AN INVESTIGATION INTO THE EARLIER VEGETATION OF CENTRAL FRIESLAND (THE NETHERLANDS)

by

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Introduction.

The samples on which this investigation was based were taken at "Het Princehof", a landscape of water and marsh in the centre of Friesland, one of the northern provinces of the Netherlands. "Het Princehof" is a rest of the formerly vast Frisian bog and has for this reason been set apart as a nature reserve.

According to the "Geological Map" the subsoil is formed by fluvioglacial sand. As the surface of the latter undulates the thickness of the peat-deposit varies from 50 cm to more than 3 m. As is shown on the map of "Het Princehof", a great part of the peat-deposit is covered by an 1—4 dm thick layer of clay. In some localities east of the boundary line there is more than 10 cm of clay. In a western and northwestern direction the clay-deposit becomes gradually thicker.

For lack of sufficient material the stratigraphic examination was rather superficial. Yet it was possible to establish some interesting facts.

The only results of pollenanalytical research in Friesland that have hitherto been published are those of FLORSCHÜTZ (5). In so far as they are of interest for this investigation they will be discussed later on, together with the various pollendiagrams obtained in the adjoining province of Drenthe and those from elsewhere.

Praeboreal period.

The first question we will try to answer, regards the vegetation on the fluvioglacial sands before peat began to form. In the chapter dealing with geology of the book "Het Princehof" (Zandstra, 17), WIEGERSMA reports that in this region an iron pan regularly occurs in the sand under the peat-deposit. This might indicate the presence of a heather vegetation in the praeboreal period, but this supposition is not in accordance with the results of the pollen analysis, for the percentage of Ericaceous pollen is very low. FLORSCHÜTZ and WASSINK (7) and BROUWER (1) found the same low percentage of Ericaceous pollen in the subsoil of the peat-bogs in Drenthe.

