A POLLENANALYTICAL INVESTIGATION OF A BORING MADE NEAR A RIVER DUNE IN SOUTH-HOLLAND

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(*received January 27th, 1964*)

ABSTRACT

In this investigation special attention was paid to phytosociological aspects. The period in which the layers were formed could be dated as extending from the beginning of the Atlanticum to the present day. Radio-carbon dating is necessary, however, in order to obtain more precise results. It is not excluded that transgressions have influenced the succession. More investigations are necessary to complete our image of the holocene development of this area.

INTRODUCTION

The post-glacial genesis of the western part of the Netherlands is comparatively well known at present. Publications like the theses by J. BENNEMA (1954) and by S. JELGERSMA (1961) and like the treatise by Dr. L. J. PONS and Dr. A. J. WIGGERS (1959), make it clear that the post-glacial genesis of the western part of the Netherlands is characterized by several, large as well as small, transgressions. However, it should be realized that the majority of the areas investigated by the above-mentioned authors, is situated north of the line The Hague–Utrecht, in many cases even north of Amsterdam. Moreover, in all these investigations but little attention was paid to palynology; though diagrams have been published, in most cases dating was done by the radio-carbon method, whilst the phytosociological aspects were almost entirely neglected.

From data obtained from the "SECTION FOR SOILMECHANICS OF THE MUNICIPALITY OF ROTTERDAM" it was learned that there is a sand hill at Hillegersberg, in the north-eastern part of Rotterdam. The area occupied by this hill is about 3 ha. The base lies about 12 m below N.A.P., the summit about 0.5 m above N.A.P. The hill sides are said to be covered by a peat layer with a thickness of about 8 m, and directly resting on sand. It appeared from literature, that this hill is a river dune of pleistocene or early holocene age. In the south-western part of the Netherlands circ. 40 of these river dunes are known, for the greater part situated in the Alblasserwaard and Krimpenerwaard.

From a publication by F. FLORSCHÜTZ and I. M. VAN DER VLERK (1939) it was learned that below Rotterdam peat of boreal age is found. It seemed interesting to see whether the peat on the hill sides, which is said to rest directly on pleistocene sand, perhaps had been developing without interruptions since the Boreal. In that case the various transgressions might find their expression in vegetational changes.

For that reason a boring was made near the dune of Hillegersberg, at a place situated about 15 m to the east of the church which stands on the hill. The code of this boring is **Hi**. The upper 90 cm turned out to be badly disturbed; for that reason this part of the boring was discarded. Then a peat layer followed with a thickness of about 5 m, then a clay layer of about 2 m, which rested on sand. That the clay layer was identified by the "SECTION FOR SOILMECHANICS" as peat, is probably due to the method they had been using. This method rests on the estimation of soil's resistance, and so a soft clay may be identified with peat. As the clay layer proved to contain a fairly large amount of pollen, we decided to go on with the investigation, notwithstanding the wrong presupposition.

The questions to which we tried to find an answer may be formulated as follows:

a. What is the history of the dune vegetation?
b. What is the history of the vegetation in the immediate vicinity?
c. Are transgressions noticeable in the history of these vegetations?

However, it will be clear that these points have so much in common, that it is difficult to keep them apart.

MATERIAL AND METHODS

Field work

The samples were collected by means of a Dachnowsky sonde in the modification developed at Utrecht (ESHUIS, 1946). The cylinders of soil which were obtained in this way, were preserved in glass test tubes. This method of preserving the samples has the advantage that the soil is neither desiccated nor transformed.

Laboratory work

Each cylinder was divided longitudinally into two halves. One half was used for the stratigraphic work, the other half for the palynological investigation.

a. The stratigraphic work. The stratigraphic work was carried out in order to obtain a better insight in the character of the vegetations which succeeded each other on the site of the boring itself. For this purpose a study was made of the macroscopically recognizable rests, including, for instance, fruits, leaves, wood, etc.

This work was carried out in three stages, viz.

a. by direct inspection of the soil samples;

b. by making a suspension of the soil in water; in such a suspension seeds come to the surface and can be removed by means of a brush;
c. by sieving the soil suspension and investigating the residue.

b. The palynological investigation. From the halved cylinder a small sample was taken at the required depth. This sample was treated according to the method of FAEGRI and IVERSEN (1950). After the investigation the rest of the sample was stored in a small glass tube (for preservation some phenol was added).

