THE POLLEN SIGNAL OF EARLY NEOLITHIC FARMING ALONG A HABITATION GRADIENT IN NORTHERN DRENTHE

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ABSTRACT: It is concluded from the uneven distribution of megalith graves (*hunebedden*) and the presence or absence of surface (settlement) finds in northern Drenthe that the inhabitants of the Funnel Beaker culture were not evenly distributed over the area. Habitation seems to concentrate on the highest part of the Hondsrug and less on the lands to the west. It was studied whether this habitation gradient is reflected in the human impact upon the vegetation. For this purpose sixteen pollen sites were investigated of which six gave information for the Early Neolithic. The Early Neolithic was selected by radiocarbon dating and analysed with high resolution. In the pollen analysis the role of the anthropogenic indicators throws doubt upon their value for the archaeological record. Pollen production, distribution and precipitation of *Artemisia vulgaris* have been studied from modern vegetation. Pollen evidence from the Early Neolithic at various elevations, ranging from three-and-halve to nine metres above Dutch Ordnance Level, demonstrate the differences in vegetation at short distances. No palynological gradient paralleling the archeological record could be found.

Suggestions for prehistoric cattle keeping are compared with the management of nature reserves with primitive breeds. Alder may well have profited from the prehistoric grazing whereas birch may have suffered from it.

KEYWORDS: the Netherlands, Drenthe, Pingo, Funnel Beaker (TRB) culture, *Artemisia*, *Plantago, Corylus/ Myrica*.

1. INTRODUCTION

It is widely known by Iversen's pioneering work (1941) that Early Neolithic activities in northwestern Europe were accompanied by the appearance or increase of pollen of Cerealia-type, *Plantago lanceolata*, *Rumex* and the lowering of some tree pollen values, for instance *Ulmus*. The appearance and/or changes of these pollen types were related with crop cultivation and animal keeping. The principle of indicative pollen types as suggested by Iversen is now generally accepted and also applied to other periods of human interference (Behre, 1981).

On a more specific level, the indicative value of these pollen types is still a matter of discussion. The quantitative side of both use and spread of farming, for example, in terms of acreage is still unclear. The same is true for the response time of these pollen types, which might be seriously delayed. The former distribution, including the long distance transport of these indicative pollen types is still a matter of guessing. Also the ecological behaviour of the plant species that produced these pollen types is not well known, the more so, since past situations do not exist anymore.

It has also became clear that Iversen's so-called '*landnam*' pollen picture is not the same all over northwestern Europe and varies with soil type and other abiotic factors, as has been indicated by a critical review of the landnam in the western Baltic by Kalis & Meurers-Balke (1998).

Up to recent research, the people of the Funnel Beaker (*Trechterbeker; TRB*) culture were considered to be the earliest farmers in the northern Netherlands. The TRB culture is still evidenced in the landscape by its megalithic tombs. The TRB traces in northern Drenthe suggest a habitation gradient with the densest habitation in the east, being the higher part of the Hondsrug, whereas much less or no habitation is known for the area west of this ridge, descending to 1.5 m above sea level.

Recently, Raemaekers (1999) and Bakker (2003) have demonstrated that the late Swifterbant culture preluded the Neolithic activities of the *Trechterbeker* (*TRB*) culture in the northern part of the Netherlands, and most probably even in Drenthe. The Swifterbant people were Mesolithic hunter-gatherers, who adopted some farming. It seems that they occurred in low numbers in northwestern Europe and left few traces.

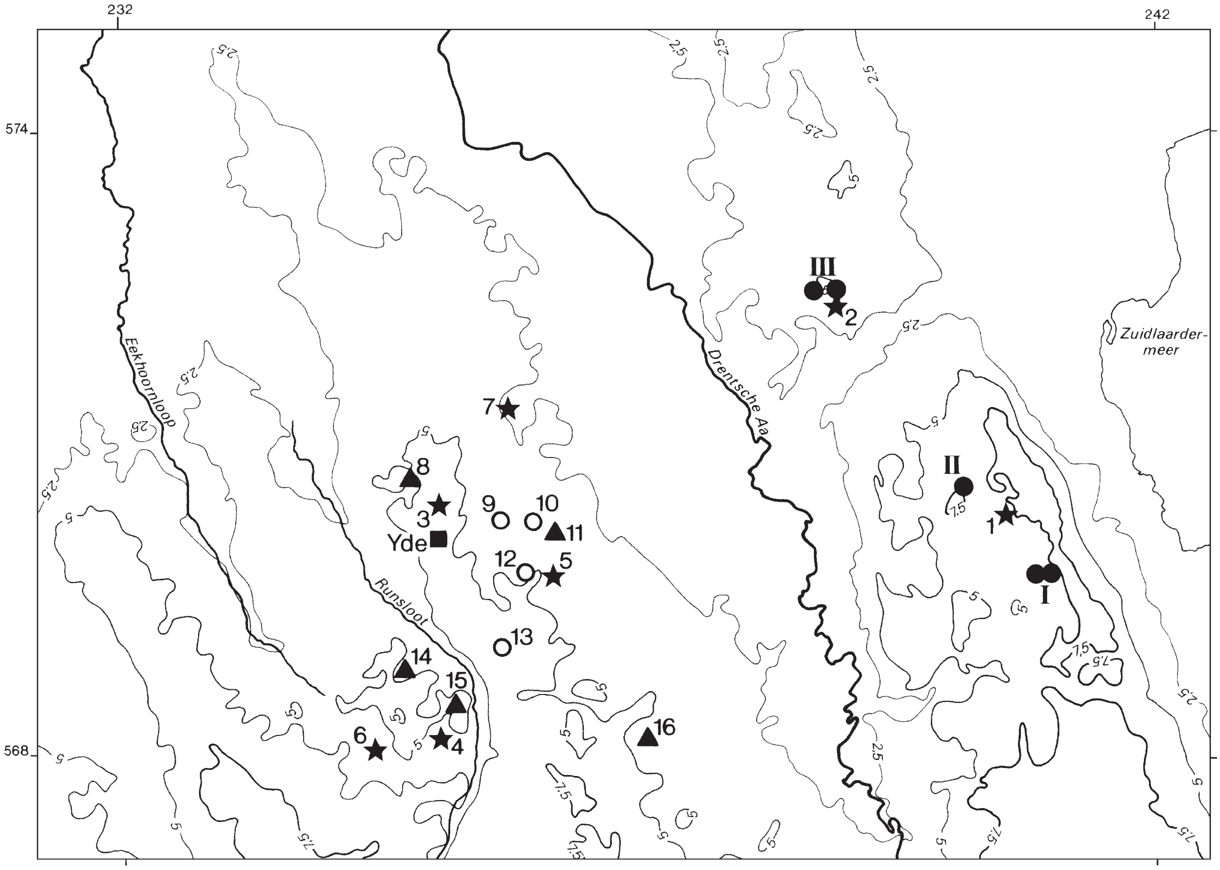

Fig. 1. Megalithic monuments (*hunebedden*; black dots) of the TRB culture, pollen sites (black stars) in northern Drenthe and pingoscars not yielding sediment or filled in with sand (open circles). 1. Noordlaren; 2. Glimmen; 3. Moespot; 4. Boekweitenveen; 5. Boekemaveen; 6. Stiefveen; 7. Bongeveen/Visgat; 8. Frearksveen; 9. Norgerweg 127; 10. Evenveen; 11. Kampstukkenweg 9; 12. Middelveen; 13. Zuides Yde; 14. Rondeveen; 15. Girl of Yde; 16. Grijze steen.

This study is aimed at looking for palynological signals that might illustrate the former habitation in part of the Hondsrug along an east-west gradient. Pollen evidence will be discussed in relation to the spread of the Neolithic tombs. Special emphasis will be laid on the indicative value of *Artemisia* and *Plantago* in the pollen diagrams in relation to the impact of man on the landscape.

2. GEOGRAPHY

The study area with its densist habitation on the northern edge of the present day Pleistocene of the province of Drenthe is found just south of the marine wetlands which were formed during the late Holocene (fig. 1). The saline impact of the rising Holocene sea level spread over the northern Netherlands in a wedge ending a little west from the Saalian Hondsrug, a pronounced Pleistocene ridge, locally 9 m above Dutch Ordnance Level. The Early Neolithic *TRB* culture extended near to the salt marshes (*kwelders*) of the Wadden Sea and once even occupied Pleistocene outcrops that were successively covered by marine clay (*e.g.* Wetsingermaar, Bornwird, Heveskes).

Our interest is the landscape of northern Drenthe in the period from about 4600–2800 cal. BC. The tidal flats were about 10–15 km distant from the study area but the marine influence penetrated even further southward by the valleys of the Hunze and Drentse A. The Neolithic people of northern Drenthe must have known these saline flats at that time.

The area under consideration covers the Hondsrug ridge, and to the west the valley of the small river Drentse A and the *Marke* of Yde (fig. 1). On the Hondsrug and in the area to the west a series of small depressions, mostly filled with peat or water, is present. Many of them are pingoscars and, those investigated, contain gyttja at the bottom covered by peat sediment. Some of the pingoscars are still partly filled with Holocene sediment, but others have been emptied completely by peat digging and are filled with water. Today, this destruction of the palaeobotanical archive is even practised by nature conservation in order to create landscape elements similar to the late Glacial environment. Mostly, lacustrine sediment is still present under water as it had no value for fuel. In some pingoscars remnants of younger peat deposits, narrow strips used for peat to dry, are still found in the lakes. Although these strips may not contain the complete sequence of peat up to recent times, they are the most promising part that has been left.

In addition to pingoscars, also other depressions are present in the area. Aeolian deflation occasionally has produced shallow depressions, often bordering each other. The sediment found in these aeolian depressions dates from the last millennia only and never from the late Glacial. A kind of depression that has never been proved to exist is '*doodijskuil*'. Such a depression is said to be produced by the melting away of a large piece of ice left by the glacier that subsequently became covered by moraine material. Such a phenomenon can, for instance, have been formed during the penultimate ice age (the Saalien Glacial), when the land ice covered the Netherlands. A depression dated to this ice age would have been filled with sediment during the Eemian. Among the fifty sediment series collected and studied at the GIA's palaeobotanical department, Eemian material was, however, never found. In the study area, the *Stiefveen* is a large shallow bog that started to form when the ground water level rose during the Boreal.

3. MEGALITHIC GRAVES IN NORTHERN DRENTHE

Many large megalithic grave monuments (*hunebedden*) are found on the Hondsrug, but they occur in smaller numbers west from this ridge. Harsema (pers. comm.) explains the distribution of the Funnel Beaker culture to have arrived from the southern Emmen region that had connections with the Hümmling. The concentration of these tombs may indicate a fair population and is assumed to be identical with the habitation of Neolithic farmers of the TRB, as indicated in figure 1 (after Van Ginkel *et al.*, 1999).

