Summary

I General introduction

The subject of this study is the emergence of agriculture as it is observed in the sediments of a pingo scar on a relatively high part of the Drenthe Plateau, the Netherlands. This pingo scar is the Gietsenveentje, located near the village of Gieten in the province of Drenthe. The sediment was used for various types of analysis: pollen analysis, radiocarbon dating, analysis of macroscopic remains and wood, and phosphorus analysis. Traditionally, it has been assumed that people of the Funnel Beaker Culture (TRB) (3400-2800 cal BC) were the first to practise agriculture on the Drenthe Plateau. However, there are faint archaeological indications that people of the Swifterbant Culture, an agrarian culture known predominantly from the lower parts of the Netherlands between 4900 and 3400 cal BC, were also present on the higher Pleistocene soils of the Drenthe Plateau. An important aim of this study is to demonstrate any presence of Swifterbant people on the Drenthe Plateau palynologically. Very detailed ^{14}C dates are necessary to achieve this. The zone in the pollen diagrams which represents the Neolithic is defined as the Neolithic Occupation Period (NOP), subdivided into three Neolithic Occupation Phases (NOP-1 to NOP-3). These features are strongly related to the phenomena identified by Iversen in Danish pollen diagrams and summarized by the term *landnam*. The manifestation of the NOP in the Gietsenveentje diagrams is analyzed by the indicator-species approach and the comparative approach.

II Occupation phases in the Neolithic as represented in pollen diagrams: a review

In Danish pollen diagrams, Iversen distinguished a *landnam* phase, caused by early farmers who cleared the Atlantic forest on a relatively large scale, particularly to create grass-rich vegetation for livestock. Troels-Smith distinguished a cultural phase preceding Iversen's *landnam*, which in his eyes pointed to clearances on a far smaller scale: the farmers possibly pollarded the trees and used the leaves as fodder. A review is presented of cultural phases dated to the beginning of the Neolithic, in pollen diagrams from different parts of Europe (the Netherlands, northern Germany, Denmark, southern Sweden, the British Isles). An attempt is made to reduce the cultural phases to either a Troels-Smith phase or an Iversen phase, although it is realised that this is a simplification. It appears that in comparable types of landscape where the same cultures were established, also a similar succession of cultural phases is found in the pollen diagrams. In many parts of Europe, the cultural phases at the beginning of the Neolithic more or less coincide with a considerable decline of pollen of *Ulmus*, an event which is reflected more or less synchronously in all northwest European pollen diagrams. This *Ulmus* decline was most probably caused by elm disease in combination with human disturbance of the vegetation. Apart from human disturbance, a climatic change may also be responsible for changes in the pollen diagrams at the beginning of the Neolithic. Indeed, there is evidence from several disciplines that a worldwide climatic change took place around 5000 BP. Most probably, the climate changed towards continentality and increased dryness. A thorough knowledge of especially the farming aspects of early Neolithic cultures is essential for the interpretation of cultural phases in pollen diagrams. The archaeological cultures which are jointly responsible for the spread of agriculture in the Netherlands are briefly discussed. An attempt is made to shed more light on the difficult questions of how and why the transition to agriculture in the Netherlands took place.

III The Drenthe Plateau: physical environment, vegetation and archaeology

The geology, soils, hydrology, climate, vegetation and archaeology of the Drenthe Plateau are briefly discussed. The Gietsenveentje and its surroundings are described in greater detail on the basis of a series of maps which all display the same area of ca. 20 km^2. Since the Gietsenveentje is a pingo scar, the formation of these relics from the last ice age, the Weichselian, is explained. An attempt is made to reconstruct the potential natural vegetation around the Gietsenveentje on the basis of current soil types. This is followed by an overview of finds from the period of the Swifterbant Culture (4900-3400 cal BC) on the Drenthe Plateau, which range from pottery, flint tools (especially the Rössen-type adzes) and horn sheaths to antler tools. In the surroundings of the Gietsenveentje, only one find from the Swifterbant period is known, but many finds from the Funnel Beaker Culture, i.e. megalithic tombs,

concentrations of flint and pottery and many stray finds, and the subsequent Single Grave and Bell Beaker Cultures. The changes in the landscape around the Gietsenveentje in the last two centuries are sketched on the basis of a number of historical topographical maps.