Tree-pollen sum (AP)

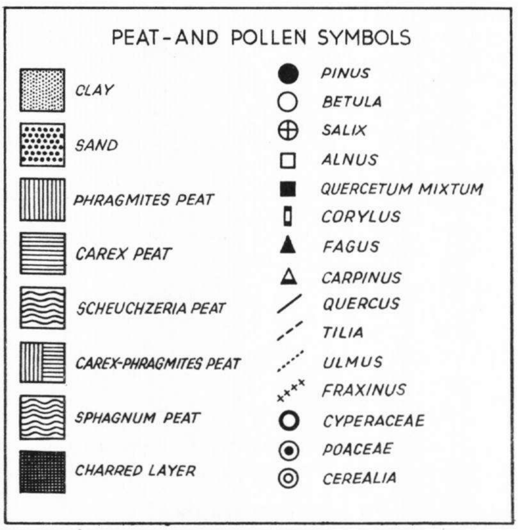
The AP comprises the pollen grains of:

Alnus	*Quercus*	*Fagus*
Betula	*Ulmus*	*Carpinus*
Corylus	*Tilia*	
Salix	*Fraxinus*	
Pinus	*Acer*	
Picea		
Abies		

In most cases up to 200 AP was counted, in some cases up to 150 AP, and up to 50, 75 or 100 AP in a few other ones. The results of the last-mentioned countings have to be considered with some reserve. In samples with a large amount of pollen, up to 500 AP was counted.

The diagram (see Fig.)

The diagram has been divided into a number of subdiagrams, each with its own scale. The first diagram gives the curves obtained



for *Alnus*, *Betula*, *Salix*, *Pinus* and the *Quercetum mixtum* (*QM*). The next three subdiagrams represent the different components of the *QM*. The fifth subdiagram gives the curves for *Fagus* and *Carpinus*. The other subdiagrams have been divided in the following way:

a. a subdiagram comprising *Poaceae non Cerealia*, *Cyperaceae*, *Cerealia*;
b. a subdiagram comprising *Dryopteris*, *Osmunda*;
c. a subdiagram for *Sphagnum*;
d. a subdiagram for *Calluna* and *Erica*;
e. subdiagrams with typical aquatic plants;
f. in alphabetical order the other herbs, each with its own curve.

Of the herbs that have been found at best five times, no graphs are given, but they are recorded with name and percentage at the depth at which they were found. The same has been done with the wood fragments.

Results

The palynological results are rendered in the diagram. The stratigraphic results are succinctly mentioned in the column in front of the diagram. The exact composition, both lithological and botanical, is given in the next table.

Table 1

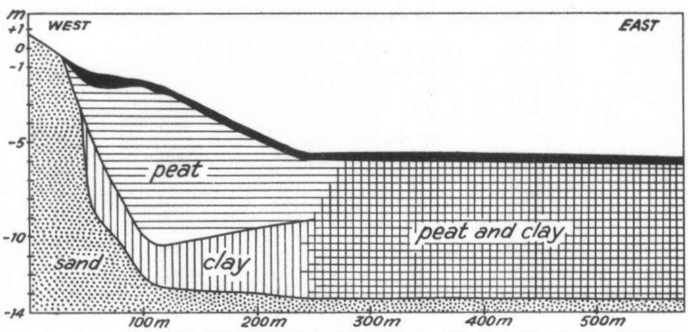
20– 40 cm:	Clay with gravel and brick fragments.
	One fruit from *Rumex* cf. *acetosella.*
40– 60 cm:	Clay with gravel.
60– 80 cm:	Clay with fine gravel.
	Fruits: *Juncus sp.*
	Rumex cf. *acetosella.*
80–100 cm:	Somewhat coarse clay.
	Fruits from *Rumex* cf. *acetosella.*
100–120 cm:	Somewhat coarse clay.
	Fruits: *Rumex sp.*
	Carex sp.
	Ranunculus cf. *fluitans.*
	Carex roots.
120–140 cm:	Peaty clay.
	Fruits and seeds: *Rumex sp.* (*acetosa* or *maritima*)
	cf. *Chenopodium*
	cf. *Trifolium*
	cf. *Fabaceae.*
140–160 cm:	Peaty clay.
	Fruits: cf. *Rumex*
	cf. *Trifolium.*
160–180 cm:	Rather fine peat.
	Fruits: cf. *Rumex*
	cf. *Chenopodium*
	cf. *Stellaria* (1 ex.)
	Rather many leaves and stems of *Sphagnum sp.*
180–200 cm:	Rather coarse peat with some clay.
	Fruit cf. *Chenopodium.*
	Phragmites rhizomes and *Carex* roots.

