnel Beaker culture.

4.7.2 Reconstruction of the natural vegetation

The landscape and vegetation in the Vecht region changed from a dryland landscape in the Middle Mesolithic to a wetland landscape in the Neolithic. Registration of the development of the vegetation only started when peat growth began (5500-5000 BC), *i.e.* later than the earliest known occupation. Preservation of organic remains that provide information on the development of the vegetation at the sites is relatively limited for most sites, although other factors including sampling strategy may have influenced the scarcity of information as well. Moreover, charcoal and wood material from various sites has not been analysed or documented completely. As a result, the archaeobotanical data of most sites are not completely representative of the development of the vegetation and cannot be assigned to separate occupation phases. It is therefore only possible to make a general reconstruction of the vegetation.

Table 4.16 shows the evidence from the macroremains, wood and charcoal identifications of the presence of dryland and wetland woodland tree and shrub taxa for all sites (some species can be part of both dryland and wetland vegetation). The macroremains most likely represent (extra-)local vegetation, although they may also represent fruits brought in from elsewhere. Wood may have been collected in the extra-local vegetation or elsewhere in the region. Pollen identifications are not included since these identifications do not necessarily demonstrate presence of taxa in the exploitation area.

The most indicators relating to the presence of woodland of dry terrain during occupation are available for the sites Schokland-P14 and Swifterbant. Schokland-P14 is theoretically the most suitable for woodland of dry terrain and indeed *Quercus* sp. is well represented in the botanical data set of the site compared with data from other sites. In contrast, woodland vegetation was probably not present at Swifterbant-S3, but instead at the more elevated terrain nearby. For Schokkerhaven-E170 the presence of macroremains of *Tilia* sp. and repeated finds of uncarbonised *Corylus* sp. indicate the presence of woodland of dry terrain, at least at the start of occupation. The macroremains from the refuse layer of Urk support the local presence of dryland vegetation, but this refuse layer represents a long period of occupation, and the evidence of dryland vegetation comes mainly from potential food plants that do not necessarily represent the natural vegetation. Dryland vegetation was probably present at Urk-E4 during the Mesolithic occupation phase, but this remains unclear for the Neolithic phase. At Emmeloord-J97 woodland vegetation of dry terrain was probably scarce or absent.

taxon (site / dryland type)	Swifterbant (S3/S5)	Schokland-P14	Schokkerhaven-E170	Urk-E4	Emmeloord-J97
	L	T	D	D	L
Acer campestre	-	w	-	-	-
Alnus glutinosa	m/w	m/w	m	m	m/w
Betula sp.	m/w	m	m	-	m/w
Cornus sanguinea	m	-	-	-	-
Corylus avellana	m/w	m/w	m	m	-
Crataegus monogyna	m	-	-	-	-
Fraxinus sp.	w	w	-	-	-
Malus sylvestris	m/w	-	-	m	-
Myrica gale	-	m	m	-	m
Pinus sp.	w	-	-	-	-
Populus sp.	w	-	-	-	-
Prunus spinosa	-	w	-	-	-
Quercus sp.	-	w	-	m	-
Rhamnus frangula	-	w	-	-	-
Rosa canina/rubiginosa	m	-	-	-	-
Rosa sp.	m	-	-	-	-
Rubus fruticosus	m	m	-	m	-
Rubus sp.	-	m	m	-	-
Salix sp.	w	w	-	-	m/w
Tilia sp.	w	-	m	-	-
Ulmus sp.	w	w	-	-	w
Viburnum opulus	-	-	-	-	m

D = inland dune
L = levee
T = lodgement till

m = macroremains
w = wood and/or charcoal
/ = and
- = not present

Table 4.16 The Vecht region, trees and shrubs, based on macroremains, wood and charcoal.