IV Material and methods

Chapter IV describes the method of coring of the sequences, the techniques used for sampling the sequences, the processing and analysis of samples used for various types of analysis and the construction of a pollen diagram. This is followed by an explanation of the two methods used for radiocarbon dating, the conventional method and the AMS method. Formulas used for calculating pollen concentration and influx are presented, as are techniques used for collecting surface samples and for recording recent vegetation plots.

V Pollen morphology and representation in surface samples of *Rumex acetosa* and *Rumex acetosella*

Pollen grains of *Rumex*-type are considered useful indicators of human activity. Ways are sought to subdivide pollen of *Rumex*-type smaller than 22 µm into pollen of *Rumex acetosa* (common sorrel) and pollen of *Rumex acetosella* (sheep sorrel) on the basis of the length and the degree of intrusion of the colpi. The ecology of these two sorrel species fundamentally differs. On the basis of a study of surface samples involving recent vegetation types in which these two species occur at Nietap, Gieten, Hijkerveld and Schiermonnikoog, it is concluded that pollen of *Rumex acetosa* together with pollen of Gramineae, *Plantago lanceolata* and sometimes *Ranunculus acris* group often points to relatively nutrient-rich grass-rich vegetation, whereas pollen of *Rumex acetosella* points to clearances on poor soils, *Secale* fields or abandoned arable land. This knowledge will be used for reconstructing the biotopes of the two sorrel species during the NOP.

VI Multidisciplinary analysis of Gietsenveentje sequences

Contour maps of the surface and of the Pleistocene subsoil of the Gietsenveentje are presented, based on a large number of corings; also four lithology transects were constructed, giving cross sections of different parts of the pingo scar. The recent vegetation inside the Gietsenveentje was mapped and surface samples were collected for comparison with subfossil pollen samples. Nine sequences from different parts of the Gietsenveentje were used for pollen analysis. The NOP seemed to be present in six of the nine resulting pollen diagrams. On the basis of the regional pollen types in the master diagram Gieten V-A, a pollen zonation system is proposed. The zones are correlated with the Blytt/Sernander periods. The local pollen types together with macroscopic remains and wood are used for a reconstruction of the local vegetation succession. In order to connect the NOP in the pollen diagrams with archaeological cultures, 56 ^{14}C dates were taken in eight sequences. Two different methods are used to calibrate these ^{14}C dates to calendar ages. Because series of dates are available in fixed stratigraphical sequences, more accurate calendar ages are obtained by applying the method of wiggle matching. The possible sources of errors in the ^{14}C dates are extensively discussed. The beginning of phase NOP-1 is dated 4100-4000 cal BC; the beginning of phase NOP-2 is dated 3500-3400 cal BC. Pollen concentration and pollen influx diagrams, which were constructed for five sequences, do not provide much additional information compared to the percentage diagrams. An influx peak around 3700 cal BC in all curves of four diagrams may point to a local small-scale forest clearance, which led to inwashing of soil and pollen. Phosphorus analysis of samples from three Gietsenveentje sequences showed a gradually increasing phosphorus content during phase NOP-1, extending into phase NOP-2, which may have been caused by the dung left by livestock at the edges of what was then a lake or by manure from arable fields.

VII Vegetation development in and around the Gietsenveentje since the Preboreal

In the Preboreal (zone 1), open *Betula* forests dominated the landscape. In the Boreal (zone 2), *Pinus* became dominant together with *Betula*; the share of *Corylus* and *Quercus* in the vegetation increased. In the Atlantic (zones 3a and 3b), stable climax forests were formed: on the till plateau, *Quercus*, *Ulmus*, *Tilia* and *Fraxinus* were the most common trees; in the coversand areas, *Quercus* and *Betula* were the most prevalent. At the beginning of the Subboreal (zones 4a, 4b and 4c), human influence becomes visible in the pollen picture. Zone 4a coincides with the Neolithic Occupation Period, which is subdivided into three phases. In phase NOP-1, the primeval forests were opened on a small scale. Apparently this was to the advantage of *Quercus* and *Tilia*, which reach maximum pollen values. There must have