In the research area five megaliths were found. The two graves from the Glimmer Es (G2 and G3) were excavated by J.N. Lanting and published by Brindley (1983; 1986) and Brindley & Lanting (1991–1992). Bakker (1982–1983) discusses the *hunebed* (G1) of Noordlaren. The two *hunebedden* of Midlaren (D3 and D4) have not been excavated.

There are rumours that the *Marke* of Yde once owned a megalith grave. There is mention of a *hunebed* in the historical record, a field called '*Steenakkers*' (stone field), owing to the presence of some large boulders and a pingoscar called '*Grijze Steen*' (grey stone) in the *marke*. Such names may point to a megalith but not exclusively so (Kloosterman, 2000). *Grijze Steen*, in local dialect called '*gries stain*', was excavated by Van Giffen without any result (pers. comm. by O.H. Harsema). According to Huiskes (1992), who investigated the occurrence of a megalith in Yde, there is no solid proof for such a monument to have existed. The area lacks archaeological finds of prehistoric occupation during the Neolithic and Bronze Age.

Brindley and Lanting discern seven ceramic horizons with the following calibrated ^{14}C chronology:

Horizon 1	*c.* 50 years	3400–3350 BC
Horizon 2	50 years	3350–3300 BC
Horizon 3	100 years	3300–3200 BC
Horizon 4	150 years	3200–3050 BC
Horizon 5	60 years	3050–2950 BC
Horizon 6	50 years	2950–2900 BC
Horizon 7	*c.* 50 years	2900–2850 BC

Hunebedden were in use at different points in times but all seemed to have been in use part of zone 3 and 4. The *hunebedden* of Glimmen as well as the one of Noordlaren date back to late horizon 2, about 3300 BC (4500 BP), which is even later than the beginning of the TRB in Drenthe. Since horizon 4, no new megalithic graves have been raised in northern Drenthe. The date of about 4500 BP suggested by Lanting (pers. comm.) for northern Drenthe, has to be considered when we are dealing with pollen diagrams.

According to Casparie & Groenman-Van Waateringe (1980), *hunebedden* were raised on abandoned arable land of limited extent. When one speaks of abandoned arable land, it must have existed some time before the grave monument was erected. It seems logical that the megalith was raised on an open field because transporting the heavy stones in a forest would be very difficult. The question presents itself as to how long the open field already existed. Was the chosen field originally used for crop cultivation first or was the forest especially cleared away for the megalith? Was a megalith raised upon arrival of the TRB people or did the newcomers first have to develop certain demographic numbers? Pollen counts obtained from soil samples from under *hunebedden* and burial mounds are, unfortunately, difficult to correlate in time with the grave monuments (Bakker, 2003).

A related problem is the possible use of *hunebedden* as territorial markers. Although this additional use has often been postulated (*e.g.* Van Ginkel *et al*., 1999), their environmental setting does not seem to support this hypothesis. Their use as territorial markers only makes sense when they were visible from a large distance. The visibility on the Hondsrug was, however, very restricted as was the visibility in the lands adjacent to the west. Even shrubs would hide a megalith grave and keep it out of sight. A clear example is presented by the painting by Koekoek 'View on the mill of Oudemolen' from the village of Tynaarlo with the megalith grave in the front. The scene shows a heath landscape with the sand tracks leading to the village of Oudemolen. Fifty years later, when sheep grazing was abandoned, the whole area was filled with forest and new houses, and no open landscape whatsoever had remained (Bottema, 1991). If *hunebedden* were also used as markers, it is more obvious to ascribe the stone configuration to markers at close encounter, for instance along a road or track that ran over the Hondsrug (pers. comm. by O.H. Harsema).

4. PALYNOLOGICAL INVESTIGATIONS

4.1. The pollen sites

The following sites in the study area were selected for palynological analyses: Midlaren, Glimmer Es, Moespot, Boekemaveen, Boekweitenveen and Stiefveen (fig. 1). The sediments have been radiocarbon dated to trace the Neolithic period (fig. 2). Other pingoscars in the area proved to be unsuitable for various reasons, including peat digging. The precise location of the coring sites is determined by the Amersfoort coordinates.

Two levels have been drawn in the diagrams: 4500 BP (the beginning of the Funnel Beaker (TRB) culture activity in the area according to Brindley & Lanting, 1991–1992) and 5100 BP. The latter level has been chosen to demonstrate the pollen precipitation of the vegetation not yet disturbed by agriculture.

Midlaren (fig. 3)

Co-ordinates: 240.55/570.37
Associated megalithic tombs: Midlaren (D3 and D4) and the *hunebed* of Noordlaren (G1)
Surface: 0.4 ha
Diameter: 70 m

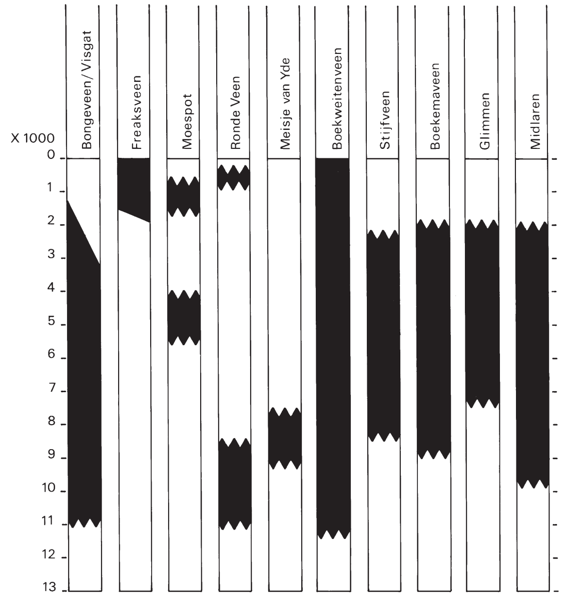

Fig. 2. Time cover of the sediments in the area.

Coring location: 15 m from the edge
Radiocarbon dating:

Depth	Date	
161–164 cm	4890±70 BP	GrN-24912
166–168 cm	5200±100 BP	GrN-24913

Sedimentation: 1 cm = 62 years. Local TRB 4500 BP at 155.7 cm. Level of 5100 BP at 165.5 cm.

The sediment between the two Midlaren radiocarbon dates consists of amorphous black peat. The distance between 168 and 161 cm represents 320 radiocarbon years. This means a sedimentation rate of 0.025 cm per year. As the usual thickness of a pollen sample is 0.6 to 1 cm, the number of years covered by a sample amounts to 27 to 45 years. The anthropogenic pollen activity, to begin in 149.5 cm dates 4370 BP and thus belongs to the end of the TRB landnam. Human impact registered in the Midlaren core seems to be present from 156 cm onward.

Plantain pollen (*Plantago*) is hardly or not correlated with the time of the TRB culture. Only in spectrum 11, dated around 3950 BP, 2% plantain pollen is found that must be ascribed to the Protruding Foot-Beaker culture.

Glimmer Es (fig. 4)

Co-ordinates: 238.9/572.4
Associated megalithic tombs: Glimmer Es (G2 and G3)
Surface: 1.2 ha
Diameter: 100–150 m

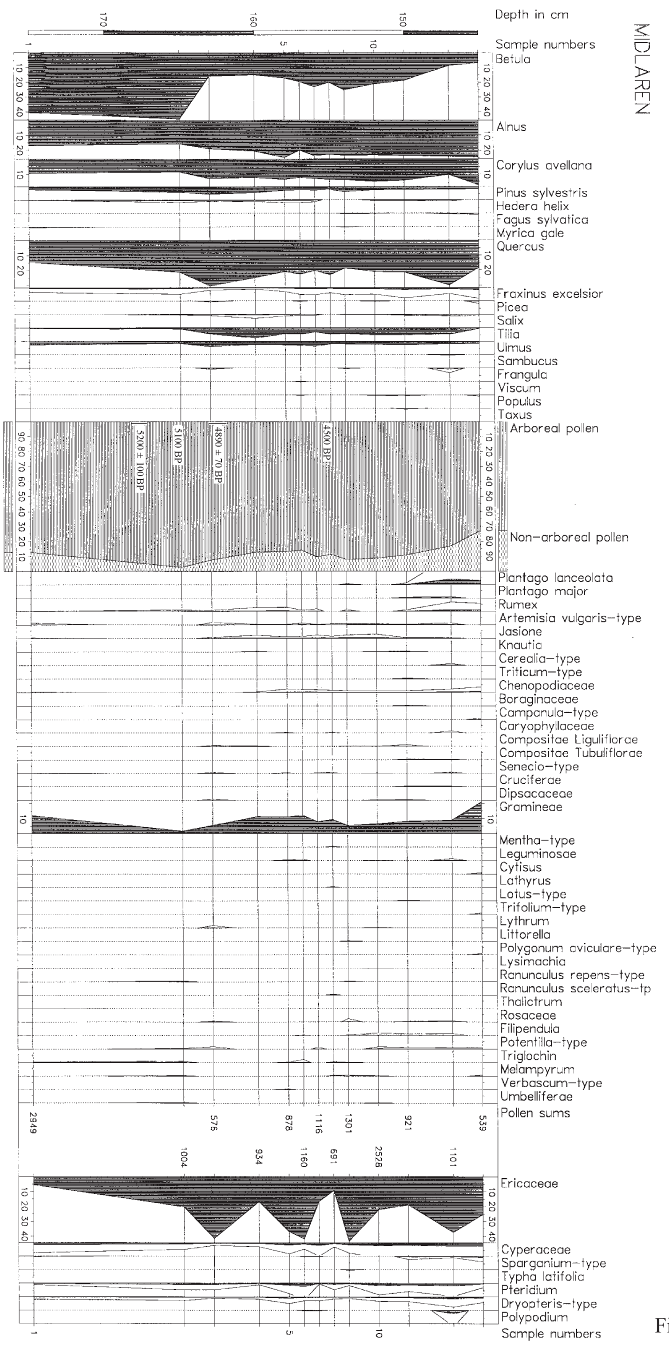

Fig. 3. Section of a pollen diagram of Midlaren showing the Early Neolithic time.

