PEAT UNDER A TABLE-SHAPED DRIFT SAND MOUND IN THE NORTHERN VELUWE (HULSHORST)

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SUMMARY

A study was made of a deposit under a table-shaped drift sand mound. The bog, on a firm B-layer (hardpan), started at the end of the Subboreal period. It was preceded by a fire and stopped by a fire in the Middle Ages, when rye was in cultivation and *Centaurea cyanus* occurred as a weed. The role of hardpan in depressions of the undulating landscape is discussed, together with the effects of tillage, burning and sodding as factors leading to the shifting of cover sand and the creation of inland dunes.

1. INTRODUCTION

The Veluwe is an undulating plain, mainly consisting of cover sand, and enclosed by ice-pushed ridges *(fig. 1)*. During the Würm Glaciation and especially in the Late-Glacial, heavy layers of cover sand were deposited which wind and snowstorms had blown off from barren stretches of soil. Organic deposits of this period (peat and gyttja) are found sporadically; they all contain considerable amounts of drift sand.

The sands did not stop shifting in the Post-Glacial, but forest growth prevented mass transport; the vegetation on poor cover sand never grew so dense as to prevent fine sands from being borne away and holocene peat and gyttja in this area therefore contain small amounts of fine drift sand (VAN ZINDEREN BAKKER 1948; POLAK 1959). The sand content increases considerably in the younger sections, especially in the Sub-Atlantic up to recent historic times.

In the Neolithic period, the Veluwe was fairly densely inhabited by cattle breeding and farming peoples (POLAK 1959; MODDERMAN 1964). They cut down and burnt the virgin forests to make fields for their crops and pastures for their animals (IVERSEN 1949; WATERBOLK 1956). Shifting cultivation and cattle grazing pushed the forest back still farther and favoured the first expansion of heathland which spread with increasing occupation, as can be seen from the diagrams (POLAK 1959). The greatest expansion was after the introduction of rye, especially after the cultivation of buckwheat in the Middle Ages, a process that continued well into the 19th century.

2. INLAND DUNES

After the forest had been cleared the first farmers loosened the sandy subsoil in order to till the land and enclosed their fields within low walls of sand (Celtic fields, WATERBOLK 1951). This created favourable conditions for the wind to

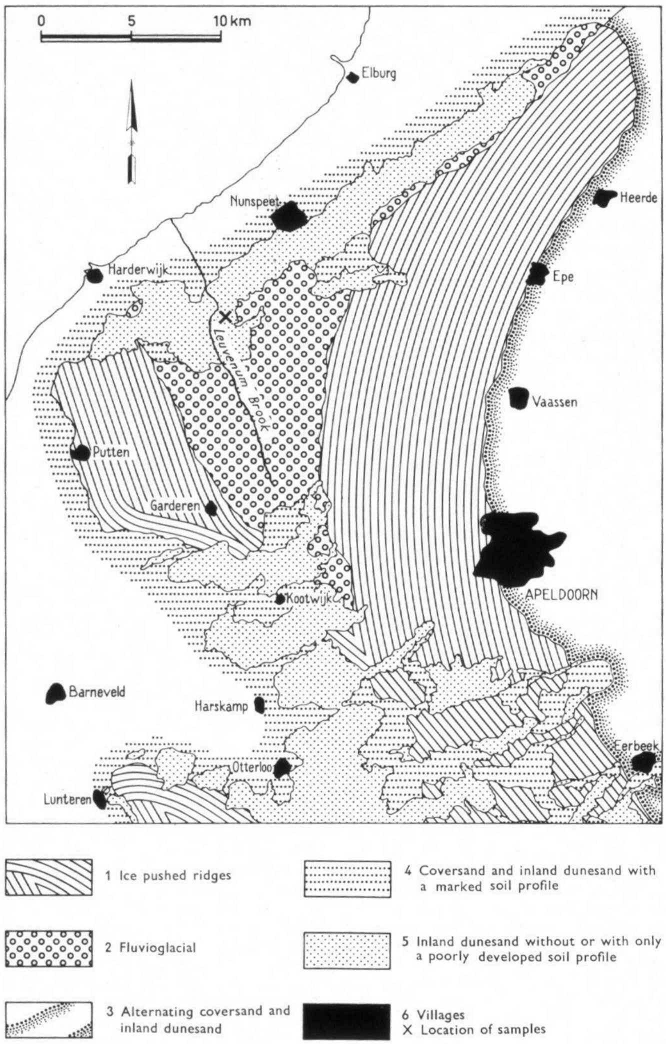


Fig. 1. Map of the northern Veluwe (after Maarleveld).

transport the sand and deposit in the oldest post-glacial sand dunes. As *fig. 1* shows, the inland dunes are situated in the cover sand area, which is the driest and most infertile part of the region.