The available sources suggest a rather unvaried type of woodland of dry terrain for the region. The number and frequency of shrub taxa that may be part of the woodland of dry terrain are relatively low compared with other regions. Only *Corylus avellana* and *Rubus fruticosus* seem to have been quite common. The (tree/) shrub) taxa *Acer campestre*, *Crataegus monogyna*, *Malus sylvestris*, *Cornus sanguinea*, *Viburnum opulus*, *Prunus spinosa* and *Rosa canina/rubiginosa* are scarce, while *Rhamnus cathartica*, *Ligustrum vulgare*, *Sambucus nigra* and *Euonymus europaeus* have not been documented at all. The scarcity of these taxa may be the result of the limited state of knowledge since the representativity of the data on the dryland vegetation from all sites except for Swifterbant can be questioned. Alternatively, it may represent a true result. The variation in the vegetation and the importance of the shrubs in the vegetation remains a subject for future research.

The general development of the wetland vegetation is well documented by Gotjé (1993). The region was dominated by reed and sedge peat, with minor elements of carr vegetation. The environment was eutrophic in the rivers and along the rivers, while eutrophic conditions decrease when the distance to rivers and channels increases. There is evidence of the presence of woodland vegetation of wet terrain for all sites, consisting of alder and/or birch carr combined with *Salix* sp., *Myrica gale*, *Rhamnus frangula*, *Populus* sp., and possibly *Viburnum opulus*, *Rubus fruticosus*, *Rubus* sp. and *Rosa* sp. Comparable evidence is also available for four non-archaeological locations near Schokland and Urk (Gotjé 1993). *Alnus* sp. is the most important taxon of trees and shrubs represented in the available wood and charcoal data. This corresponds with the limited presence of dryland woodland/hardwood alluvial woodland vegetation and the dominance of wetland vegetation during the Neolithic.

Marine influence was probably very weak but is nevertheless demonstrated at Swifterbant (macroremains and diatoms), Schokland-P14 (diatoms) and Schokkerhaven-E170 (macroremains and Hystrichosphaeridae). The presence or absence of marine influence at Urk-E4 was not demonstrated.[10] The marine influence in the region probably consisted of flooding less than once a year, and possibly only once in the ten years, occurring in the late autumn and/or winter and/or early spring (*cf.* Ente 1976). Only in exceptional cases did the flooding result in the transportation of diatoms and macroremains of plants from the high salt marshes towards the studied sites.[11] The weak marine influence indicates that high salt marshes were not present in the exploitation area of the people in the Vecht region, as expected from palaeogeographical reconstructions (Ente 1976) and as confirmed by the zoological assemblages.

4.7.3 Human impact on the vegetation

The analysis of the pollen and macroremains diagrams of the Vecht region (Swifterbant, Schokland-P14, Schokkerhaven-E170 and Emmeloord-J97) does not provide information on the development of the vegetation before, during and after occupation phases. Only at Emmeloord-J97 there are indications of the disturbance of alder carr vegetation during occupation but a clear relation to occupation is lacking. At sites other than Emmeloord-J97 the best indicators of human disturbance visible in the diagrams are the Cerealia-type pollen, ruderals and indicators of disturbance. There are no indications of an increased presence of shrub vegetation, which is in contrast to the observations in the central river area. The data thus seem to suggest weak human impact. It is however the absence of the reconstruction of the development of the vegetation and the scarcity of suitable pollen diagrams that makes it rather impossible to assess human impact with certainty.

It is assumed that the carbonised state of macroremains indicates that people handled the seeds and fruits (unintentionally or intentionally). Table 4.17 shows the taxa that have been found in a carbonised state

10 The research at Urk-E4 did not demonstrate any marine influence, but did not demonstrate absence of marine influence either since the research did not include diatom analysis and only restricted pollen analysis from anthropogenic features. Gotjé demonstrated marine influence north of the glacial till at Urk (Gotjé 1993, 49).