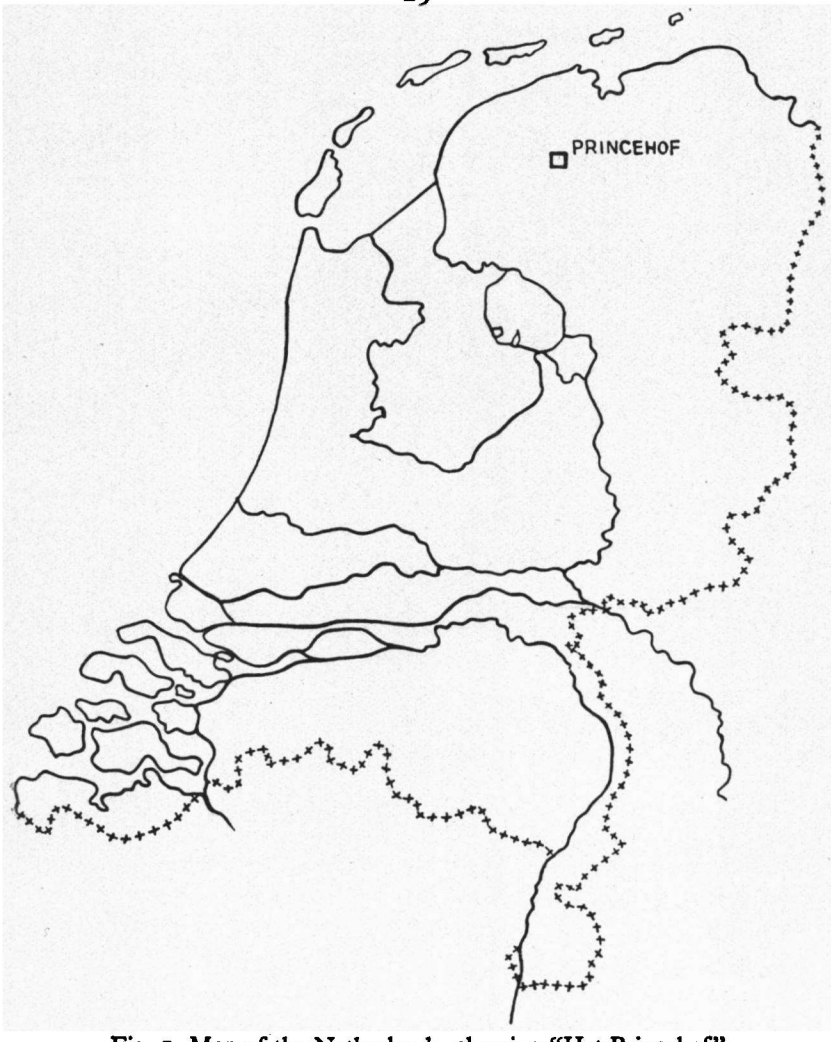

Fig. 1. Map of the Netherlands, showing "Het Princehof"

SCHROEDER (15) found a high percentage of Ericaceous pollen in the A_2 layer ("Bleichsand") of a podzol-profile under peat in the Wieringermeer (province of Noord-Holland), while the A_0 horizon contained many Calluna rests. He thus concluded to the presence of an early Calluna vegetation in the Wieringermeer.

Although POLAK (13) as a rule did not find a high percentage

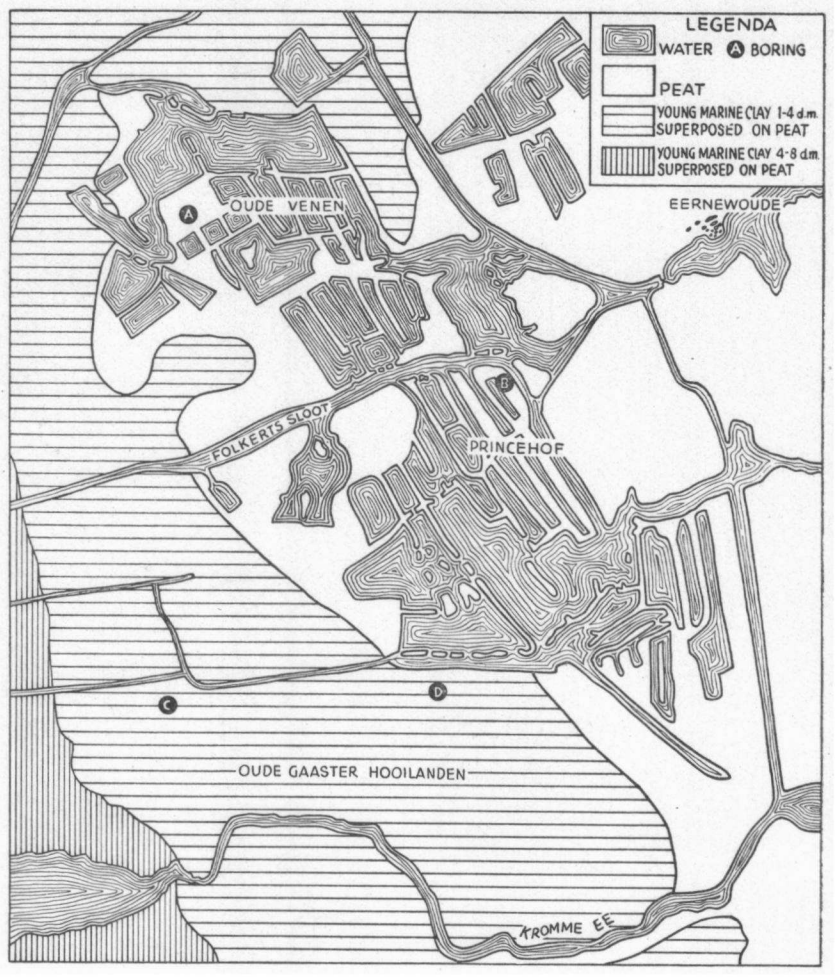

Fig. 2. Map of "Het Princehof" and surroundings

of Ericaceous pollen in the Noordoostpolder, she does not exclude the possibility of a former Ericaceous vegetation; she admits that her sandsamples may have been taken at an insufficient depth.