STOUTJESDIJK (1959) states that after the original oak forest had been cleared, the higher cover sands of the Veluwe gradually became overgrown with heath, producing a highly developed podsol stratification with a thick hardpan. The landscape must have been slightly undulating, with a more marked relief in parts. Owing to the impermeable hardpan, pools and bogs were formed in depressions.

The expanding heathfields provide a good protection for the soil where the cover was not attacked by man who damaged the heath by peat-cutting and burning.

Before the introduction of artificial fertilizers, a great deal of litter was transferred to the old arable land. Heath soils were reclaimed in this area and manured with heather-sod litter. The use of large quantities of heather-sod litter resulted in "desodded" soils beside the cultivated area (DOMHOF 1951). A considerable portion of humous topsoil was removed with the sods, the moisture retentivity impaired and the danger of wind erosion greatly increased. According to DOMHOF (1951) approximately 10 cows need an annual 2000–4000 sq. m. of heath soil for litter, which means a severe attack on the protecting vegetation, especially as this practice goes back 1000–2000 years.

FASTABEND & VON RAUPACH (1962), give ^{14}C datings of fossil sods taken from the deepest layers of old cultivated fields. In three samples they found 1250 $\pm$ 85 years, 1275 $\pm$ 85 years and 2480 $\pm$ 120 years from 1950. SCHNEEKLOTH & WENDT (1962) dated the beginning of sod-cutting from 525 B.C. -700 A.D.

Sod-cutting for the production of litter and manure obviously coincides with the beginning of rye cultivation.

Burning is an even older procedure. Deliberate burning, and especially accidental fires result in the destruction of the vegetation and scorching of the raw humus, after which the vitality of regenerating heath is low, particularly if the humus layer is all but completely destroyed.

If an undulating landscape is stripped of vegetation for any reason, it becomes subject to wind erosion and the sand may be blown out on to the hardpan, resulting in sand dunes and depressions in which water stagnates on the impenetrable subsoil. If the hardpan is pierced the water oozes away. Many of these small, shallow sheets of water lay scattered over the Veluwe, on the Drente plain and in other heathland areas of the Netherlands. SCHIMMEL & TER HOEVE (1952) described the structure and origin of such a pool (Gerritsfles). A moorland vegetation may develop in a shallow, humid depression not covered by water, and in course of time it may change into a small sphagnum bog.

These moist vegetations are ideal for catching blown sands; the bog or moor becomes covered and a sand dune rises on the former depression. This results in an inversion of the relief, the former elevations are eroded and blown away, and the sand is retained by the depressions (SCHELLING 1955, fig. 2).

Peat covered by drift sand occurs in several places on the Veluwe (VAN ZINDEREN BAKKER 1948; SCHELLING 1955; HAVINGA 1962) as well as on the Drente plain (BROUWER 1947; DE ROO 1952; WATERBOLK 1951). De Roo even mentions a farmstead built on a sand dune underlain by peat.