been small-scale arable fields and various types of grass-rich vegetation, maintained by livestock. In phase NOP-2, more widespread clearances occurred, especially in the rich forests on the till plateau. Now also *Quercus* and *Tilia* were affected. Phase NOP-3 reflects a period of temporarily decreased pressure on the vegetation. In the later part of the Subboreal (zones 4b and 4c) and in the next period, the Subatlantic (zones 5a, 5b and 5c), a development can be seen towards complete clearance of the forests, and their replacement by agricultural land. Simultaneously, the area of exhausted, abandoned arable fields, dominated by *Calluna vulgaris*, progressively increased, finally producing the extensive heathfields which dominated the Drenthe Plateau until the early 20th century.
The local vegetation development of the pingo scar can be followed from the Preboreal, when a small, eutrophic lake was present in the centre. This lake expanded until it reached its maximum size in the first part of the Atlantic, around 6000 cal BC. After that time, a process of terrestrialization started, which gradually transformed the open water, bordered by "shore weed" vegetation, into oligotrophic raised-bog vegetation dominated by *Sphagnum*. By 1500 cal BC, the open water had completely disappeared.

VIII Discussion and conclusions

On the basis of pollen diagrams from Drenthe and *Siedlungskammer* Flögeln, a model is constructed which describes the course of selected pollen curves during the NOP in Pleistocene areas near the North Sea coast. It is emphasized that the manifestation of the NOP in a pollen diagram can be severely influenced by local conditions, viz. basin size, sediment type, location of the coring within the basin and distance to the site of former human activity.
Concerning the culture-indicator types, it appears from the Gietsenveentje master diagram that in the NOP *Rumex acetosa* occurred in nutrient-rich grass-rich vegetation, while *Rumex acetosella*, increasing only after the NOP together with *Calluna vulgaris*, most probably grew on exhausted soils, formerly used as arable fields. *Plantago lanceolata* is considered to be an indicator type for grass-rich vegetation, not for arable land.
The "classic" *Ulmus* decline in the Gietsenveentje diagrams took hundreds of years; it probably was mainly caused by activities of the first farmers. No evidence is found for elm disease.
On the basis of the Gietsenveentje pollen data, combined with archaeological data and macroscopic-remains and pollen data from archaeological contexts, an attempt is made to reconstruct the agricultural economies of the cultures involved in the emergence and early development of agriculture on the Drenthe Plateau. In phase NOP-1 (4050-3450 cal BC), people of the Swifterbant Culture foddered their livestock partly with leaves and twigs of *Ulmus* and *Tilia* in particular; however, also small-scale woodland pastures must have been employed. The cultivation of cereals started ca. 4050 cal BC at the earliest. Phase NOP-2 (3450-2600 cal BC) is connected with the Funnel Beaker Culture, the first fully agrarian culture on the Drenthe Plateau. Apparently, stock keeping became more important: the area of woodland pasture increased. No large-scale burning was used to clear the forest. It cannot be determined whether the arable fields were used only once or on a more permanent basis. Phase NOP-3 (2600-1770 cal BC) is connected with the Single Grave Culture (EGK) and the Bell Beaker Culture (BB). More concentrated habitation and more intensively grazed pastures, covering a smaller area than in phase NOP-2, probably caused an overall decrease of human pressure on the vegetation. Locally, the exhaustion of soils gave rise to an increase of vegetation types with *Calluna vulgaris*.
People of the Swifterbant Culture obtained their knowledge of agriculture from the Rössen Culture, but it was not until the period of the subsequent Michelsberg Culture that agriculture gained considerably in importance. In the wetland communities, stock keeping was adopted around 4750 cal BC, and crop cultivation only around 4200 cal BC. This study has demonstrated that farming was practised by what appear to be upland communities of the Swifterbant Culture, from 4050 cal BC onwards.