11 Absence of pollen identifications of indicators of marine influence may be related to the scarcity of these pollen grains in combination with the limited amount of pollen analysis and/or publication for the sites Swifterbant, Urk-E4 and Emmeloord-J97.

taxon (site / number of samples)	Swifterbant-S3	Schokland-P14	Schokkerhaven-E170	Urk-E4
number of samples	46	?	6	23
Woodland vegetation of dry terrain				
Corylus avellana	+	+	+	+
Crataegus monogyna	+	-	-	+
Malus sylvestris	+	-	-	+
Quercus sp., cupulae	-	-	-	+
Querucs sp.	-	+	-	-
Rubus sp.	-	+	-	-
Galium aparine	+	-	-	+
Ruderals and pioneers of dry terrain				
Vicia hirsuta/tetrasperma	-	-	-	+
Crop plants				
Cerealia indet. (cf. Triticum sp.)	-	-	-	+
Cerealia indet. (cf. Triticum sp.)	-	-	+	+
Hordeum vulgare	-	+	-	+
Hordeum vulgare var. nudum	+	+	+	+
Hordeum vulgare var. nudum, chaff (glumes, bracts and rachillas)	+	-	-	-
Hordeum vulgare var. nudum, rachis internodia	+	-	-	-
Triticum dicoccon	-	+	+	-
Triticum dicoccon, rachis internodia	-	+	-	-
Crop plants (cont.)				
Triticum dicoccon, spikelet forks	-	+	+	-
Triticum monococcum-type	-	-	-	+
Triticum cf. aestivum	+	-	-	-
Triticum sp., glume bases	-	-	-	+
Marsh vegetation				
Bolboschoenus cf. maritimus	-	-	+	-
Cladium mariscus	-	-	-	+
Oenanthe aquatica	+	-	-	-
Phragmites australis, stem fragments	+	-	-	-
Sparganium erectum	-	-	+	-
Wetland pioneer vegetation				
Chenopodium glaucum/rubrum	-	+	-	-
Open water vegetation				
Ceratophyllum submersum	+	-	-	-
Trapa natans, spines	-	+	-	-
Ecologically indeterminate				
Claviceps purpurea	+	-	-	-
Poaceae	-	-	+	-
Poaceae, stem fragments	-	-	-	+
Polygonum sp. (Fallopia sp./ Persicaria sp./Polygonum sp.)	-	-	+	-
cf. Vicia sp.	-	-	-	+

+ = present - = not present

Table 4.17 The Vecht region, carbonised macroremains and impressions in pottery. The number of samples does not include samples collected from sieve residues and handpicked finds.

for each site. The cereal identifications based on impressions are included in the table as well. The total number of taxa found in a carbonised state is small compared with the number of carbonised taxa in other regions. The taxa represent crop plants, potential food plants, potential arable weeds and marsh plants. Crop plants and indicators of disturbance are discussed below. Most of the marsh plants found in a carbonised state were common elements of the natural vegetation. It is nevertheless possible that they represent exploited plants (see chapter 9). The group of potential wild food plants is rather small. Potential food plants of which carbonised macroremains are until now absent are *Prunus spinosa*, *Sambucus nigra*, *Cornus sanguinea*, *Rubus caesius* and *Ranunculus ficaria*. The absence of carbonised finds of potential food plants may firstly be related to poor preservation and research methods (site selection, sample selection, number of investigated samples, mesh width of sieves, attention to botanical remains, and attention to carbonised tissue remains). Secondly, the composition of the vegetation may have resulted in the absence of certain food plants. Thirdly, human activity such as site function, seasonality, and cultural preferences may play a role.

The data on wood and charcoal material other than posts give remarkably little evidence of selective use of wood based on the quality of the wood and the function of artefacts. There is no information on charcoal from single contexts that could have supported fuel selection. Wooden artefacts dating to the Swifterbant culture are only published for Swifterbant and Emmeloord-J97. Wood selection for artefacts at Swifterbant does not indicate selective use based on the quality of the wood since there is only restricted correspondene with selective use as known from the southern part of the Netherlands (see chapter 8). Only the posts of Swifterbant potentially indicate selective use. The absence of wood selection at Swifterbant remains unexplained since some of the assumed preferable taxa (*e.g. Fraxinus excelsior*) are not completely absent in the wood assemblage. The fish trap of Emmeloord-J97 supports the selective use of *Salix* sp. because of the quality of the wood. This choice corresponds with the use of *Salix* sp. for the fish traps at Hoge Vaart (see Out 2008b). For both Schokland-P14 and Swifterbant there is unfortunately no information on which taxa were used for any of the distinguished structures. Indications of woodland management are discussed in chapter 8.