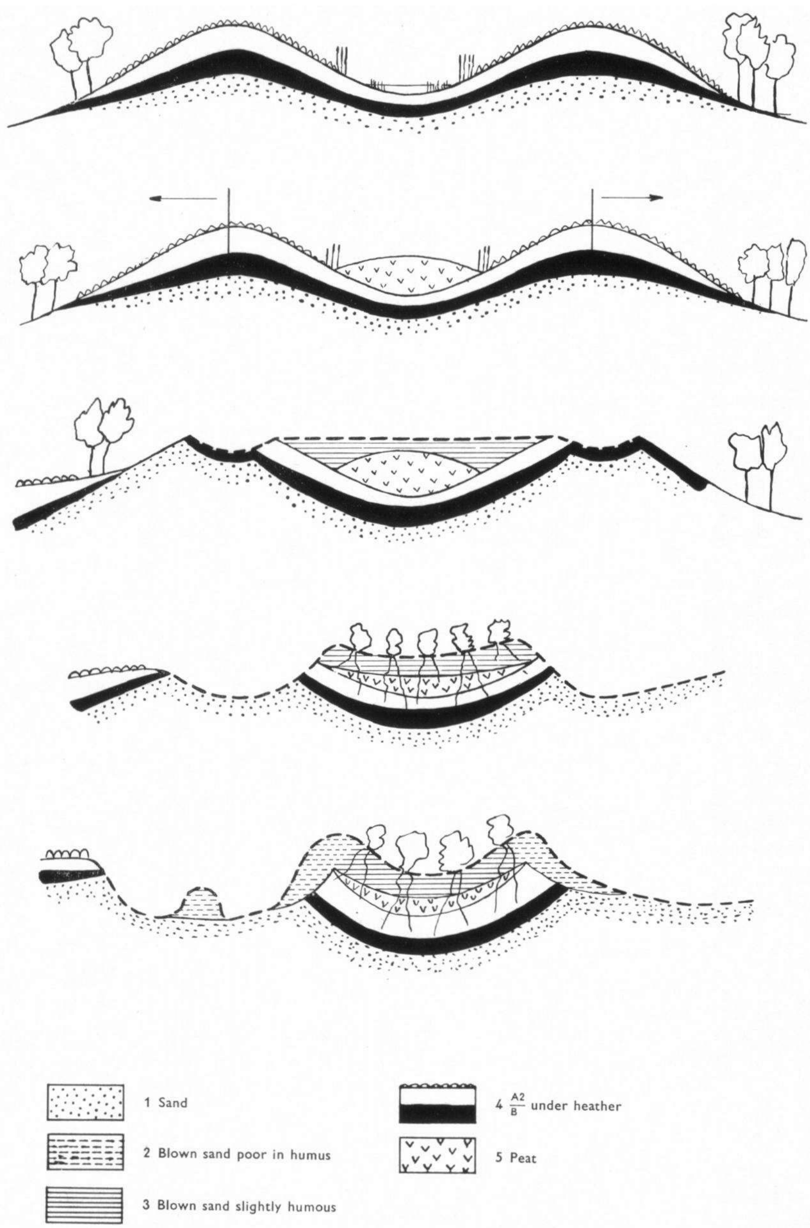


Fig. 2. Development of a table-shaped drift sand mound known as "Fort" (modified after Schelling 1955).

3. PEAT UNDER TABLE-SHAPED DRIFTSAND MOUNDS KNOWN AS "FORTS"

In the northern Veluwe, a driftsand region occurs of table shaped, fairly steep dunes *(fig. 1* and *3)*. Nowadays they are planted with Scots pine, and an oak or pinetree sometimes grows on the top. The present author investigated the underlaying peat. However, after examining several of those mounds, only one with a peat layer in the subsoil was found (first detected by Firet); the others only rested on hardpan. The structure of those mounds is represented in *fig. 2* and *3* and was described by SCHELLING (1955). Shallow pools on podsolised depressions, or even a plate of hardpan grown with a boggy vegetation, are obviously just as suitable for catching drift sand as small peat bogs.

At the centre of the mound investigated, a layer of approximately 3 m of drift sand rests on a heavily compressed peatbody of approximatily 60 cm, underlain by a firm hardpan.

With a view to sampling the peat, a hole was dug at the top of the hill, but far above the ground water level, water oozed out of the sand on all sides and filled the cavity. After the peat and underlaying hardpan had been pierced, the water flowed away and samples could be taken from the peat wall.

Dark bands could be observed in the peat with the naked eye; under the microscope they were seen to contain a multitude of fine charcoal particles. As the peat deposit started on such a charcoal layer, peat formation was obviously assisted by fires that scorched the vegetation and formed a crust.

