Summary

This thesis deals with the archaeobotanical analysis of soil samples of the Heveskesklooster terp (province of Groningen, the Netherlands). It is characterized by a methodological approach, in which additional studies were done that are helpful for the ecological interpretation of the records.

When interpreting subfossil plant remains from soil samples, several processes that affect the ultimate composition of the subfossil records have to be taken into account. These processes, together with the structures that are influenced, are incorporated in a palaeoecological model. Central structural concepts in this model are: (1) vegetation and accompanying environment, (2) soil flora, (3) subfossil assemblage and (4) subfossil records. This approach has been elaborated in chapter 1.

An ecological characterization of the Dutch Holocene palaeobotanical records has been performed and compared with the recent Dutch flora present in c. 1850, to determine the representativeness of subfossil records as to various ecological variables. A total of over one third of the recent Dutch flora is represented by subfossil macro-remains, excluding records based on pollen or wood only. If each species is assigned to only one ecological group, it appears that in particular plants indicative of ruderal places, arable fields, dry underwood, fresh water and banks are well represented in the subfossil records. Species growing in woods, dry grasslands and on walls are underrepresented. It proves that the type of preservation makes little difference to the representation on this level of analysis. A more detailed analysis of representativeness is obtained if ecological ranges in indicator values are taken into account. It shows that the distribution of species as to both abiotic environmental characteristics and the structure of vegetation and succession is determined by the type of preservation, feature type and species frequency.

In addition to indicator values, a number of select indicator species can also be used in the ecological characterization of a flora. Groups of indicator plants have been compiled for the following (a)biotic characteristics: (1) salinity, (2) moisture regime, (3) nutrient availability and (4) the structure of vegetation and the stage of succession. Selection criteria are adapted to palaeobotanical research. Taxon weights are assigned to indicator plants and express the possibility of recovery in an archaeological context. These weights are based on sample frequency in the Dutch palaeobotanical records and are calculated according to the type of preservation.

The analysis of drift litter collected on river beaches and the North Sea coast revealed that flowing water is an import dispersal agent of plant remains. Seeds of waterplants especially adapted to water dispersal make up only a minor part of the total assemblage, due to the submerged condition in which most of the plant remains are transported. Species in the drift litter show that they originate from a wide variety of habitats. Running water is therefore considered to be a vital link in long-distance dispersal. The botanical composition of samples from the west coast is mainly determined by rivers that flow into the North Sea, in which transport of sewage plays an important role. On the other hand, plants from local salt marshes and high tidal flats are well represented in drift litter along the northern part of the coast.

In addition to wild plant species, cultivated plants are represented in drift litter as well. Remains of these species partly originate from refuse and sewage and partly from standing vegetation. Subfossil and fossil plant remains are also found in drift litter and originate from older sediments dissected by flowing water.

Therefore, in the interpretation of seed records from sediments that may have been in contact with flowing water, long-distance dispersal by water has to be taken into account. This

also applies to terps, that were in contact with water during storm surges until late medieval times. Drift litter deposited on the slopes of terps will also include plant remains washed away from the inundated soil.

Subfossil endocarps of members of the Potamogetonaceae are frequently found and would be a major contribution towards an ecological interpretation. To improve future identifications of these remains that are difficult to determine, a morphological analysis was performed on endocarps from recent drift litter and on a Weichselian Pleniglacial deposit. A total of seventeen species were established and are documented by SEM photographs and descriptions of their characteristic features.

The frequent presence of subfossil endocarps of *Potamogeton* gave reasons to re-examine the endocarps of Dutch dwelling mounds. One endocarp of *P. filiformis* was found among the unidentified endocarps of the Ouddorp terp (province of Zeeland). This evidence indicates the possibility that in the past drift litter was deposited on the slopes of terps.

The habitation of the Heveskesklooster terp, which was called 'Oosterwierum' until the nineteenth century, is subdivided in four periods: (1) c. 50 BC - c. 400 AD, (2) c. 800 - c. 1300, (3) c. 1300 - 1610 and (4) 1610 - 1975. The presence of a small terp from the very beginning of habitation and sedimentary records indicate moist conditions. Written sources report floodings which frequently affected the area until the end of the third habitation period. Farmhouses were present on the terp during the first, second and last period. Archaeological excavation showed for the first time the presence of agricultural land on the terp proper, called valg(e). During the third habitation period a commandery of the Johanniter order was founded at Heveskesklooster.