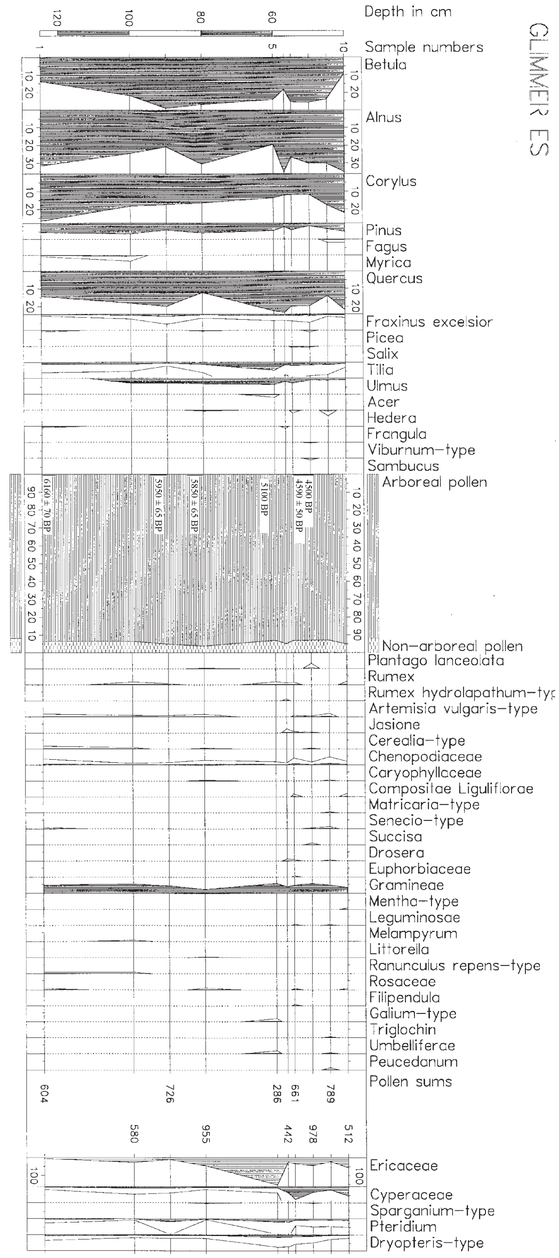

Fig. 4. Section of a pollen diagram of Glimmer Es.

Coring location: 50 m from the edge
Radiocarbon dating:

Depth	Date	
50–55 cm	4590±50 BP	GrN-26971
80–85 cm	5850±65 BP	GrN-26735
90–95 cm	5950±65 BP	GrN-26736
121–124 cm	6160±70 BP	GrN-24910
126–129 cm	6280±110 BP	GrN-24911

Sedimentation: 1 cm is 42 years. Local TRB 4500 BP at 50.5 cm. Level of 5100 BP at 64.35 cm.

Moespot (fig. 5)

Co-ordinates: 235.06/570.38
Associated megalithic tombs: none
Surface: 1.9 ha
Diameter: 150 m
Coring location: centre of pingoscar
Radiocarbon dating:

Depth	Date	
267–270 cm	3880±80 BP	GrN-25127
278–281 cm	5180±80 BP	GrN-25128

Sedimentation: 1 cm is 118 years. Local TRB 4500 BP at 273.6 cm. Level 5100 BP at 278.5 cm.

Boekweitenveen (fig. 6)

Co-ordinates: 235.05/568.10
Associated megalithic tombs: none.
Surface: 3.5 ha
Diameter: 210 m
Coring location: centre of the pingoscar.
Radiocarbon dating:

Depth	Date	
149–151 cm	4860±70 BP	GrN-24904
189–191 cm	6110±100 BP	GrN-24905

Sedimentation: 1 cm is 31 years. Local TRB 4500 BP at 141 cm. Level 5100 BP at 156 cm.

The depth from 184–120 cm was screened for indicative pollen types and general pollen contents. Cerealia-type pollen grains were found at 176, 180, and 184 cm. The oldest spectrum, where Cerealia-type is found, is about 6000 BP. One could doubt the limit of 40μ, an important but arbitrary identification trait. Especially from emmer wheat, pollen grains of about 50μ would be more convincing. It is striking that no Cerealia-types are found with a size larger than 40μ.

Boekemaveen (fig. 7)

Co-ordinates: 236.15/569.72
Associated megalithic tombs: none
Surface: 0.4 ha
Diameter: 70 m
Coring location: 20 m from the edge
Radiocarbon dating:

Depth	Date	
40 cm 339	60±60 BP	GrN-26773
89–92 cm	6320±120 BP	GrN-24902
131–135 cm	7280±120 BP	GrN-24903

Sedimentation: 1 cm is 50.5 years. Local TRB 4500 BP at 62 cm depth. Level 5100 BP at 66.5 cm.

The part of 53–72 cm was analysed around the calculated date of 4500 BP and is shown in figure 12. The whole sequence of 15 cm covers about 850 years. The course of the pollen curves is remarkably even. At the date of 4500 BP (62 cm), there are only very vague indications for agricultural evidence in the form of single grains of *Rumex, Artemisia* and Chenopodiaceae. *Jasione* and *Pteridium* were already present before this depth. The first few grains of *Plantago lanceolata* and *Plantago major* appear about 120 years later.

Conspicuous is the presence of umbelliferous pollen, which is matched by *Peucedanum*. This plant was at least present in reasonable numbers from about 5400–4000 BP. It is proof that a site may have its typical signature, which differs altogether for millennia from nearby sites.

Stiefveen (fig. 8)

Co-ordinates: 234.30/568.07
Associated megalithic tombs: none
Surface: 10 ha
Diameter: 430 m
Coring location: 180 m from the edge
Radiocarbon dating:

Depth	Date	
40–42 cm	2340±80 BP	GrN-26775
70–73 cm	6170±110 BP	GrN-24908
88–91 cm	6870±90 BP	GrN-24909

Sedimentation: 1 cm is125 years. Local TRB 4500 BP at 58.3 cm. Level 5100 BP at 63 cm.

The peatbog is very much destroyed by peat digging and drainage in the last three decades of the twentieth century. The desiccation, which followed the drainage, caused an explosion of birch growth on the decayed *Sphagnum* peat.

The detailed analysis of the Stiefveen sequence gives a record in which arboreal-pollen values are invariably high. No anthropogenic indicators are visible in the spectrum at 59 cm, dated 4500 BP, and neither in the following spectrum at 53 cm, that is 700 years

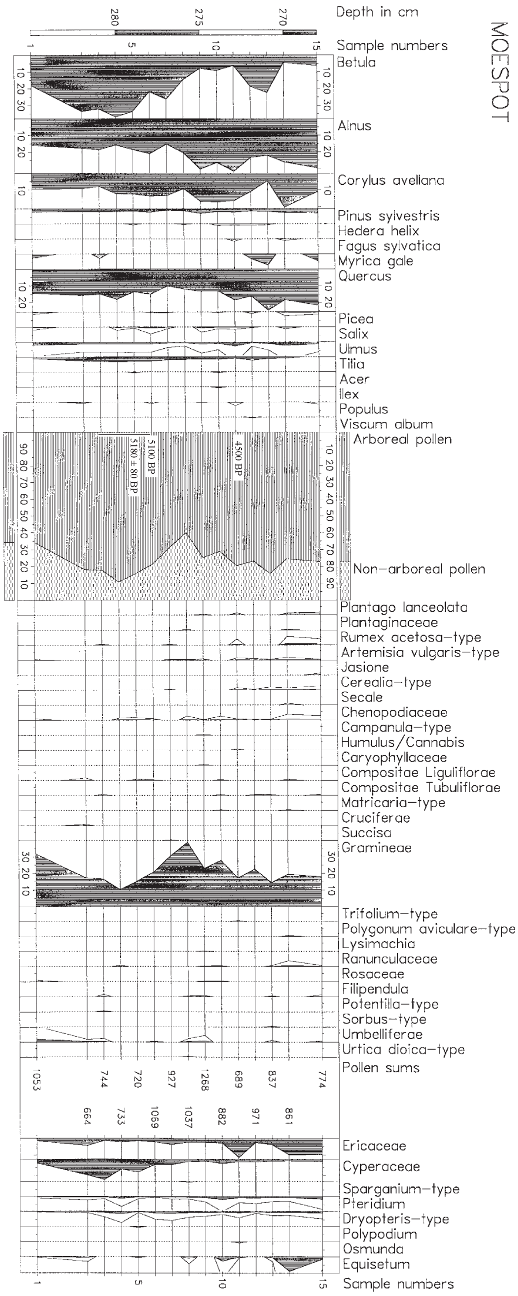

Fig. 5. Section of a pollen diagram of the Moespot.

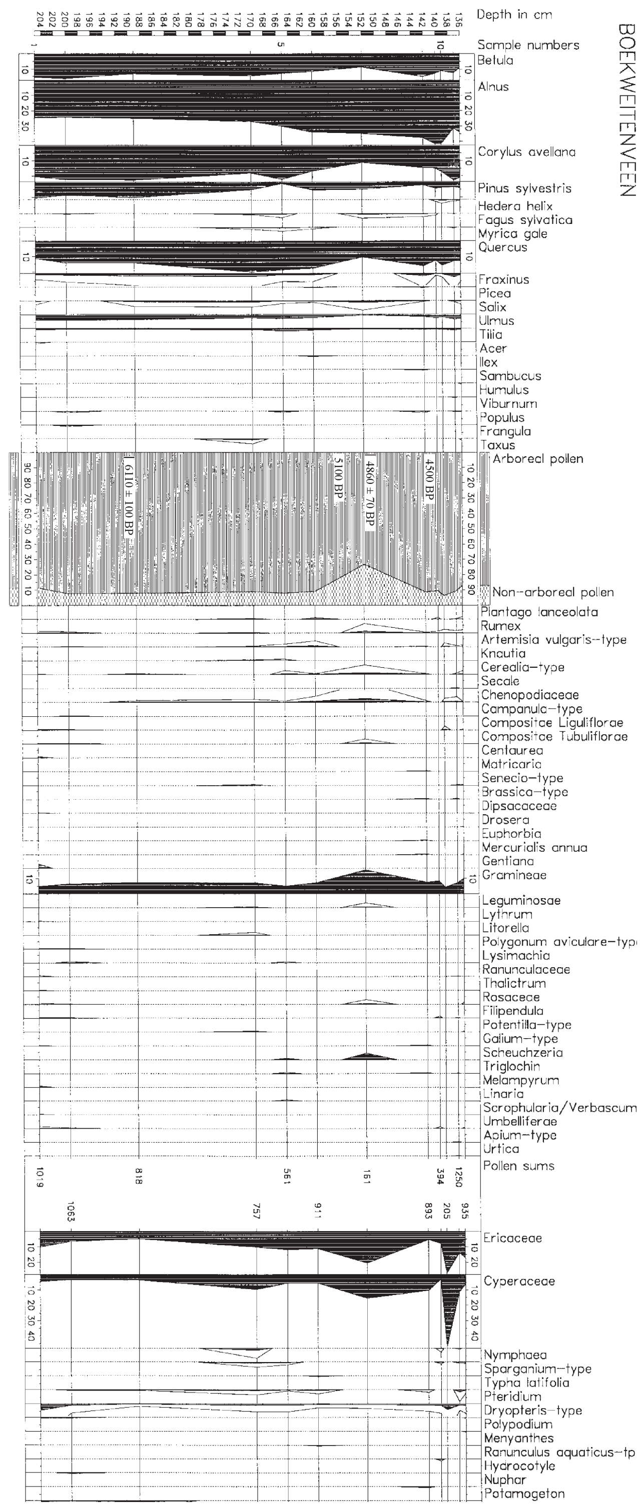

Fig. 6. Section of a pollen diagram of Boekweitenveen.

younger. From 62 to 60 cm, slight changes in the AP values can be seen. Hazel and oak show lower pollen percentages, and especially alder increases from 25 to 40%. Elm and lime do not have important values but decrease after 62 cm.