Generally speaking, very little attention has been paid to the destructive

Photograph of a "Fort". (Stiboka Nr. R7–31)

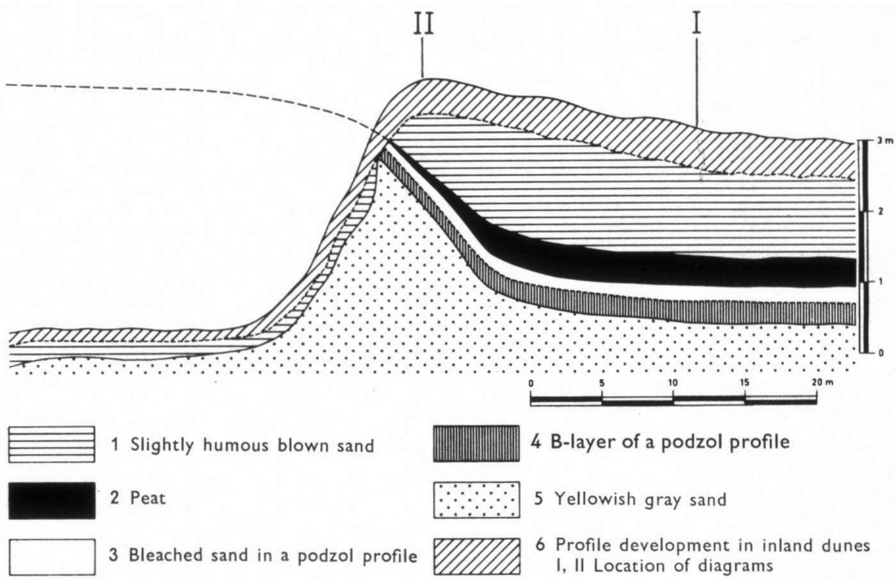


Fig. 3. Crossection of a "Fort" near Hulshorst (After Schelling 1955).

part played by accidental fires that destroy the heath cover and char the underlying humus deposit. STOUTJESDIJK (1959) however, devoted a chapter to this problem, from which most of the above mentioned accounts are derived.

Most authors describing blown-over peat or inland dunes make no reference to charcoal or charred layers (BROUWER 1947; VAN ZINDEREN BAKKER 1948; WATERBOLK 1951; DE ROO 1952; SCHELLING 1955). Further investigation will show whether these layers were overlooked or were absent. But it is a generally assumed belief that in heath areas, sheets of water might originate from burning. Even the Uddelermeer, though definitely of Pleistocene origin (POLAK 1959), is said to have been created by an accidental fire caused by a shepherd in 1222 (HARTMAN 1889).

IVERSEN (1964) depicts a change in the development of a Jutland forest as a result of burning. A distinct layer of charcoal was observed in the raw humus deposit. The pollen diagram of the humus deposit shows a change of the vegetation after the fire; the forest is replaced by a *Calluna* heath. In some places a thin layer of *Sphagnum* peat first develops, followed by *Calluna*.

HAVINGA (1962) studied a podsol overlain by 6–7 cm of drift sand. The drift sand is separated from the A horizon by a very thin layer of microscopic charcoal particles. Further on, a peat layer is intercalated between the charcoal and the drift sand.

4. COMPOSITION OF THE PEAT DEPOSIT

Sequence I (Diagram I)

It was mentioned above that the peat under the drift sand mound is situated on a charred layer of about 5 cm. In the scorched substance (mostly *Calluna*), pollen grains are rare and badly damaged, crumpled or corroded. Abundant fungal hyphae and spores are found.

The content of charcoal gradually decreases; at 5 cm from the bottom of the deposit the pollen grains are still in a poor state, many being filled with fungal spores. Plant remains consist of rootlets and epiderms of *Cyperaceae*, *Hypnaceae*, (including *Aulacomnium palustre)*, and some small-leaved *Sphagna*. This is overlain by a *Callunetum*, mixed with rootlets and epiderms of *Cyperaceae* and small-leaved *Sphagna*, including *Sphagnum cuspidatum*. In an upward direction charcoal decreases and fungal hyphae stay fairly abundant. *Cyperaceae* again dominate together with *Sphagnum cuspidatum*. In the next layer *Cyperaceae* decrease and the main constituents are *Polytrichum* (stalks and leaves), *Sphagnum cuspidatum* and *Aulacomnium palustre*. In the middle of the deposit charcoal disappears, but fungi are still abundant. Small-leaved *Sphagna* and *Polytrichum* dominate and the Rhizopods *Amphitrema flavum* and *Assulina* become fairly frequent. At a depth of 21–26 cm a *Scheuchzerietum* occurs, succeeded by a *Sphagnetum cuspidati*, which merges into a broad-leaved *Sphagnetum* in which upward *Eriophorum vaginatum* increases.