In "Het Princehof" as mentioned above the percentage of heather pollen in the sand is very low and there are no other rests of *Ericaceae* either. Therefore it is not unlikely that the podzol-profile in the

sand below the peat is not due to a former heather vegetation, but that the podzolisation took place under the influence of the acid peat. The occurence of this type of podzolisation has already been noted by pedologists who dealt with other peat-bogs.

The lower part of the diagram A represents the third phase of the Late-Glacial period, i.e. the first appearance of such thermophilous trees as *Alnus* and *Corylus* (*Betula* is still dominant). The high percentage of Cyperaceous and Graminaceous pollen would indicate that there was no dense forest vegetation during the Late-Glacial period, but that the landscape may have shown the character of a Park-Steppe with a herbaceous layer consisting of *Cyperaceae* and *Gramineae*.

Boreal period.

During the boreal period the circumstances were apparently not favourable for the formation of peat. This is proved by the thinness of the peat-deposit found between the praeboreal and the atlantic part of diagram A. In this diagram in the boreal period too the birch is the dominating tree. However this is no rule, for in the boreal part of diagram D the percentage of *Pinus* pollen is high, while *Betula* pollen is totally absent. This dominance of the *Betula* pollen is also observed in some other profiles found in the northeastern part of the Netherlands. From this it may be concluded that the birch has played in this region, at least locally, an important rôle in boreal times.

Corylus pollen does not reach a maximum in the boreal period, the percentage itself nearly reaches a value of 20. The first maximum is attained in the lower part of the atlantic period, at least in diagram A. ESHUIS (3) already noted that *Corylus* pollen reaches in this country not always a maximum in the boreal period, that its first maximum is rather frequently found in the atlantic part of the diagrams. It is not possible to discover any regularity in the appearance of the first *Corylus* maximum: most peatbogs of Northwest Germany show a boreal *Corylus* maximum; the same is true for Drenthe, where it is often accompanied by a boreal *Pinus* maximum, but a number of pollendiagrams relating to peatbogs lying between Drenthe and Northwest Germany (Valthermond, Bourtangerveen, Hoornderveen) show the first *Corylus* maximum in the atlantic period. It is not unlikely that the appearance of a *Corylus* maximum in the boreal period depended for a great deal on local circumstances, for in Friesland the diagrams of Parrega (FLORSCHÜTZ, 5) and Opende (not yet published) show a distinct boreal maximum of the hazel.