Bongeveen/Visgat (fig. 9 and table 1)

Co-ordinates: 235.70/571.35
Associated megalithic tombs: none
Surface: 1.0 ha
Diameter: 120 m
Coring location: 30 m from the edge
Radiocarbon dating:

Depth	Date	
52–53 cm	6810±120 BP	GrN-26774
69–70 cm	7240±120 BP	GrN-24906
83–84 cm	7340±130 BP	GrN-24907

Sedimentation: 1 cm is 25.3 year. Level of 5100 BP above 50 cm.

Table 1. Results of the pollen counts of Bongeveen, depth 50 cm (c. 5100 BP).

	N	*%*
Quercus	53	9.5
Betula	77	13.9
Corylus	153	27.5
Alnus	187	33.7
Ulmus	11	2.0
Tilia	10	1.8
Hedera	1	0.2
Pinus	34	6.1
Myrica	2	0.4
∑AP	528	
Artemisia	1	0.2
Gramineae	15	2.7
Jasione	1	0.2
Sum	545	
Cyperaceae	17	3.1
Calluna	66	11.9
Vaccinium-type	4	0.7
Ericaceae p.p.	36	6.5
Sparganium-type	1	0.2
Pteridium	6	1.1
Dryopteris	2	0.4

The Bongeveen/Visgat pingoscar should not be mistaken for the Bongeveen/Scheperijen near the village of Bunne. Bongeveen/Visgat forms the most southerly part of a former area of drift sand and small peatbogs where today the Airport of Groningen is. The 310 cm of sediment dates back to the Late Glacial. In the upper part peat cutting caused the loss of a significant part of the younger sediment. Radiocarbon dates indicate that no younger sediment is available than about 5000 BP. Anthropogenic indicators were found in the upper spectra only. High scores of Cerealia-type in the upper spectra are from rye and date from medieval times. A decrease in AP values and the presence of early Cerealia-type pollen grains registered at about 70 cm were taken as orientation point for the search of the TRB. The beginning of the Atlantic, based upon the beginning of the *Alnus* curve (about 8000 BP) is found at a depth of 130 cm.

A drop in arboreal-pollen values takes place at 40 cm. The first author analysed the sample at 50 cm in search of types indicative for human activity, but without any result. This sample is considered to represent the situation at 5100 BP. About 15% Ericaceae, present already at a depth of 70 cm, predates the beginning of the Neolithic period.

4.2. Methodological considerations

4.2.1. *The indicative value of some pollen types*

Artemisia

Several plant species are connected with farming or the opening up of the dense Atlantic forest. A pronounced light-demanding taxon is wormwood (*Artemisia*). Certain *Artemisia* species are indicative for steppe vegetation where they flower towards the end of the summer. In the steppe vegetation of Spain and Morocco, *Artemisia* pollen is reported to be overrepresented (Iglesias, 1998). For northern Drenthe, we can expect *Artemisia vulgaris*, but the area was also under the palynological reach of the coastal species *Artemisia maritima* that grows under saline conditions. In the concerning period, such conditions were found north of the Hondsrug (Roeleveld, 1974).

The Dutch Pleistocene soils are inhabited by *Artemisia vulgaris,* a plant ascribed by Iversen (1941;1973) to the natural vegetation. *Artemisia vulgaris* needs more light than *Plantago lanceolata,* a value of 7 (plantain 5–7) (Ellenberg *et al.*, 1991). *Artemisia* cannot stand mowing or frequent disturbances of the soil, but farm animals mostly avoid the plant. It is a plant of disturbance by man more then a weed of agriculture. When we analyse the role of this plant in the vegetation of northern Drenthe at the end of the Atlantic and at the beginning of the Neolithic, *Artemisia vulgaris* may have been more a plant of settlements, especially abandoned settlements and along

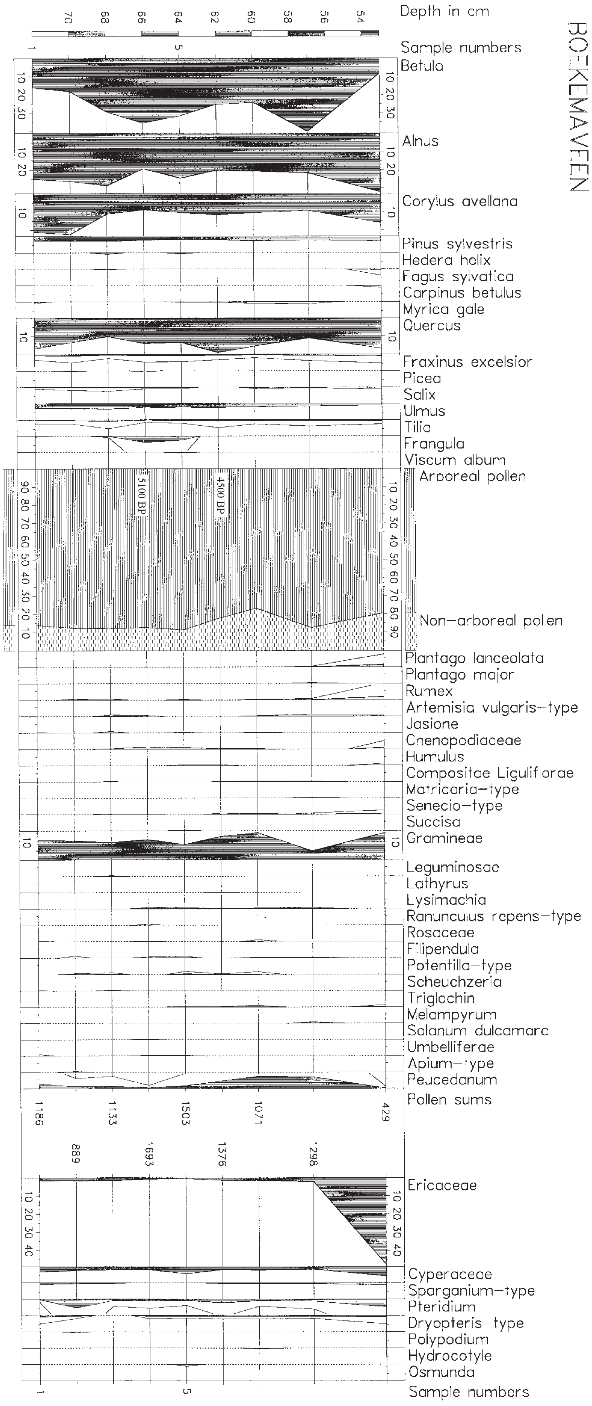

Fig. 7. Section of a pollen diagram of Boekemaveen.

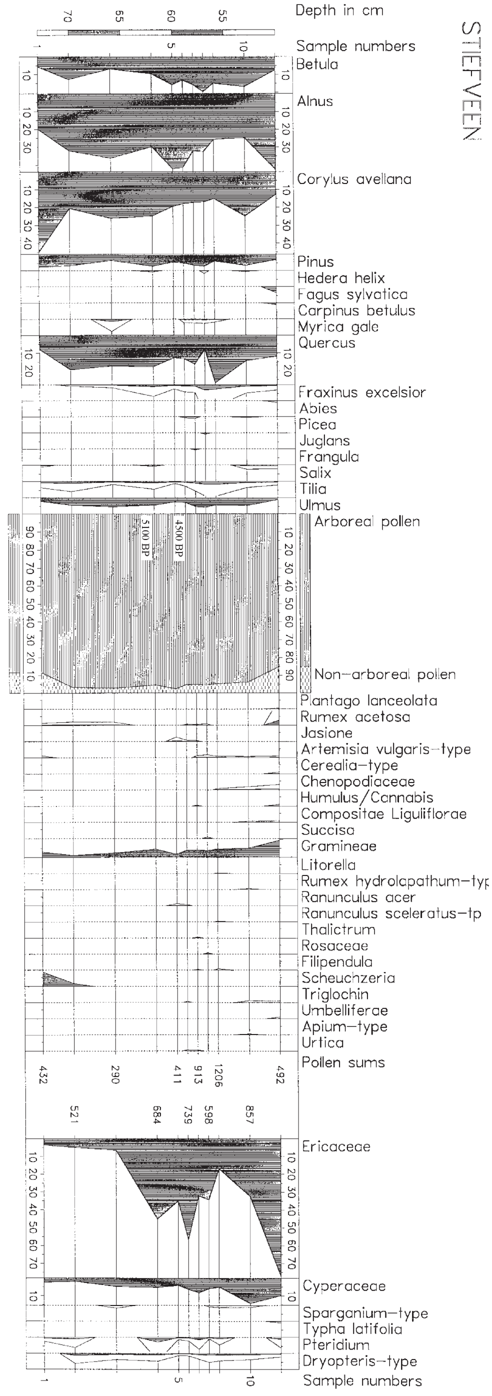

Fig. 8. Section of a pollen diagram of Stiefveen.

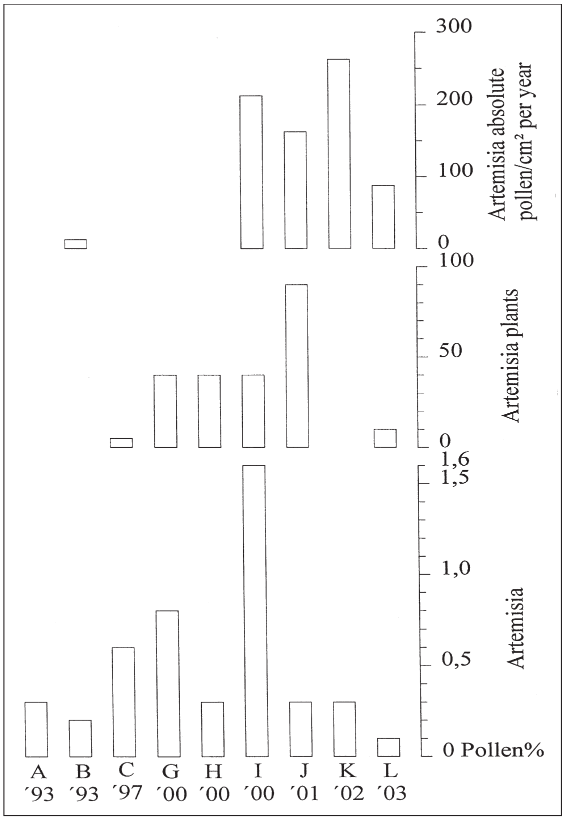

Fig. 9. Percentages and absolute numbers of *Artemisia vulgaris* pollen in surface samples of mosses and pollen traps in a farmyard in Yde (northern Drenthe) collected in 1993 through 2003. Lower rank: traditional surface samples; middle rank: number of *Artemisia* plants in ten years; top rank: absolute pollen numbers of *Artemisia* in the pollen traps.

roads, then a weed of crop cultivation.

Artemisia maritima pollen resembles *Artemisia vulgaris*, but in some cases it is possible to separate the two species. *Artemisia vulgaris* is more micro-echinate than *Artemisia maritima*. Often the micro-echinae cannot be seen in cross-section but show up on the surface of the intercolpium at 1000 times magnification. The pollen observed in northern Drenthe resembles *Artemisia vulgaris*.