At a depth of 6 cm another charcoal layer occurs, which again damaged pollen grains. The fire that caused it put an end to peat growth and started the sand dunes.

However broad-leaved *Sphagna* are the main components of the upper layers, no *Sphagnum imbricatum* or *papillosum* is found.

During its development, the bog must have had a high water level, as appears from the considerable amounts of *Botryococcus* and the occurrence of many wet bog plants. The *Erica tetralix* values also point in this direction.

Sequence II (Diagram II), taken at the edge, is more disturbed than the peat at the centre (diagram I). All the samples are contaminated with drift sand and charcoal, and the upper and underlying material is especially badly damaged. The plant succession is more or less the same as in the centre, except that the broad-leaved *Sphagnetum* is not developed. Apparently at least three fires scorched the edge. The second one stopped the growth of the *Eriophoretum* but did not reach the centre. At the edge the broad-leaved *Sphagna* are replaced by a more or less scorched *Callunetum*. The last fire covered the entire bog and preceded the blowing over of drift sand.

5. THE DIAGRAMS

According to WATERBOLK & VAN ANDEL (1951) podsolisation starts in the late Subboreal together with the expansion of heather. It can be seen from our

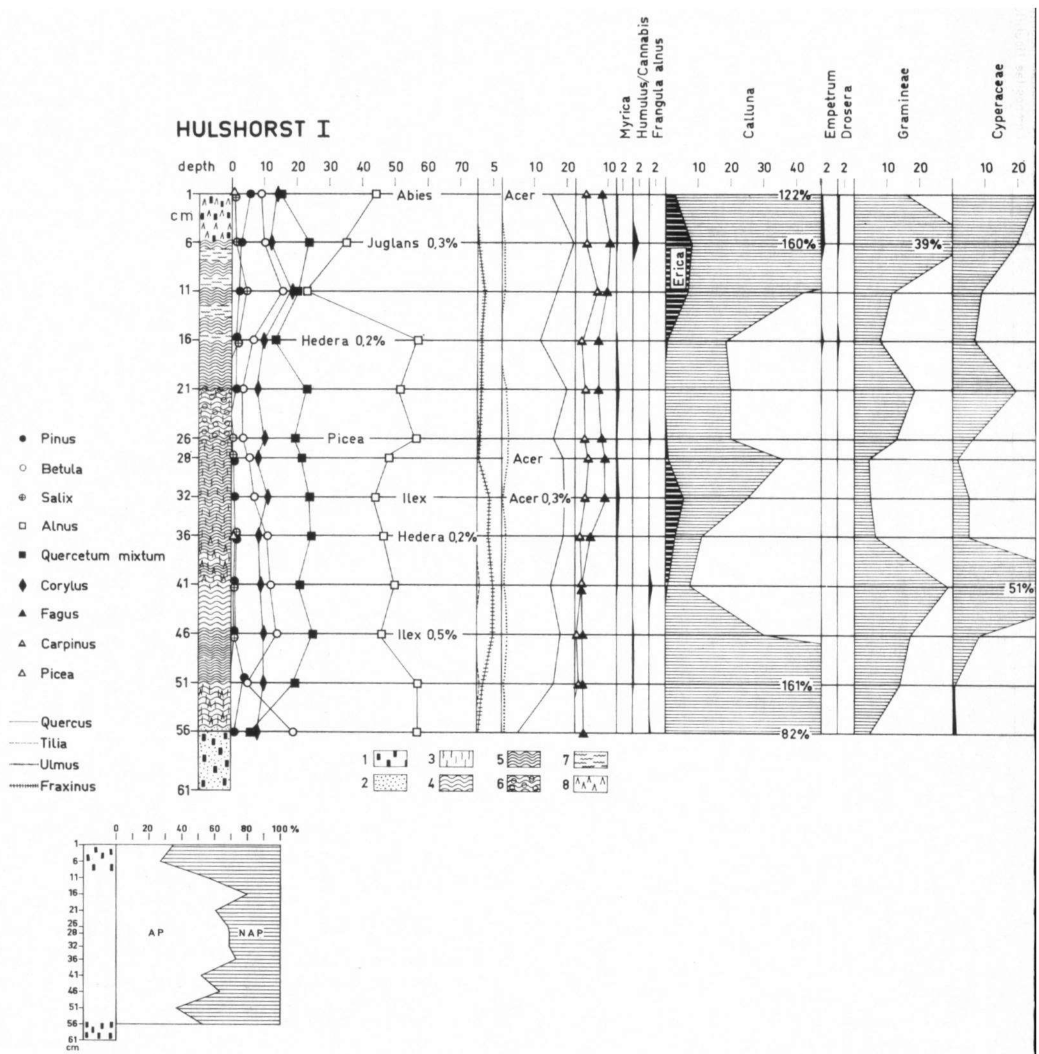
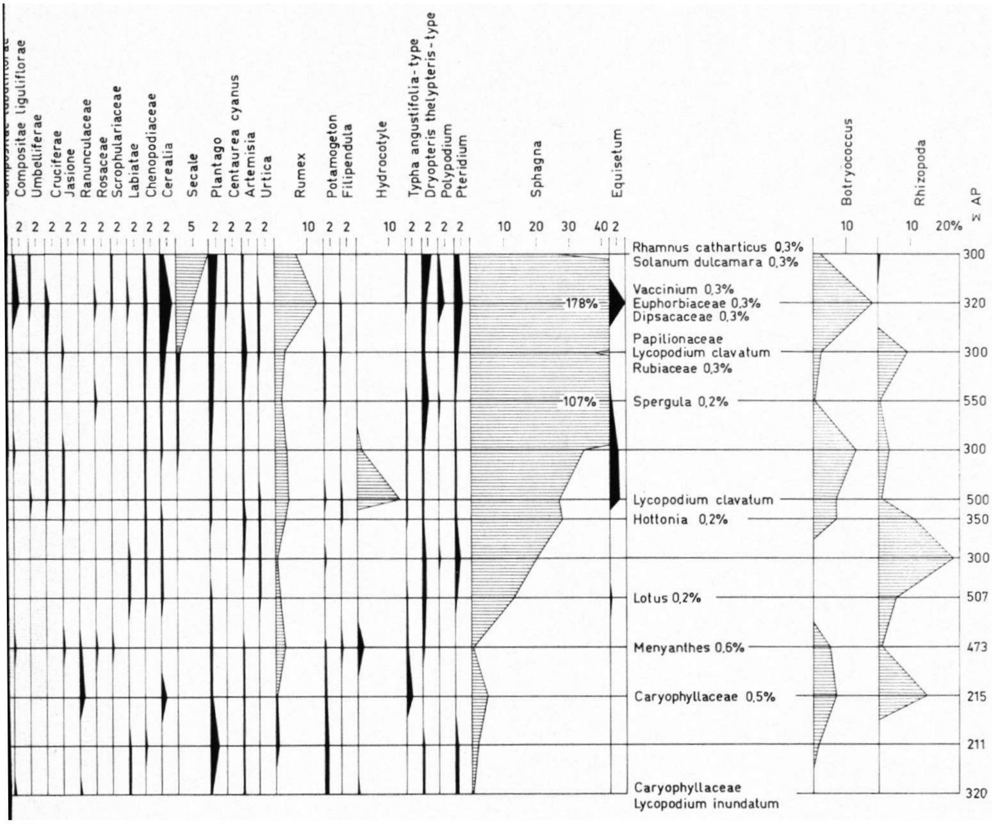