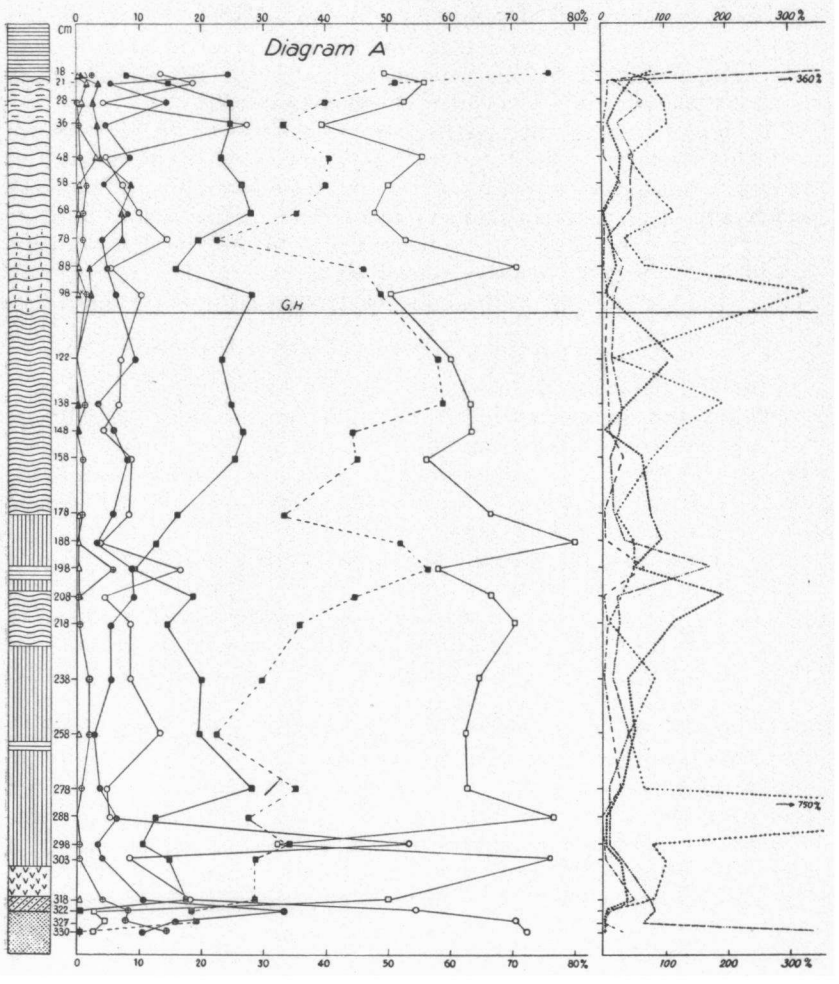

Fig. 3. Pollen diagram, obtained from boring A (see fig. 2). Legenda: see fig. 6

Atlantic period.

It is generally accepted that the atlantic period begins where in the pollendiagram the suddenly rising *Alnus* line intersects the descending *Pinus* line. The Atlanticum is characterized, among other things, by a considerable formation of peat: at first this is sedge peat, while later *Sphagnum* becomes the main contributor.

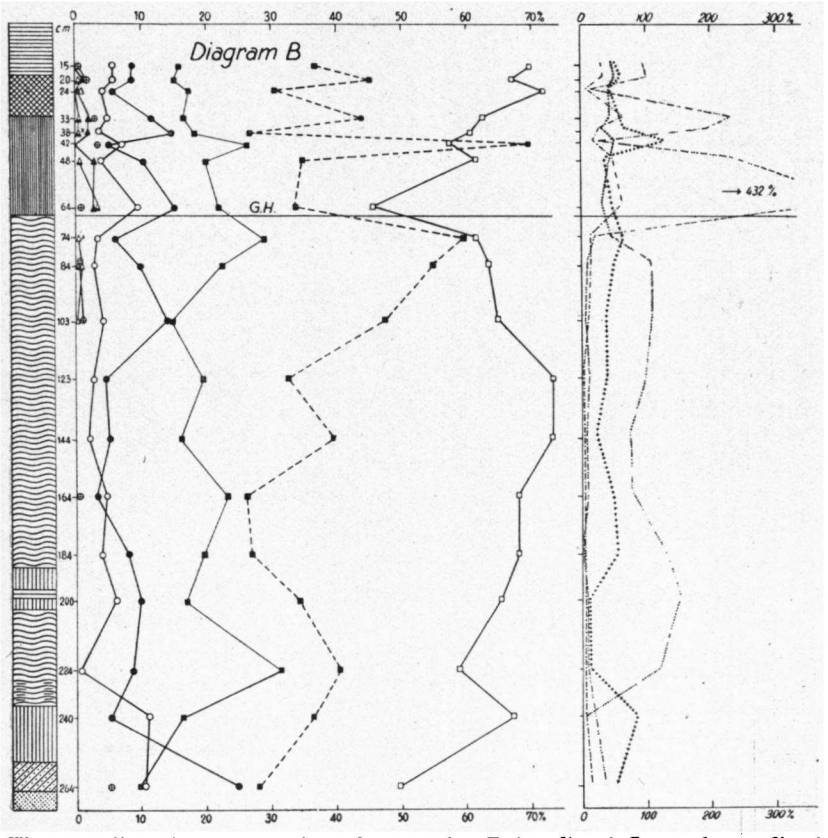

Fig. 4. Pollen diagram, obtained from boring B (see fig. 2). Legenda: see fig. 6

This leads to the formation of the "Old Sphagnum peat", which contains in the upper part an increasing amount of Ericaceous fragments.