The pollen behaviour of *Artemisia vulgaris* was studied by the analysis of pollen deposition in moss cushions and in artificial pollen traps. The moss cushions, which were annually collected, provided the pollen percentage of *Artemisia* in relation to other pollen, whereas the artificial pollen traps offered the opportunity to calculate the absolute pollen precipitation of *Artemisia*. The difference between the two kinds of samples is the time factor: the age of moss cushions is unknown; in traps the time is chosen for instance annually.

Chosen was the farmyard of the first author, where the pollen precipitation of an expanding population could be followed over several years. The investigations took place under a constantly increasing population of *Artemisia vulgaris*. The first pollen traps, including moss cushions, were collected when *Artemisia* was not yet growing in the yard. In 1997, the first *Artemisia* plants appeared in the yard. The population established itself and subsequently more and more plants developed from seed finally culminating in about ninety *Artemisia* plants in 2001. To measure the palynological effect, all *Artemisia* plants were taken away in 2002 well before they developed flowers.

The pollen production of *Artemisia* was calculated in 2000, when the population consisted of 40 plants. Twenty-five flower heads from one-and-a-half metre high and two-year-old wormwood plant were collected on the 3rd and the 10th of August 2000. First batch: one flowering head contained 18865 pollen grains. All plants in the farmyard are estimated to produce 18865×35000×10= 660275.104 pollen grains. Second batch: one flowering head is calculated to contain 17090 pollen grains. All the *Artemisia* plants in the farmyard are estimated to have produced $17090 \times 35000 \times 10 = 598150 \times 10^4$ pollen grains. The wormwood plants present in the yard were not all of the size of this plant, but are estimated to have produced 10 times the calculated amount. Growing in an area of about 1000 m2 this would have succeeded in a precipitation of about $6 \times 10^9/10^7 = 600$ grains per cm2.

The pollen precipitation in each year is summarized in figure 9. The lower row gives the percentages of *Artemisia* in moss samples in bars. The second row gives the number of *Artemisia* plants in the yard, about up to 40 m around the location of the pollen trap. Note the absence of plants in 2002 and 2003. The third row gives the number of *Artemisia* pollen precipitated per cm2/year. It seems that the absolute trap results give a more reliable result than the moss cushions. This seems to be supported by the time control and the possibility of emptying the pollen trap at a desired period, usually every winter. Still the trap sampling has its own problems as they may also trap insects. This is especially problematic when insects collecting pollen, such as honey bees, are caught. Especially in 1997 and 2002, insect-pollinated types outnumbered the normal wind-pollinated types, thus increasing the pollen sum and reducing the percentages. Of course the absolute influx of *Artemisia* was not affected by these disturbances.

When the numbers of *Artemisia* plants appeared and increased in the farmyard, the percentages first increased and then decreased, depending upon the pollen sum. More interesting are the absolute *Artemisia*-pollen numbers, which do not only increase with the number of plants but do even appear when such plants are no longer present: during the season 2002 still a total of 80–268 grains per cm2 were trapped although all plants were removed long before flowering. This implies that a large amount of *Artemisia* pollen stays in circulation.

The percentage of *Artemisia*-pollen grains precipitated in the farmyard is low, also when many wormwood plants are found. The percentages of subfossil wormwood-pollen present in the northern-Drenthe diagrams do not exclude a larger number of these plants here and there. It is quite possible that *Artemisia vulgaris* established itself on settlements of the Early Neolithic people and before that time on (abandoned) campsites of hunter-gatherers, especially, where openings were made by campfires.

Plantago

The impact of prehistoric people on the environment resulted in the creation of suitable conditions for the establishment of *Plantago lanceolata*. It is questionable after how long a period this newcomer becomes visible in a pollen diagram. The appearance of this pollen is claimed to be the beginning of human activity, but there will be some time between the founding of the farm and the appearing of plantain pollen.

Is the appearance of plantain pollen connected with farming, the disappearance of *Plantago lanceolata* is often thought to point to people leaving the area, implying that natural or secondary vegetation could regenerate. This conclusion may not always be true. The behaviour of plantain was observed by the first author in grazed meadows in northern Drenthe, where in 1970 a lot of four acres grassland was obtained. The original land consisted of well-developed grassland with some species originating from more old-fashioned meadow, for instance *Anthoxanthum odoratum* and *Cardamine pratensis*, but without *P. lanceolata*. The land was divided into two parcels, one of which was annually fertilized with composted cattle dung mixed with straw and some nitrogen. It was exploited by cattle grazing and haying. The other parcel had year-round grazing with sheep and no fertilizing whatsoever. After about five years, *Plantago lanceolata* appeared in the sheep-grazed land. The land had obviously reached the level of nutrient-availability that suited plantain and soon this plant became very common. After another five years, plantain disappeared again because the sheep had exhausted the land beyond the level accepted by plantain. Since then poor heath-land species started to appear including *Pilosella* and *Hieracium.* The other half of the land under traditional management, including fertilising and grazing, never had any plantain. In such a case the disappearance of *Plantago lanceolata* has nothing to do with people abandoning the area, but with the depletion of certain nutrients. Such a change in vegetation, which also affected plantain, took place in the 18th-19th century large-scale development of heath-land. The end of a ribwort plantain curve in a pollen diagram can just as well mean exhaustion of grazed fields.

Another aspect is the origin of the plantain pollen in the pollen precipitation: what part is locally produced and what part of the pollen comes from further away? The plantain percentages present in the pollen diagrams of Emmererfscheidenveen en Bargeroosterveld in southeast Drenthe, a large peatbog east of the Hondsrug (Van Zeist, 1955; 1959), are easily explained by long-distance transport. The cores are located several kilometres east from the forests on the Pleistocene ridge, but to the east a large bog stretched completely devoid of trees. In that case sources have to be looked for where plantain produces enough pollen to be transported, even if these are further away. It should be investigated whether the plantain curves in small bogs, such as pingoscars, are contemporaneous with the curves resulting from long distance transport in large bogs. In the area of northern Drenthe, plantain pollen is especially expected near sites with TRB activity, for instance close to the *hunebedden* of Midlaren and Glimmen and it is therefore assumed that the TRB activity took place less than 50 m from the catchment area (see 4.4.3). More to the west the plantain-pollen percentages could be expected to drop together with increasing distance from habitation.

Corylus and *Myrica*

In the present-day vegetation of some pingoscars *Myrica gale* (bog myrtle) is very common. Its pollen very much resembles that of *Corylus* and one wonders whether they can be separated safely.

Although the separation of pollen of hazel and bog myrtle can be done on the basis of morphological characteristics, a considerable overlap occurs. Especially in the case of subfossil material, a sufficient separation of these two types may offer problems.

The separation of the two species is done on the basis of the pore-endopore region (Iversen, 1975). The larger size of the diameter of the *Myrica* pore is not a solid identification trait. Size dimensions can be sediment-induced, but especially the position of the pollen grain in the sample hinders measuring. A better identification trait of the pollen of *Myrica* is the structure of the surface around the pore that differs from the structure of the body, which is not the case in *Corylus.*

To get more information about the production and distribution of *Myrica* pollen, surface samples from the Boekweitenveen have been studied. One sample originates from under *Myrica* shrub and another sample was collected ten metres outside this belt, one metre from the location of the pollen core of Boekweitenveen. *Myrica* pollen values from under the shrub amount to 17.5%, but at some ten-metre distance their value has already dropped to 1.9%. *Corylus,* that is rare in the area and only grows in a shrub barrier to prevent an imals to feed on the fields of the Es, measures a meagre 0.9% in both samples.

It is expected that *Myrica* plays no role in the pollen precipitation of the northern Netherlands during the Atlantic and Subboreal periods. In subfossil spectra, pollen grains morphologically ascribed to *Myrica* are rarely met with. *Myrica* seems to profit from drainage of the bogs that would happen much later in time. *Myrica* would have had higher percentages only when growing in the near vicinity of the collecting point. Conclusive for this problem are the cores from gyttja that exclude local growth of bog myrtle. In such sediments hazel has high percentages.

4.2.2. *The delay of the TRB-pollen pattern: evidence by the Buinen trackway*

When we ascribe a certain pollen pattern to the TRB culture, we may ask at what time after the material appearance of this culture the human impact will be visible in pollen assemblages.

An interesting chronological difference between Funnel Beaker people activity and the pollen signal that is believed to have been caused by this culture, forms the pollen diagram by Waterbolk (1959), prepared in connection with the trackway of Buinen. The remnants of this trackway were excavated on a farmyard that was laid out on the drained peat. Because of oxidation the peat accumulation was no longer complete and the sedimentation rate could not be calculated. The pollen assemblage that is linked to the wood of the trackway is dated to the TRB (fig. 10).

The Buinen trackway-pollen diagram resembles in many aspects the other diagrams from northern Drenthe. Above the level of the trackway, there is a closed curve of low ribwort-plantain (*Plantago lanceolata*) percentages from 65 cm onward. At the

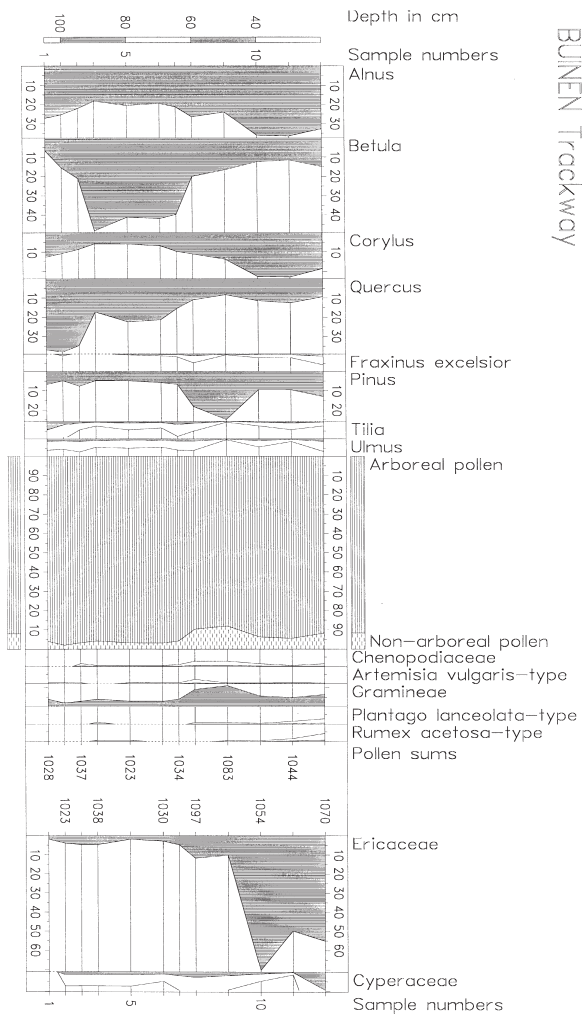

Fig. 10. Pollen diagram of the trackway of Buinen (recalculated after Waterbolk, 1959).

same depth there is a sharp decrease of birch-pollen (*Betula*) values, whereas pine-pollen (*Pinus*) values sharply increase.