Diagram I and II

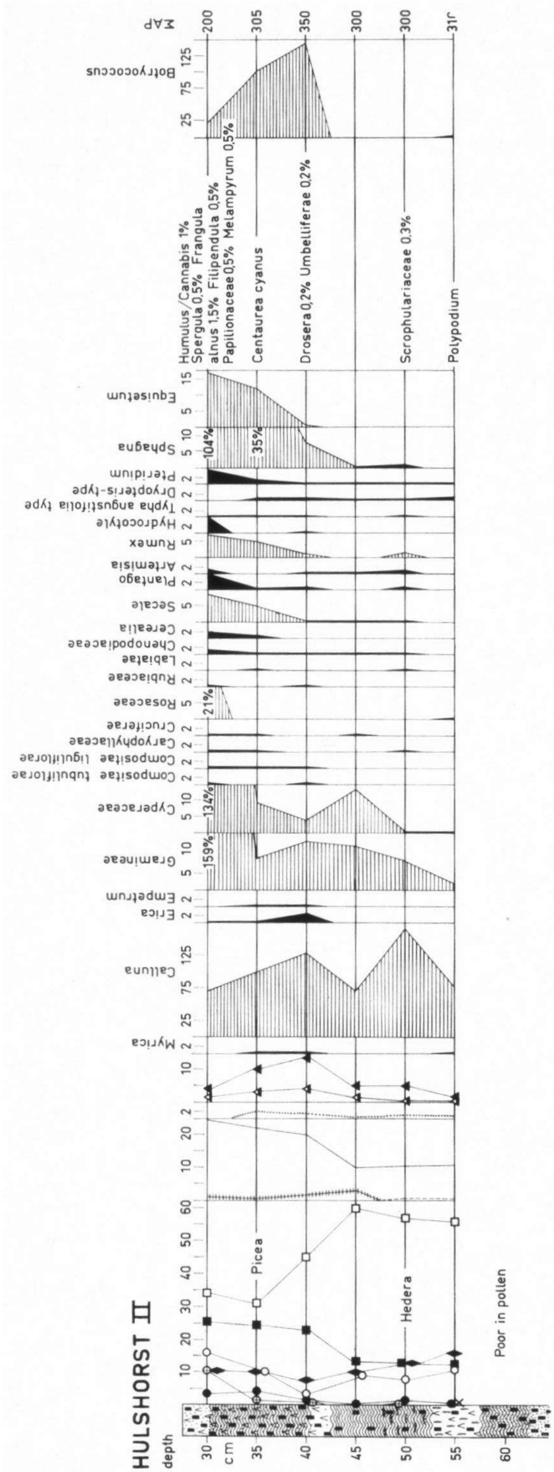
1 Charcoal 2 Sand 3 *Hypnaceae* 4 *Sphagnum* 5 *Calluna* 6 *Scheuchzeria* 7 *Eriophorum* 8 *Cyperaceae*



diagrams that a heath field has been burnt (cf. the high values for *Calluna* at the bottom and the scorched branches of heath in the peat).

Peat formation starts at the transition of the Subboreal-Subatlantic, with low values for *Fagus* and *Carpinus*. In the middle of the deposit both *Fagus* and *Carpinus* increase, *Fagus* hardly exceeding 10%. It is not quite clear whether, being susceptible to fire, *Fagus* has been damaged and its increase is the result of regeneration after the burning. In this case the entire diagram should be placed in the Subatlantic. In any case, the forest-open vegetation ratio shows there was an increase in tree growth in the centre of the diagram.

As may be expected, indications of human occupation occur throughout the diagram. *Plantago* (mainly *lanceolata)*, is present from the beginning, which might point to animal husbandry. Somewhat later, however, clear signs of agriculture start, e.g. *Cerealia* and *Rumex*. At first *Cerealia (Triticum)* start with low values. At 21 cm *Secale* is present with a small number of pollen grains and increases in the upper layers to a maximum of 10%. The upper two samples contain *Centaurea cyanus* together with rye, which means that these layers date from the Middle Ages (MIKKELSEN 1954). At this period peat growth is stopped


HULSHORST II
depth
cm
Picea
Hedera
Poor in pollen
Myrica
Calluna
Erica
Empetrum
Gramineae
Cyperaceae
Compositae tubuliflorae
Compositae liguliflorae
Caryophyllaceae
Cruciferae
Rosaceae
Rubiaceae
Labiatae
Chenopodiaceae
Cerealia
Secale
Plantago
Artemisia
Rumex
Hydrocotyle
Typha angustifolia type
Dryopteris-type
Pteridium
Sphagna
Equisetum
Humulus/Cannabis 1%
Spergula 0,5% Frangula
alnus 1,5% Filipendula 0,5%
Papilionaceae 0,5% Melampyrum 0,5%
Centaurea cyanus
Drosera 0,2% Umbelliferae 0,2%
Scrophulariaceae 0,3%
Polypodium
Botryococcus
MAP
159%
134%
21%
104%
35%

by fire and the peat is blown over by drift sand. The spread of *Secale* coincides with the expansion of heath and the regression of the forest.

SCHELLING (1955) quotes Florschütz who found *Fagopyrum* pollen in the drift sand; it is absent from the underlying peat. The fire that put an end to peat growth occurred at a period in which winter rye was cultivated, but before the introduction of buckwheat, *i.e.* between 1200 to 1300 A.D.

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