Especially in diagram D the rise of the ground-water level in the atlantic period comes out clearly. Without a visible transition an alderbog is developing on the humous sand, which we would expect to be well drained; some samples proved valueless for pollen-analytical work because of the presence of numerous alderstamens full of pollen.

In the profiles B and C peat begins to develop in the early Atlanticum. The atlantic spectra do not show any remarkable deviation. See for instance the diagram A: the *Quercetum-mixtum* shows a

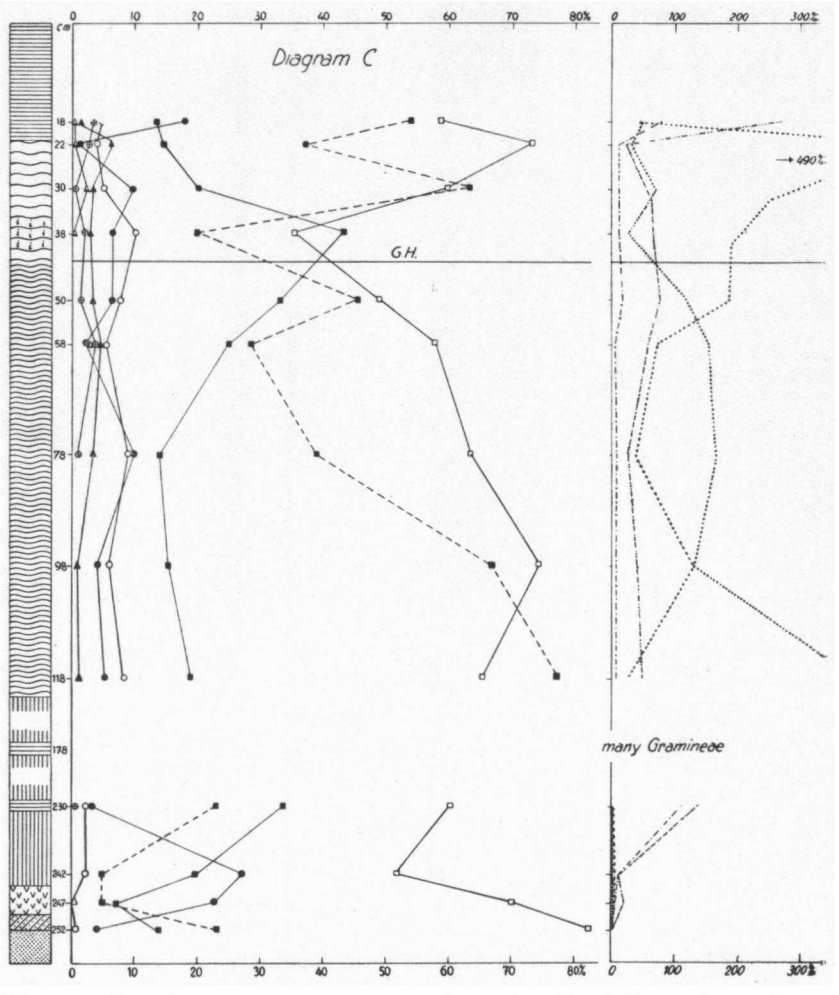

Fig. 5. Pollen diagram, obtained from boring C (see fig. 2). Legenda: see fig. 6

not very prominent maximum (27 per cent) in the early atlantic period, fluctuates then between 10 and 20 per cent and reaches nearly 30 per cent at the end of the Atlanticum. The percentage of *Alnus* pollen is high, on the average 70 per cent, while *Corylus* pollen reaches a maximum in the atlantic period. *Picea* pollen is regularly present in a low percentage and *Fagus* appears in the