The Buinen pollen diagram indicates that it takes at least 5 cm and maximally 10 cm of peat deposition before a reaction of indicative anthropogenic pollen types takes place (Waterbolk, 1959). The peat growth in Drenthe is highly variable and a series of radiocarbon dates offers possibilities of 15–100 year per cm deposit. One must realize that such figures hold for all kind of uncertainties. The bulk of the calculations centres around 30–50 years per cm. From the diagram in figure 10 it is obvious that there is a delay in reaction of *Plantago lanceolata, Betula, Pinus* and Gramineae. The time span represented by this delay is difficult to estimate, but may be in between 100 and 400 years.

The latter estimate would even suggest that the occupation phase was not even caused by Funnel Beaker farmers (TRB) but by later Protruding Foot Beaker people (PFB). This implies that the impact of the TRB people, who laid out the wooden trackway, is not visible in the pollen record of Buinen. Changes in the vegetation, measured in terms of pollen percentages, were apparently a good deal later.

4.2.3. *Pollen dispersal and the relevant source area*

Key questions with respect to the spatial distribution of pollen, concern the size of the area which is represented by the pollen diagram and the location of the concerning vegetation types in relation to the pollen core. These questions are crucial for the discussion on the effect of prehistoric people on the environment, and the vegetation in particular.

The interpretation of the pollen record in terms of vegetation was, and still is, mostly intuitive because the origin of the pollen grains can only be guessed. Sugita *et al.* (1997) studied the palynologic results of forest fire and the modelling of such disturbances. Forest fires can be compared with clearances for fields and settlements made by Early Neolithic people. The palynologic effect of the disturbance was found to be depended on both the size of the catchment basin and the distance from the disturbance to the core location. The disturbance must be at least eight times the size of the catchment basin and must be located at or very near to the shore/edge. A 2500 hectare disturbance only a few hundred metres away from the catchment basin could not be detected, which is true for both the amount and the percentages of the pollen. A forest fire that took place in 1861, however, came to less than hundred metres from Lake Rainbow and in this case its effects on pollen precipitation and charcoal content of the sediment was very clear.

According to Davis (2000), the strength of the pollen signal is distance-weighted, with nearby trees much more strongly represented than trees at a distance. For a lake with a diameter of 100 m the signal of trees near the lake is much greater than that of trees only 200 m away, and considerably greater than that of trees 1000 m from the lake. Trees adjacent to the lake shed large amounts of pollen onto the basin. This quantity is roughly proportional to the ratio of perimeter to area and decreases when the lake radius increases. The precipitation from regional vegetation of the catchment basin remains constant per unit area because deposition from this source is nearly the same everywhere on the surface of the sedimentary basin. The consequence is also that the ratio of pollen precipitation from nearby vegetation to regional vegetation grows smaller and smaller as the basin increases in size. Lakes several kilometres in diameter are dominated by regional pollen.

Similar results have been published by Hicks (2001). From her modelling work it became clear that pollen-catchment basins with a diameter less than 200 m collect mostly local-pollen rain, in which the size of the opening in the canopy and the distance to the high trees plays the most significant role. Local pollen types are considered not to come further than maximally one hundred metres away from the sampling point. A catchment basin with a larger diameter than 200 metres traps more regional pollen.

Hicks' observations were done from pollen traps placed in the centre of basins. In northern Drenthe the catchment basin could only very seldom be cored in the centre, as sediment had disappeared after peat digging. Thus, a location had to be cored that could be any place where sediment had remained. This mostly was a place close to the edge.

Hicks emphasizes that a difference exists between a lake (with water) and a mire with organic marsh deposit. In a lake thorough mixing throughout the water body may happen and this will not happen, for example, in *Sphagnum* peat. On the other hand, flowering conifer species or willow and alder may cover the water surface with yellow dust and such a film of pollen can be blown in a corner, thus causing locally anomalously high percentages. It is also possible that peculiar differences occur which are not easily predicted. Hicks emphasizes that the problem of sampling another location than the centre of the catchment basin was initially not paid attention to. The vegetation of the area around the sampling point plays an important role.

In further communication Hicks confirms that small openings in the forest, whether by fire or other disturbance, can be followed palynologically only if closer than 50–100 metres. If further away, these changes go unnoticed in the pollen precipitation. This would explain the scarcity of indicative pollen types at the level of Funnel Beakers in the study by Bakker *et al.* (1999). The presence of indicative pollen types in deposits from large basins can be explained by assuming that background pollen coming from outside the relevant source area form a much larger component of the total pollen in large mires than in the small pingoscars. Moreover, this background pollen will give a composite picture of all the vegetation types in the region. If there were a considerable amount of farming, large mires would receive a fair share of primary anthropogenic pollen, whereas the local pollen would

Table 2. The size of the catchment basin and the distance of the core location to the edge of this catchment basin.

Site	Diameter	*Distance of core – edge*
Midlaren	70 m	15 m
Glimmer Es	110 m	55 m
Moespot	150 m	75 m
Boekweitenveen	210 m	105 m
Boekemaveen	70 m	20 m
Bongeveen	120 m	30 m
Stiefveen	430 m	180 m

still dominate the small mires. To prove this idea for past pollen records, small and large catchments have to be studied and very well dated (see also Bakker, 2003).

It is clear that the pingoscars in this paper are not only of small size, but the location of the coring often took place near the edge, thus enlarging the local effect (see table 2). When the distance is about half the diameter, it means that the coring took place in the centre of the catchment basin, otherwise the core location lies closer to the edge.

5. CONCLUSIONS AND DISCUSSION

5.1. Correlation of the pollendiagrams

The correlation of the six pollen diagrams was done on the basis of the radiocarbon dates, the sedimentation rate and significant changes of the pollen curves. Still differences in absolute dating may happen from site to site due to minor irregularities in the sedimentation (see also Bakker, 2003). The dating by radiocarbon and the obtaining of inferred dates by assumption of a constant sedimentation rate for short stretches are nevertheless the best options for correlation. The correlation by means of culture types is not so easy and reliable as one might think. The number of for instance the earliest *Plantago lanceolata* grains is very small. Such statistically insignificant data are not suitable to establish a model (Kalis & Meurers-Balke, 1998). Correlation on the basis of these early grains is not possible. It will be seen in the discussions of the diagrams what pollen-types offer a more reliable basis for correlation.

Pleistocene sandy soils that are exploited will get exhausted when no fertilizer is applied. Under a certain grazing regime heath-land may develop. On dry land *Calluna* vegetation may develop while on more moist soils another Ericaceae (*Erica tetralix*) prevails. These species, when forming dominant open vegetation, are a clear anthropogenic feature and their pollen could be used as an indicator of depletion by farming and grazing. Vegetation units not linked with human action, which carry such Ericaceae, are found in mires where they are connected with hydrology of the peat formation.

The Ericaceae curve includes several genera as well as the Empetraceae. In general, *Calluna* forms the bulk of this group, but the beginning of the advance of the Ericaceae in the pingoscars was sometimes formed by other genera such as *Oxycoccus palustris* and *Erica,* both most probably growing on the organic sediment which had filled the pingo scar at that time. All Ericaceae curves have more or less the same shape, but the time of appearance differs widely. The increase in Ericaceae is more related to peat formation in the pingoscar under Atlantic moisture conditions and not to anthropogenic heath-land formation. For correlation an Ericaceae curve is not reliable.

5.2. The habitation gradient in terms of pollen

It is assumed that the part of the area with many megaliths had a denser habitation than the lowlands to the west, where these grave monuments are absent. It is not clear whether this lower part was not in some manner utilized by the megalith builders or not, but no archaeological evidence was found. In this respect it is interesting to see, whether the pollen diagrams display the same gradient, especially where the anthropogenic-indicative pollen types are concerned. One would expect that certain uniformity in pollen assemblages appears where the indicative pollen is concerned. However, such a common behaviour is lacking. This must be inherent on the nature of these assemblages. The pollen percentages of the indicative types are very low during and before the early TRB time and they are often absent. Although the percentages do not change when larger numbers of pollen are counted, does the chance of meeting a rare type increase. To test the value of the pollen diagrams with respect to the habitation gradient, four types are displayed in the time stretch of 6500–4000 BP (fig. 11). For three types, *Plantago lanceolata, Artemisia vulgaris*-type and Cerealia-type, the first appearances were listed. For the fourth type, the Ericaceae, the first clear expansion is recorded.

The results are not encouraging. The earliest occurrence of pollen of *Plantago lanceolata* and Cerealia-type is not found in the diagram of the little peatbog of Midlaren. This is remarkable because