The samples of Heveskesklooster yielded many botanical remains. With the exception of one sample, most remains were preserved by waterlogging. As to the vascular plants, species composition was mainly determined by age (period), feature type and depth. Environmental changes, reflected by a shift in species composition of the samples, could be demonstrated for the transition of: (1) the second and third periods and (2) the third and last periods, though there were a limited number of samples of the last period. There was no clear indication of the presence of drift litter material in the examined samples. However, species composition of the samples do indicate a mix of species of different origins, including the supply from beyond the terp.

During all four periods of habitation, both halophytic and glycophytic species are well represented. There is a slight decrease of halophytes in favour of glycophytes in the course of time. Salt-marsh vegetations of the first period have been treated in detail. Plants indicative of moist and wet conditions dominate in all four habitation periods, but the third and fourth periods show a clear increase in the number of plants indicative of dry conditions. As to nutrient availability, all four periods are represented by species indicating poor, moderate and rich soils, and there is evidence of an increase of taxa indicating moderate soils from the first period onwards. Dominant vegetation types for all periods are grasslands and pioneer vegetation. This picture fits in quite well with the characterization of other terps along the Dutch and German coasts. Heveskesklooster stands out by indicator taxa for saline conditions. Classes of moisture regimes and nutrient availability are also relatively well represented.

The ecological characterization of the habitation periods partly overlap at the level of individual samples. Some differentiation is possible by classifying samples as to location and feature type.

Important agricultural plants cultivated by the terp dwellers are: *Hordeum vulgare* (in the third period also ssp. *distichum*), *Avena sativa*, *Linum usitatissimum*, *Camelina sativa*, *Vicia faba* var. *minor* and probably also *Brassica rapa* and *Cannabis sativa*. These crops are also mentioned in connection with other Dutch terps. Samples of the third habitation periods show the highest diversity.

The presence of the Johanniter order in Heveskesklooster during the third period is also inferred from the increase of other economically important plants, of which *Aframomum melegueta* should be mentioned. Of other plants of this category, *Isatis tinctoria* constitutes an exception, for it was found only in samples of the first habitation period. The diversity of economically important plants in Heveskesklooster is high and, compared with other Dutch terps, is equalled by the Leeuwarden terps only.

In addition to the analysis of macro-remains, also palynological research was performed. The examined section comprises the upper part of the basal peat (BP) and the clay layers belonging to Dunkerque I (DI-B 1a,c) and Dunkerque II (DII), intercalated by a *Phragmites/Scirpus* horizon (DI-B 1b) and two vegetation horizons (VH-1,2), and the lower part of the terp belonging to the second habitation period.

Samples of Heveskesklooster yielded 43 different taxa of mosses. It is shown that the more common species are still present in the area, whereas the less frequently encountered species are nowadays rare or lacking in the north-eastern part of the Netherlands. In contrast with recent mosses of Heveskesklooster and its near surroundings, subfossil mosses of this site that do not grow on soil are scarce as a category. The analysis of seeds, fruits and leaves provides evidence for the presence of the following trees: *Betula* spp., *Salix viminalis*, *Quercus* sp., *Sambucus nigra*, *Malus sylvestris* and *Prunus domestica*. Usually, these trees have a poor epiphytic moss flora.

As far as the mosses of Heveskesklooster with a small ecological range are concerned, they are indicative of fresh water, moist and poor soils and pioneer vegetation. Generally, this characterization corresponds with subfossil mosses of other terps. The ecological spectrum of mosses of Heveskesklooster differs only slightly from recent mosses in the Netherlands, but is clearly distinguishable from subfossil vascular plants of Heveskesklooster and recent vascular plants of the Netherlands. Halophytic mosses are rare, whereas subfossil halophytic vascular plants of Heveskesklooster are well represented in comparison with the spectrum of recent vascular plants. A similar shift is shown in waterplants. This category is rarely represented in mosses, whereas they are relatively well represented in the subfossil vascular plants of Heveskesklooster. A noticeable difference between mosses and vascular plants is shown in nutrient availability. Both subfossil and recent mosses are mostly indicative of low nutrient supply, whereas vascular plants are not. This is strengthened by the spectrum of subfossil vascular plants, showing clearly that high nutrient supply is overrepresented at the expense of low nutrient supply. As to structure of vegetation and succession, subfossil mosses and vascular plants of Heveskesklooster are quite similar, for they both are indicative of particularly grasslands and pioneer vegetation. Despite this similarity, vascular plant represent more classes. Comparing these four groups, it is manifest that the ecological interpretation is influenced by the selection of plants and the information derived from groups used as a frame of reference.