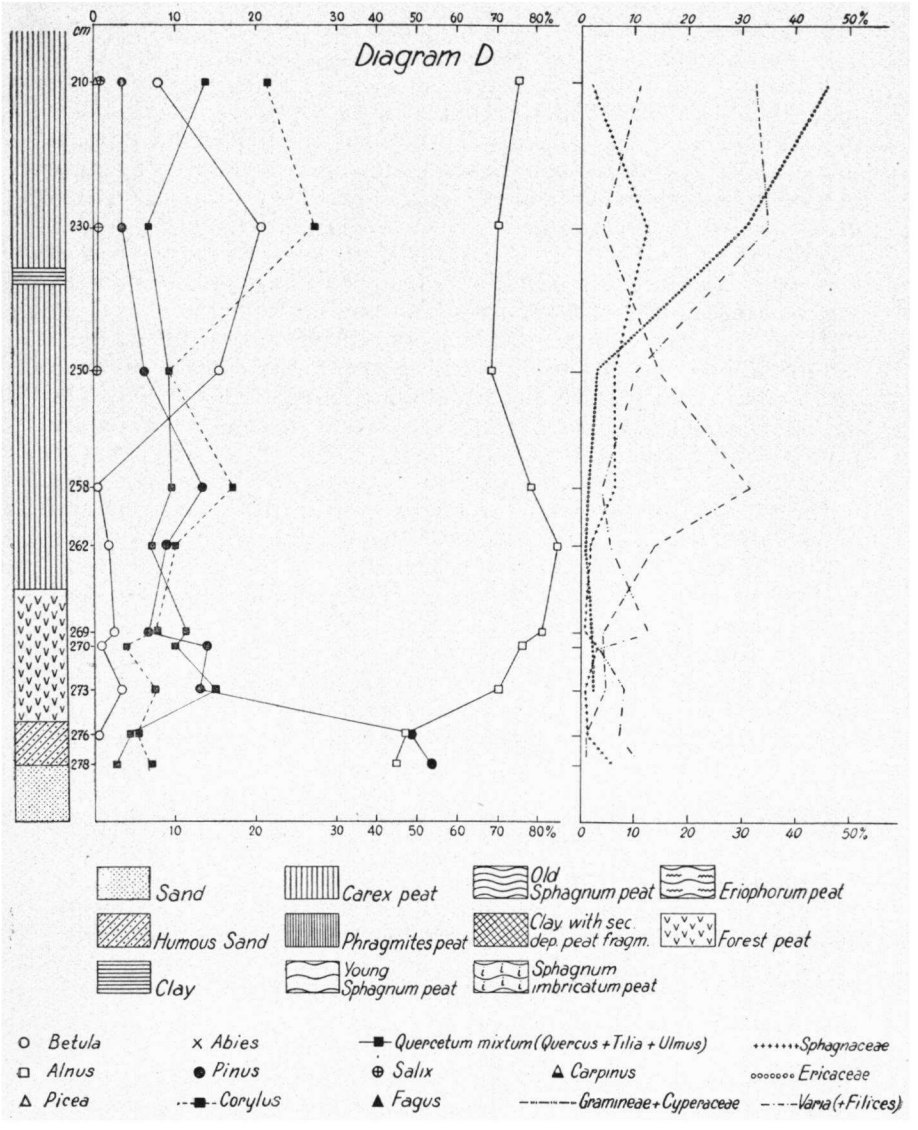

Fig. 6. Pollen diagram, obtained from boring D (see fig. 2).

upper part of the Atlanticum. The diagrams B and C give nearly the same picture: a *Quercetum-mixtum* maximum in the early Atlanticum, while the percentages of *Corylus* pollen too are rather high; there is, however, no maximum in the Atlanticum.