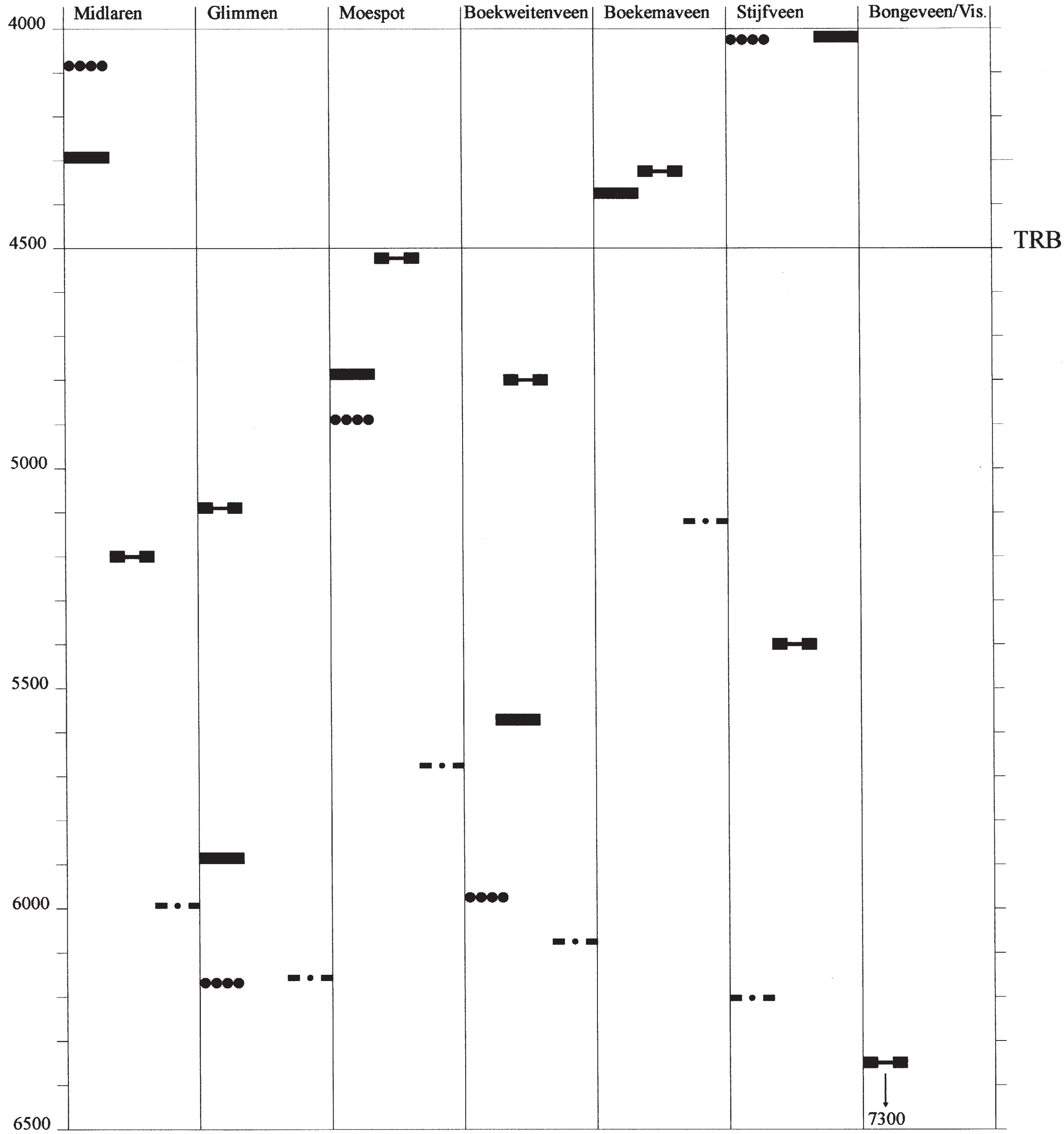

Fig. 11. First appearance or clear increase of pollen of Cerealia, *Plantago lanceolata*, *Artemisia* and Ericaceae in the pollen diagrams. Legend: ••• Cerealia, ▬ *Plantago lanceolata*, ▬▬ *Artemisia*, ▬ • ▬ Ericaceae.

archaeological activities are present there in the form of the megalith graves and not near the other peat-bogs. Moreover, these anthropogenic pollen types are found millennia earlier in Glimmen than in Midlaren (fig. 11). When one expected the sites in the lowlands to show a retarded development because they lack Neolithic finds, Boekweitenveen demonstrates early *Plantago lanceolata* and Cerealia-type which are only found a few millennia later in the neighbouring core of *Stiefveen*. The only remarkable fact is the grouping of both types which suggests that one could question the dating. However, the grouping does not correlate with the behaviour of birch en alder pollen. To ascribe early finds of culture indicators to activities of the Swifterbant people is not supported by archaeological evidence. *Artemisia vulgaris* pollen is mostly present during the whole period of 6500–4000 BP and this type is often present before 6500 BP. In some way or another there must have been small disturbances somewhere in the area, but these are not related to a habitation gradient as suggested by the archaeological evidence.

The fourth type, the Ericaceae includes *Calluna vulgaris,* the heather which is greatly supported by human activity. In general, the Ericaceae pollen in the pollen diagrams of northern Drenthe is formed by *Calluna*, but sometimes *Erica, Oxycoccus palustris,* or even *Empetrum nigrum* (Empetraceae) dominated the spectra. The first important increase of Ericaceae pollen in the area took place at very different moments, even at distances of a few hundred metres. In time the increase in Ericaceae differs up to 3000 years. Such increases could not be connected with farming activity. Part of the evidence shows a gradient. The two sites on the ridge show earlier increase than the following Moespot, Boekweitenveen and Boekemaveen. The Ericaceae of the Stiefveen increase about 5400 BP. This earlier increase could be explained by the Stiefveen being a large bog and not a small pingoscar.

Finally the earliest increase in Ericaceae pollen in the Bongeveen pingoscar took place around 7300 BP. In this dune landscape, dry and poor situations occurred naturally and when Atlantic conditions arrived, heather started to grow there.

The conclusion is that the anthropogenic pollen assemblage does not correlate with the archaeological results and with the absolute dates. It is not impossible that the relevant plant species were a rare part of the natural vegetation or a consequence of the Mesolithic way of life. The fact that the special pollen types differed in time of appearance, while the core locations were quite close to each other, may depend upon the size of the catchment basin.

5.3. The variation in Atlantic vegetation in northern Drenthe

Next to focussing upon the plant succession of every site in northern Drenthe, the vegetation of the area at a certain fixed period preceding the TRB culture is paid attention to. The pollen composition at 5100 BP was selected for every site. The time of 5100 BP was chosen because it is assumed that at that time no farming impact upon the vegetation of northern Drenthe existed. Apart from the six pollen sites, which produced the information for this study, evidence from Bongeveen is used. The pingoscar Bongeveen (fig. 1) is situated at the southern point of a former drift-sand area, at present Airport Groningen, which area was not suitable for farming.

To illustrate, among others, whether there is any relation between the pollen precipitation and the hydrological characteristics, the contemporaneous pollen precipitation (5100 BP) is drawn along a transect through the field against decreasing elevation (fig. 12). The order is elevation in metres to begin with the Midlaren site on the top of the Pleistocene ridge at 9 m above sea level. The elevation used is that of the land around the pingoscar from which the pollen core has been taken. The following sites are presented: Midlaren (9 m), Moespot (7 m), Glimmer Es (5 m), Boekemaveen (5 m), Boekweitenveen (3.5 m), Stiefveen (3.5 m) and Bongeveen (3.5 m).

Birch (*Betula*) pollen values correlate positively with elevation. They clearly dominated on the high Pleistocene ridge (the Hondsrug) whereas the lowest percentages were found in the area around Stiefveen and Bongeveen. Hazel (*Corylus*) and alder (*Alnus*) show the reverse. They were more common in the lowest part of the study area than in the highest part. This is clear where alder is concerned as it demands moisture, but for hazel it is not easily explained. One could easily accept a dry sunny growth place for hazel because of its role during Boreal times. It is altogether illustrative that hazel expands during the Boreal already strongest in the lower part of the study area.

The oak-pollen percentages do not seem to be influenced by elevation as the percentages remain more or less the same. Elm (*Ulmus*) and lime (*Tilia*), being more demanding genera, do not show any differences in relation with elevation. The trees may have been evenly spread over the area. An abrupt fall or a gradual decrease of elm pollen is not found.

5.4. The Atlantic/Subboreal environment in northern Drenthe in relation to farming

5.4.1. *The impact of animals on the vegetation*

During the Atlantic, northern Drenthe was covered by forest and it is of interest to judge upon the impact of animals on the vegetation. Most probably, such animals were allowed to feed themselves in the available vegetation, mainly forest, edges of small bogs and some stubble fields and fallow land. For a detailed discussion on the potential keeping of cattle, indoors as well as outdoors, in prehistory, see Zimmermann (1999a;1999b).

It is difficult to form an opinion on grazing in forest, as nowadays cattle graze mostly in man-made meadows. For that reason it is very informing to follow the effect of forest grazing, as it is in use by present day nature conservancy organizations. An important argument is that an assemblage of such animals, each

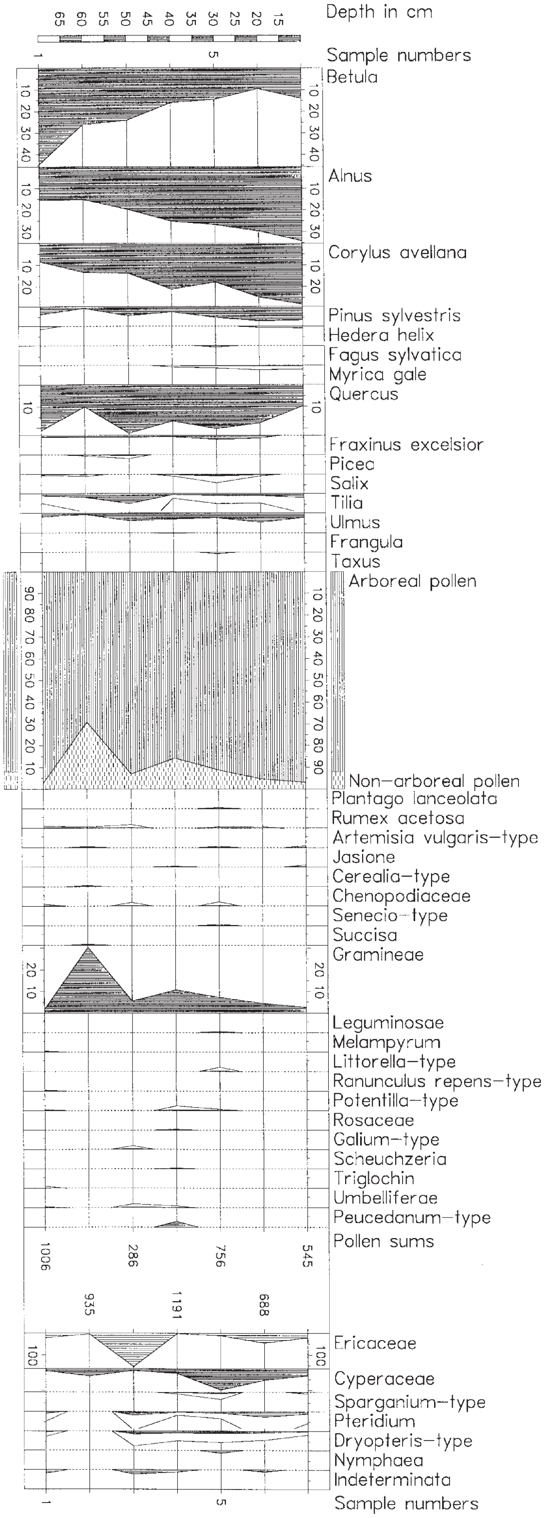

Fig. 12. The spectra of 5100 BP from the diagrams of Midlaren, Glimmer Es, Moespot, Boekweitenveen, Boekemaveen and Stiefveen. Row order according to the ordnance.

with a specific preference for part of the vegetation, can prevent landscapes from turning into dense forests (Dirkx, 1997; Meurs, 1989; Oonc, 1993; Van der Bilt, 1982, 1987; Wallis de Vries, 1989). It also turned out that different vegetation especially develops from herding, instead of leaving the animals inside the area grazing on their own. When herded, the herdsman controls the vegetation. When free roaming, the animals select the vegetation.

The original vegetation, the number of cattle, the time of grazing (year-round or seasonal) was studied in many cases to obtain an idea of the effect of this system. In general, primitive and/or old-fashioned breeds were used for this management. However, no proof was available that primitive breeds were identical to prehistoric breeds. Still one can obtain a reasonable idea on the possibilities of forest grazing from the knowledge gathered by the nature conservancy.

Without additional fodder and without applying fertilizer, during the past few centuries farmers in Western Europe needed about three hectares (six acres) of pasture to keep a cow in production. If cattle were kept outside all seasons in woodland mixed with herbs and shrub, about ten hectares per head were needed. In time this would have made forest disappear. According to Van der Bilt (director of 'Het Drentse Landschap' (Drenthe Organization of Nature Conservancy), a key number for the slow disappearance of forest is one cow in seven hectares of forest. The grazing animal will not eat trees but forest rejuvenation is prevented. Young birches will not all be killed but will be kept under 60 cm and will not produce flowers and seeds. If there are sheep around, birches will even be more reduced. In certain density sheep and goats are even more lethal to forestry than cattle. To compare such situations with wild grazing animals, it should be noted that the latter eat less than 1% of the annual botanical production where farm animals have to take at least 18% to maintain grassland.