4.7.4 Crop cultivation

4.7.4.1 Suitability of the landscape for cultivation

At the currently recognised time of the introduction of agriculture (possibly from *c.* 4400 BC onwards, see paragraph 4.7.1), the landscape in the Vecht region was a wetland landscape where dry terrain formed a minor element. It is assumed that the dryland patches that were under moderate influence of the ground water table were suited for arable farming. A ground water table that was too high did not allow successful crop cultivation. One the one hand, the chance of winter flooding can be considered as a risk. On the other hand, the chance of flooding may also have functioned as natural fertilisation. In addition the deposition of clay may have increased the capillary capacity of the soil, assuring availability of water in the top layers of the soil.

Dryland patches suitable for crop cultivation were the glacial till outcrops, inland dunes and levees. The till outcrops did not submerge during the period studied, were covered with a layer of sand, and offered plenty of space. These outcrops were therefore probably very suitable for crop cultivation (relevant for Schokland-P14). The dunes were also suitable for crop cultivation, although they gradually submerged and became less suitable through time (relevant for Urk-E4, Schokkerhaven-E170 and some of the Swifterbant sites). The levees were the lowest dryland patches in the landscape and were most often flooded (possibly yearly). This presumably made them unsuitable for winter crop cultivation. The fertile effect of floods may nevertheless possibly have resulted in improved suitability of the levees for summer crop cultivation (*cf.* Cappers and Raemaekers 2008; relevant for some of the Swifterbant sites and for Emmeloord-J97).

4.7.4.2 Crop plants

The evidence of the presence of crop plants based on pollen analysis consists of pollen of *Triticum*-type found at Schokland-P14 and Urk-E4, pollen of *Hordeum*-type at Schokland-P14 and E170, and pollen of Cerealia-type found at Lelystad and Tollebeek (see De Roever 2004). The published data from the last two sites do not allow a discussion (see paragraph 4.2.2.4). The evidence from pollen at all sites except for Lelystad and Tollebeek is confirmed by finds of the macroremains of cereals.

Table 4.17 shows the macroremains of crop plants of the Swifterbant culture found in the Vecht region. The main crops are *Triticum dicoccon* (emmer) and *Hordeum vulgare* var. *nudum* (naked barley). The remains are generally found in a carbonised state. Chaff remains of emmer have been found at Swifterbant-S3, Schokland-P14 and E170. Chaff remains of naked barley were only found at Swifterbant-S3. The absence of chaff remains of both taxa at other sites is however not demonstrated since the site investigations never aimed to demonstrate the presence or absence of chaff remains. At most sites the research did not include sieving of a representative number of samples on the 0.25 mm sieve for archaeobotanical analysis. It can therefore be presumed that chaff remains of both emmer and naked barley may have been present at all sites where crop plants were present and that absence is a matter of representativity.

Additional identifications of crop plants are *Triticum aestivum/durum* and *Triticum monococcum*. A grain of *Triticum aestivum/durum* found at Swifterbant can be interpreted as *Triticum dicoccon*. Two carbonised grains of *Triticum monococcum* were found at Urk-E4 are interpreted as *Triticum dicoccon/monoccocum* (see paragraph 4.5.5). Identifications of *Triticum monococcum* are also known from impressions in pottery found at Hüde I, related to the Swifterbant culture and/or the Funnel Beaker culture (see chapter 6). This parallel does however not solve the problem since the number of cereal impressions from Hüde I is too small for a final conclusion either. Therefore, the role of *T. monoccum* in the Vecht region remains to be investigated.