A sample of boring A from a depth of 198 cm appeared to contain much clay. The microscopic examination gave a high percentage of Graminaceous pollen and of varia. These varia were composed of the pollen of *Compositae*, *Chenopodiaceae* and *Caryophyllaceae*. OVERBECK and SCHMITZ (12) found the same: as soon as in the profile clay takes the place of peat the pollen percentages of *Gramineae*, *Chenopodiaceae* and *Caryophyllaceae* show an increase. It is not difficult to understand this phenomenon; the solution of the problem lies in the presence of a halophytic vegetation. Most of the common salt-marsh plants belong to the families enumerated above. The appearance of these pollen grains probably indicates a temporary transgression of the sea.

After an exact stratigraphic examination it was possible to conclude to the presence of two marine transgressions in the Atlanticum and in view of the thinness of the clay bands, the latter must have reached their farthest point in this region.

This indication for marine transgressions in the beginning and in the second half of the atlantic period is not the only one. MULLER and VAN RAADSHOVEN (11) also distinguish two atlantic transgressions in the Holocene of the Noordoostpolder. The first transgression, the Unio-clay phase, has deposited there a thick layer of clay, the clay of the Cardium-clay phase has practically been lost, the only remnant consisting usually of a deposit of Cardium fragments.

The atlantic transgressions of the Noordoostpolder agree very well with those of "Het Princehof". It is very likely that these transgressions were of more than local importance and that it is permitted to connect them with the results obtained by GODWIN (8) for the Fenlands in Cambridgeshire and by SCHÜTTE (16) for Northwest Germany as MULLER and VAN RAADSHOVEN (11) already have done.

There is no distinct boundary line between the atlantic and the subboreal period. The upper part of the Old Sphagnum peat is almost entirely composed of rests of Ericaceae.

Grenzhorizont.

It was not possible to distinguish a grenzhorizont in our samples. Only stratigraphically there was a distinct difference between the Old Sphagnum peat and the less humified Young Sphagnum peat. The position of the grenzhorizont has been indicated in the diagrams.

The variation in the Ericaceous pollen too is a very good indication

of the transition to the Subatlanticum. In the diagrams one can see a sudden decrease of the Ericaceous pollen after it has reached high percentages in the atlantic and in the subboreal period. In the Subatlanticum the rôle of the *Ericaceae* is of less importance. In Drenthe BROUWER (1) found a corresponding decrease of the Ericaceous pollen after the subboreal period. FLORSCHÜTZ and WASSINK (7) published a number of diagrams from Drenthe, which show an increase in the percentage of Ericaceous pollen in the Subatlanticum. In this case it may have been due to a human influence on the vegetation. One may accept that man did not exercise any influence on the large impassable bog of Central Friesland.

Thus in this region the rise of the ground-water level in the Subatlanticum is proved by a sudden decrease of the percentage of Ericaceous pollen; after a relatively dry period, in which the upper layer of the peat-deposit dried up and became covered by an Ericaceous vegetation, the climate became in the Subatlanticum more humid and the growth of *Sphagnum* became once more abundant. In this period the Young Sphagnum peat was formed.

The third indication for the transition to the subatlantic period, which consists in a maximum of *Corylus* pollen just below the grenzhorizont, is not present here. During the whole Subatlanticum the percentage of *Corylus* pollen remains high.

Subatlantic period.