Although we can be sure that people of the Swifterbant and TRB culture kept cattle and goats, as has been demonstrated by Raemaekers (1999), it is not known how many farm animals were kept by people of the Swifterbant and TRB culture. It is assumed that the number of cattle in a TRB settlement will not have been high, otherwise the effect on the forest vegetation would have been greater. Opening up the forest will have been local, but it is not clear where the cattle was brought to feed. It is very well possible that a tree like elm suffered not so much from cutting, but rejuvenation would be made impossible. It is striking to see that cattle collects all elm leaves which are shed during the fall onto the grass even when the nutritive value of fallen leaves has lowered compared with elm leaves on a tree.

It certainly is a fact that cattle and smaller ruminants like leaves of several tree species. Since Troels-Smith launched the idea of leaf foddering this method is widely embraced by archaeologists. Still, this method is very much in contradiction with Iversen's reconstruction of the Late Atlantic forest. The trees would have grown slender long stems without side branches and their foliage would be only in the high canopy (Bottema, 1998). Because of the strong light competition in the forest, the foliage per tree was far from optimal and it is very much the question if any farmer would take the trouble to climb the straight tree with a stone tool to gather a few branches. Branches with buds were hardly eaten by cattle of the first author. Loose (cut) branches collected from lime trees during the winter offered problems for the animals, because they have no teeth in the upper mandible. They can very well eat from branches growing on a tree with their lower teeth in combination with their tongue. Cut from a tree such branches have to be made in short pieces to be eaten.

Only when the forest had been artificially opened up and trees started to form side branches lower to the ground, man will have started to exploit the edible leaves. This developed into forms of pollarding, lopping or *Schneitelwald*. When arriving in an untouched forest area, it is more likely that farmers brought their animals to natural open place such as stream valleys, edges of pingoscars or other bogs. It is striking to see for instance Swedish Fjäll cattle, a hornless breed, feed with their body half way in the water and even swim to edible matter.

The pollen diagrams do not show any sign of leaf foddering. For the western part of the study area, this could be proof of the supposition that no farmers settled there, but for the eastern part the megalithic graves are an indication that that part was inhabited. Still the pollen of those deciduous trees that are brought forward as fodder-producers does not show changes around the crucial period.

In modern nature management, grazing has been considered a tool to increase plant species diversity. Among other things, this has been observed if domestic grazers are introduced in forest or heath land. In this study an increase in species diversity is concluded from the growing number of pollen types, for instance when the time slice 5100 BP, representing undisturbed vegetation, is compared with that of 4500 BP, the time of the first farmers in northern Drenthe. The increase in palynologic diversity is demonstrated in table 3.

Table 3. Number of pollen types (AP = arboreal pollen; NAP = non-arboreal pollen; LOC = local pollen including aquatics and spores) and pollen sums for the spectra of 5100 and 4500 BP in seven locations in northern Drenthe.

Site	AP	NAP	*LOC*	∑
Midlaren (5100 BP)	10	7	4	1004
Midlaren (4500 BP)	10	7	6	1116
Glimmer Es (5100 BP)	9	5	4	286
Glimmer Es (4500 BP)	12	8	5	978
Moespot (5100 BP)	10	5	4	1080
Moespot (4500 BP)	12	9	6	753
Boekweitenveen (5100 BP)	12	7	7	937
Boekweitenveen (4500 BP)	13	13	5	927
Boekemaveen (5100 BP)	10	11	4	1693
Boekemaveen (4500 BP)	10	9	5	1376
Stiefveen (5100 BP)	10	1	4	684
Stiefveen (4500 BP)	10	6	4	739

5.4.2. *The presence of some characteristic trees and herbs*

In pollen diagrams there is often at the level of Early Neolithic farming a decrease in birch pollen which can be explained by human exploitation of the trees, amongst others for fuel, because it is easy to cut. Furthermore, tar is made from birch wood for several purposes. One may also postulate that the soil, that carries birches, is the lightest soil that may be dry and very well drained. In case slash and burn is applied, birch is burned away more easily than the other deciduous species. This soil could have been selected first for agriculture. As a pioneer birch will come back on clearings and abandoned fields and this seems to have been the situation in Iversen's *landnam* in the Baltic area. Birch can only regenerate when there are no farm animals running around to graze the birches away.

In connection with the taste for certain trees, there is dislike for others. Alder replaces the birch-pollen percentages that decrease around TRB time on the Pleistocene soils of Drenthe. The most logic conclusion is that this tree takes over the place of the birches in the vegetation. In nature reserves where open ground, for instance arable or meadows, is obtained and grazing with cattle is applied, one observes that at least two species increase very much. Under the grazing regime, the landscape becomes dominated by soft rush (*Juncus effusus*) and alder (*Alnus glutinosa*) appears. Only in a very young stage cattle eat the soft rushes and alder is avoided completely, whereas competitive birches and willows are eaten away. The germination of alder is very peculiar and takes place mainly after a strong disturbance, generally large erosion or other mechanical change of the surroundings. The germination takes place only in one occasion. The next season the impulse is not operating any more. A relation with soil-transport disturbance/movement and hydrology seems obvious. A disturbance of the soil, such as ploughing or slash and burn followed by abandonment, may be the impulse for germination of alder.

The early, scarce appearance of pollen of plantain (*Plantago lanceolata*) in northern Drenthe is difficult to explain. Behre (1981), Behre & Kuçan (1994) even leave the possibility open that this plant occurred in very low numbers in the natural Atlantic vegetation. In this respect the study by Cappers & Bottema (2003) on the environment of the Middle Pleistocene mammoths of Orvelte is intriguing. Of 60 plant species of 45.000 years ago, identified by Cappers from seeds, 58 are present at the moment. These species could never be identified from pollen, because there the level of identification would stop at genera or even family and where arctic conditions would more or less be a matter of expectation. The main difference of the glacial with modern times was the absence of trees! Such evidence would plead for a scarce occurrence of plantain during the Atlantic.

Plantain would have profited from forest renewal where light in the scale 5–7 was present (Ellenberg *et al*., 1991). A plant considered as a perennial weed, which demands even more light than plantain, is wormwood (*Artemisia vulgaris*). In northern Drenthe in theory two *Artemisia* species could be found in the pollen record of the Atlantic and Subboreal. In the first place *Artemisia vulgaris,* that still occurs in the area, and in the second place *Artemisia maritima*, which pollen blew in from the coastal marine meadows.

Low percentages of *Artemisia* are present throughout the Atlantic pollen record of northern Drenthe and one wonders whether this is a natural occurrence of these plants or that it is somehow related to human activity. The pollen morphology points to *Artemisia vulgaris* although it is not possible to separate *Artemisia vulgaris* and *Artemisia maritima* completely. Wormwood species need a large amount of light and many of these species are steppe plants, where according to Iglesias (1998) their pollen production leads to over-representation.

A surface sample study in northern Drenthe supplied the following information. In northern Drenthe wormwood does not seem to be over-represented. Ninety wormwood plants, developed after ten years of protection on the farmyard of the first author, never had more than 0.6%. *Artemisia* increased in the vegetation and absolute numbers in the pollen traps increased to 169 pollen grain y/cm^2. Puzzling is however the result of the season of 2002, when all the plants were removed and still a deposition of 268 grains per y/cm^2 was found. *Artemisia* may be an indicator of (abandoned) settlements more than a field weed. Animals do not eat *Artemisia*; it is easily weeded out and destroyed. It seems to indicate disturbance and may even be the result of abandoned campsites of hunter/gatherers. It is a slow starter that cannot stand treading, a reason to think of its appearance in abandoned sites.

5.4.3. *Evidence of farming*

The Neolithic period in northern Drenthe as it is defined by radiocarbon dating has not produced a uniform pollen assemblage, even when the studied sites are found so close to each other. Reasonable pollen percentages of anthropogenic indicators show up in an advanced stage of farming, suggesting that later stages of the Neolithic caused this appearance. This was partly demonstrated by the radiocarbon dates, but also by Waterbolk's pollen diagram of the wooden trackway of Buinen, where the Funnel-Beaker trackway was only followed by indicative pollen after several centuries. Exact times of appearance of indicative pollen are not yet defined.

The preparation of fields in primeval forest is suggested to have happened by slash and burn (Iversen, 1973). The example of marginal agriculture in Boreal forest of the Karelians was based on slash and burn but for the Early Neolithic phase this has to be proved.

In a meeting on experimental archaeology in Paris (March 1982) the first author was informed by Prof. Axel Steensberg about the classical experiments in Draved Skov. Steensberg formed part of the research team with Iversen and Troels-Smith. The research team had finally successfully felled the lime trees with stone tools, but the burning of the deciduous trees formed a problem. Prof. K. Vilkuna from Helsinki was asked for help, as he was an expert in swidden cultivation, but without any result. Finally, the army was asked that came with flame-throwers and cleared the wood away. The time of firing the wood may be crucial, not only with respect to dryness but also in connection with the sowing period, either winter or summer crops. There is quite some variation in Karelian swidden cultivation, as appears from the compilation by Lasse Lovén (Swidden heritage alive and well in Koli).

Although the deciduous Atlantic forest may have formed a problem for the Danes to burn lime forest in Draved in Jutland, Early Neolithic man may not have had any problem. Steensberg reported from his work in New Guinea that Papua women could burn forest even during the rain monsoon.

Charcoal in the sediments of northern Drenthe indicates some form of fire, but the kind of fire is quite unclear and has many possible origins (Goudsblom, 1992). Charcoal appeared in four-year-old mosses (*Eurhynchium praelongum*) without any clear sign of fire in the farmyard of the first author. The origin remained unclear whether the charcoal splashed in from the underlying soil or came from the air from burning stoves. In earlier times it may have been caused by slash and burn, but it may also be related to domestic fire, for instance plain cooking or fire by lightning. There is a correlation with archaeological evidence because the charcoal is especially found in the record of Midlaren and Glimmen starting at 4000–4800 BP. In the little bog of Boekema, charcoal appears at about 4600 BP but soon stops. The larger Boekweitenveen lacks charcoal, but in the nearby Stiefveen charcoal is found from about 4300 onward. The Moespot has some charcoal at a depth dated around 5200 BP.

6. ACKNOWLEDGEMENTS

The authors are much indebted to Mr. P.H. Wieland for his practical support with the fieldwork as well as obtaining permission to core the pingoscars. The State Forestry Service kindly gave permission to core the Stiefveen. The first author is very grateful to Dr. S. Hicks (Oulu) for help with the interpretation of the pollen evidence. Information on the local TRB culture was given by Drs. J.N. Lanting and Drs. O.H. Harsema. We are grateful to G. Entjes-Nieborg, who assisted in the production of the pollen diagrams.

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