4.7.4.3 Arable weeds

Concentrations of carbonised cereals were not retrieved in the Vecht region (with exception of the concentrations of chaff remains at Swifterbant on which no further details on the sample content are available). It is therefore not possible to distinguish arable weeds as is commonly done (*cf.* Hillman 1981). The sites in the Vecht region show the presence of various ruderals that may represent arable weeds. All potential arable weeds may have been part of the natural vegetation, and as a result there are no indications of the import of crops from other regions. Table 4.18 shows the macroremains finds of potential arable weeds found in the region (the table represents a selection of taxa that are characteristic of habitats that may have turned into arable plots, see chapter 10). The number of carbonised remains is very small in view of the presence of crop plants and presumed daily crop processing at most sites during at least some of the occupation phases. The small number of taxa found in a carbonised state corresponds with the small number of wild food plants found in a carbonised state. The indications at separate sites that certain taxa functioned as arable weeds (as presented above) do not correspond with each other. There are no indications that cereal remains are associated with salt marsh taxa since salt marsh taxa are found in a very low frequency and not in a carbonised state. Chapter 10 further discusses potential arable weeds of the Swifterbant culture.

4.7.4.4 Local cultivation

The arguments in favour of local crop cultivation are finds of fragments of querns (P14, Swifterbant and Emmeloord-J97), finds of pollen and macroremains of cereals, and finds of chaff remains of naked barley. There are two additional arguments in favour of local cultivation for this region, of which the first consists of the possible indications of tillage found at Swifterbant and Urk-E4. It is not precisely known how people of the Swifterbant culture worked the fields and this hampers interpretation of the features. Cultivation possibly occurred with an artefact used for digging, such as a stick made of wood or antler.

taxon \ site / category	Swifterbant-S3 C	Swifterbant-S3 W	Schokland-P14 C	Schokland-P14 W	Schokkerhaven-E170 C	Schokkerhaven-E170 W	Urk-E4 C	Urk-E4 W	Emmeloord-J97 C	Emmeloord-J97 W
Aethusa cynapium	-	-	-	-	-	-	-	+	-	-
Alopecurus pratensis	-	-	-	-	-	+	-	-	-	-
Anagallis arvensis	-	-	-	-	-	-	-	+	-	-
Anthriscus sylvestris	-	+	-	-	-	-	-	-	-	-
Arctium lappa	-	+	-	-	-	-	-	-	-	-
Artemisia vulgaris	-	+	-	-	-	-	-	-	-	-
Atriplex littoralis/prostrata	-	-	-	+	-	-	-	-	-	-
Atriplex patula/prostata	-	+	-	-	-	+	-	+	-	-
Bromus mollis/secalinus	-	+	-	-	-	-	-	-	-	-
Capsella bursa-pastoris	-	+	-	-	-	-	-	-	-	-
Carduus crispus	-	+	-	-	-	-	-	-	-	-
Carex disticha	-	+	-	-	-	-	-	-	-	-
Chenopodium album	-	+	-	+	-	+	-	+	-	-
Chenopodium ficifolium	-	-	-	+	-	+	-	-	-	-
Chenopodium sp.	-	-	-	-	-	+	-	-	-	-
Cirsium arvense	-	+	-	-	-	-	-	-	-	-
Claviceps purpurea	+	-	-	-	-	-	-	-	-	-
Conium maculatum	-	+	-	-	-	-	-	-	-	-
Daucus carota	-	-	-	-	-	+	-	-	-	-
Galeopsis-type	-	+	-	-	-	+	-	+	-	-
Galium aparine	+	-	-	-	-	+	+	-	-	-
Juncus gerardii	-	+	-	-	-	-	-	-	-	-
Lapsana communis	-	+	-	-	-	+	-	-	-	-
Lychnis flos-cuculi	-	+	-	-	-	+	-	-	-	-
Moehringia trinervia	-	+	-	-	-	+	-	-	-	-
Persicaria bistorta	-	-	-	-	-	+	-	-	-	-
Persicaria lapathifolia	-	+	-	-	-	+	-	-	-	-

Table 4.18 part 1.