This period is characterized among other things by the presence of *Fagus*. Yet the pollen of this tree never reaches a high percentage. This is in full agreement with the results obtained by the analysis of peat from Drenthe and Southeast Groningen (BROUWER (1), FLORSCHÜTZ and WASSINK (6), ESHUIS (3)) on the one hand and from Southwest Friesland (FLORSCHÜTZ (5)) on the other. BROUWER (1) already could confirm the supposition of OVERBECK and SCHMITZ (12) that the importance of the beech decreases from East to West in the subatlantic diagrams. In Germany *Fagus* pollen reaches a fairly high percentage during this time. In the diagrams of Central Friesland *Fagus* never attains the level of 10 per cent. FLORSCHÜTZ (5) found the same for Southwest Friesland, as already mentioned. Thus the results of this investigation once more confirm the supposition of OVERBECK and SCHMITZ.

The pollen percentage of *Carpinus* also remains low, while the values for the *Quercetum-mixtum* are about as high as during the Atlanticum.

The Young Sphagnum peat in the profiles A and C especially consists of *Sphagna* of the *Cymbifolia* section, at first *Sphagnum*

imbricatum, later on *Sphagnum palustre*. FLORSCHÜTZ (5) found *Cymbifolium* peat in only one of the profiles in Southwest Friesland and he supposed that in the other cases it has been washed away by the sea. It is very likely that during the early Subatlanticum a peat layer formed by Sphagna of the *Cymbifolia* section has been formed in all parts of the large Frisian peatbog.

It is a striking fact that in the superficial clay-layer of both the diagrams A and C the percentage of *Pinus* pollen suddenly increases. OVERBECK and SCHMITZ (12) saw the same phenomenon, as soon as the peat has been replaced by clay. Their explanation is: during the marine transgression forest vegetation was impossible in the flooded areas; the distance separating the trees by which the pollen is produced from the submerged peat became greater. For this reason the percentage of *Pinus* pollen in the clay shows a relative increase because these pollen grains are more easily transported.

In boring B all the Young Sphagnum peat had been washed away. At a depth of 70 cm a clay-layer begins, which contains many fragments of *Phragmites* roots and leaves. As was to be expected the percentage of Graminaceous pollen too is high; the microscopic examination also showed strongly wheathered rests of *Sphagnum* and *Eriophorum*. The latter were first washed away and then deposited here with clay, especially at a depth of 18 to 30 cm. A washed in fragment of *Sphagnum* peat at 42 cm is probably of atlantic origin, as it lacks *Fagus* and *Carpinus* pollen.

The disturbance of the upper layer by the sea thus proves to be locally very different.

As mentioned above human influence in this region was probably during long times of little importance. This is in agreement with the almost complete absence of the pollen of cereals and with the fact that the percentage of *Alnus* pollen does not decrease as BROUWER (1) found it did in Drenthe.

The first time man began to exercise its influence, was in the 12th century when the monks of the neighbouring monasteries commenced with peat digging.

Summary.

1. This paper deals with a pollenanalytical investigation of holocenic peat-layers in Central Friesland.

2. One diagram shows a praeboreal spectrum with *Betula* in the dominant position, the first appearance of thermophilous trees (*Corylus*, *Alnus*) and a high percentage of Gramineous and Cyperaceous pollen.

3. Originally in all diagrams the percentages of Ericaceous pollen are low.

4. During the boreal time the peat formation was of little importance. A maximum of *Corylus* pollen in the boreal period has not been found here.

5. In the Atlanticum a thick layer of peat has been formed; the percentage of *Alnus* pollen remains high, the *Quercetum-mixtum* fluctuates between 10 and 25 per cent and there is also much *Corylus* pollen.

6. Two narrow clay-bands are present in the peat. They contain many pollen grains of halophytic plants, which indicates that there must have been two marine transgressions in the Atlanticum. These transgressions will have reached their farthest point in this region.

7. In the upper atlantic and subboreal peat-layers there are many fragments of *Ericaceae* and also a high percentage of Ericaceous pollen.

8. The Young Sphagnum peat consists of *Sphagnum* species of the *Cymbifolia* section. The presence of *Fagus* pollen never reaches a level of 10 per cent.

9. During the subatlantic transgression the Young Sphagnum peat has locally been washed away and was replaced by clay with many *Phragmites* rests.

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