site / category / taxon	Swifterbant-S3 C	Swifterbant-S3 W	Schokland-P14 C	Schokland-P14 W	Schokkerhaven-E170 C	Schokkerhaven-E170 W	Urk-E4 C	Urk-E4 W	Emmeloord-J97 C	Emmeloord-J97 W
Persicaria lapathifolia/ maculosa	-	-	-	-	-	-	-	+	-	-
Persicaria maculosa	-	+	-	-	-	+	-	-	-	-
Plantago major	-	+	-	-	-	-	-	-	-	-
Poa annua	-	-	-	-	-	+	-	-	-	-
Polygonum aviculare	-	+	-	-	-	-	-	+	-	-
Ranunculus acris	-	+	-	-	-	-	-	-	-	-
Rumex acetosella	-	-	-	+	-	-	-	-	-	-
Solanum nigrum	-	+	-	+	-	+	-	+	-	-
Sonchus arvensis	-	-	-	-	-	-	-	+	-	-
Sonchus asper	-	+	-	-	-	+	-	+	-	-
Sonchus oleraceus	-	-	-	-	-	-	-	+	-	-
Sonchus sp.	-	-	-	-	-	+	-	-	-	-
Stellaria cf. nemorum	-	-	-	-	-	+	-	-	-	-
Stellaria media	-	+	-	+	-	+	-	+	-	-
Trifolium repens	-	+	-	-	-	-	-	-	-	-
Urtica dioica	-	+	-	-	-	+	-	+	-	+
Urtica urens	-	-	-	-	-	-	-	+	-	-
Vicia hirsuta/tetrasperma	-	-	-	-	-	-	+	-	-	-
Vicia sp.	-	+	-	-	-	-	+	-	-	-

C = carbonised macroremains   + = present
W = waterlogged macroremains   - = not present

Table 4.18 The Vecht region, potential arable weeds, based on macroremains, part 2.

For both sites the relevant features are, however, not published yet in detail.[12] The second additional argument is the trend that naked barley dominates the crop assemblage. At Swifterbant-S3 the dominant crop was naked barley (supported by the results of recent excavations, Raemaekers *et al.* 2005). At Schokland-P14 and Urk-E4 naked barley seems to be dominant as well, but the amount of data available for these sites cannot be considered as representative, and the ratio of emmer and naked barley at these sites can therefore only be considered as a trend. It can be hypothesised that the dominance of naked barley, that is more resistant to brackish conditions than emmer, is related to the minor marine influence that resulted in slightly increased brackish soil conditions. This supports local crop cultivation in the region, although differences between sites and phases are possible.

A first possible argument against local crop cultivation is the apparent absence of evidence of sickle gloss resulting from cereal processing, although evidence of absence is not demonstrated for most sites. However, the absence of sickle gloss does not reject local crop cultivation since alternative harvest methods may have been applied. Sickles may alternatively have been deposited at off-site locations. A second possible argument against local crop cultivation is the limited knowledge about site function and the occupation history of sites. Details on subsistence including the role of crop plants cannot be distinguished for separate occupation phases.

In conclusion, local crop cultivation is a possibility for the Swifterbant cluster, Schokland-P14, Schokkerhaven-E170 and Urk-E4. The evidence is too limited to conclude local crop cultivation, while it cannot be excluded either. The presumed features at S4 and Urk-E4 and the dominance of naked barley at Swifterbant-S3 form the best evidence of local crop cultivation. Crop cultivation at S3 itself during occupation is however rejected. Emmeloord-J97 forms a clear exception since local crop cultivation at that site is very unlikely. The main arguments against local cultivation are the suitability of the terrain and the interpretation of the site as a fishing camp. Chapter 11 further discusses local cultivation.

4.8 Suggestions for further research

An important subject that remains to be investigated at Mesolithic and Neolithic sites in the Vecht region is the development of the vegetation before, during and after separate occupation phases. Such detailed reconstruction of the natural vegetation would also enable analysis of human impact. In the case of Swifterbant, the dunes could receive further attention. Possible marks indicative of tillage are a major topic for future research in relation to local cultivation.

For the goals presented above, the analysis of pollen diagrams, macroremains diagrams, wood and charcoal remains should receive optimal attention, as well as the analysis and publication of finds from earlier excavations. Suggestions for pollen analysis are a small sample interval, transects of cores, and macroremains diagrams. The number of samples, sample location and control samples are important focus points for investigation of the presumed tillage marks.

12 Micromorphological analysis of the features of Swifterbant-S4 has been published after completion of the research described in this thesis.