200–210 cm:	Rather coarse peat with some clay.
	Fruits: cf. *Chenopodium*
	Sonchus sp. (1 ex.)
	Sphagnum leaves and *Carex* roots.
210–218 cm:	Layer containing very small, black branches (0,2–2 cm).
218–245 cm:	Somewhat clayey peat.
	Fruits: cf. *Chenopodium*
	cf. *Polygonaceae*
	Juncus inflexus (1 ex.)
	Carex sp.
	Phragmites epidermis, *Carex* roots and pieces of *Sphagnum.*
	At 230 cm: Wood from *Frangula alnus.*
245–320 cm:	Rather loose, slightly fibrous peat.
	Carex roots and *Phragmites* rests.
	At 270 cm: Wood from *Frangula alnus.*
	At 310–320 cm: Wood from *Betula* cf. *verrucosa.*
320–360 cm:	Very loose, fibrous peat.
	Fruits: *Juncus* cf. *squarosus.*
	Very many *Carex* roots.
	Rather many leaves from *Sphagnum* cf. *imbricatum.*
	At 330 cm: Wood from *Salix sp.*
	At 340–360 cm: Wood from *Frangula alnus.*
360–400 cm:	Coarse, very fibrous peat.
	Carex- and *Scheuchzeria* rests.
400–420 cm:	Very loose, fibrous peat.
	Very many *Carex* roots.
	At 410 cm: Wood from *Salix sp.* and *Quercus sp.*
420–440 cm:	Loose peat with coarse fibres.
	Carex roots and *Phragmites* rests.
	At 430 cm: Wood from *Salix sp.*
440–460 cm:	Rather solid peat, very fibrous.
	Fruits: *Chenopodiaceae*
	Polygonum cf. *hydropiper* (1 ex.)
	Carex sp.
	Carex roots and *Phragmites* rests.
460–480 cm:	Rather coarse, rather fibrous peat.
	Many *Carex*- and *Phragmites* rests.
480–500 cm:	Rather solid, fibrous peat.
	Fruits: *Scirpus sp.*
	Carex sp.
	Many *Carex* roots and *Phragmites* rests.
500–520 cm:	Rather loose, fibrous peat.
	Fruits: *Carex sp.*
	Carex roots and *Phragmites* rests.
520–560 cm:	Somewhat clayey peat, with coarse fibres.
	Carex roots and *Phragmites* rests.
	At 540 cm: Wood from *Quercus* cf. *petraea.*
560–580 cm:	Solid fine peat, clayey, not fibrous.
	Fruits: cf. *Polygonaceae*
	Chenopodium sp.
	Carex roots and many *Phragmites* rests.
580–615 cm:	Clayey peat with rather coarse fibres.
	Fruits: *Polygonum sp.*
	Carex sp.
	Carex roots and *Phragmites* rests.
615–630 cm:	Somewhat peaty clay.
	Carex roots and *Phragmites* rests.
630–795 cm:	Fine, gray clay, sandy at the bottom.
	At 630 cm: Wood from cf. *Quercus.*
795–810 cm:	Rather coarse to coarse sand.

Discussion

In considering the **Hi**-profile, it should be realized that the pollen was derived from various sources. It should be borne in mind that the boring was made against the side of a hill. So in the diagram firstly the vegetation on the hill will play its part, the hill vegetation; secondly the vegetation at the place of the boring itself, the hill side vegetation; and thirdly the vegetation in the surrounding area, the surrounding vegetation.

By the aid of borings, made by the "Section for Soilmechanics" a profile could be composed (see fig. 1).



The composition and succession of the layers leads to the following suppositions:

a. When the hill is regarded as a river dune, it did fly up in the Late glacial, from a late glacial river valley.

b. After the riverdune was formed, (a) meandering river(s) deposited clayey river-basin soils.

c. The meandering river became a tidal river. Between the different river branches, peat developed. Far from the river branches this peat is oligotrophic. The alteration from a meandering river into a tidal river may in this case be due to a transgression of the sea.

As the meandering as well as the tidal river from time to time changed their course, borings made in the surrounding area show a tangle of clay and peat layers.

From 810–630 cm the **Hi**-profile changes from sand into fine gray clay without macroscopical rests. This agrees with the composition of clayey river-basin soils. At 630 cm wood fragments were found together with the first *Carex*- and *Phragmites* rests; *Carex-Phragmites* peat starts at about 615 cm. It appears from the diagram that from 800–630 cm *Sparganium* is well represented, but that it declines towards 630 cm. *Lemna* is present from 800–740 cm, *Poaceae* and *Cyperaceae* are continually present.

The first stages of a transformation from water into land are visible here. First there is an open water with *Lemna* and *Sparganium* (or

Typha angustifolia), later on with *Carex* and *Phragmites*; with the latter two at last starts the development of peat.

The vegetation in the surrounding area probably showed much resemblance with the "Biesbos" (a virgin part of North Brabant exposed to the influence of the tides in the North Sea, i.e. the mineral soils (like river levees) bore an *Alnion incanae*, *Ulmion* or *Salicion*, the more peaty parts an *Irido-Alnion*; or vegetations developing into these associations.

In the diagram the *Pinus-Alnus* crossing at once attracts attention. It is found at 780 cm and can be dated as at the beginning of the Atlanticum. The percentages of the *QM* do not change much from 800–650 cm, whilst after that a rise is noted which reaches its maximum at 590 cm. The *Pinus* curve falls regularly; above 570 cm it stays below 5 %. *Corylus* on the contrary rises, with a maximum at 650 cm, and than falls quickly. *Betula* and *Salix* are present in small percentages, just like *Tilia*, whilst *Ulmus* shows at circ. 550 cm a decrease. *Quercus* is responsible for the greater part of the *QM* curve, among other things for the rise at 650 cm. *Fraxinus* is present from 800–715 cm.

The decrease of *Ulmus* may coincide with the end of the Atlanticum, as is assumed here, but a radio-carbon dating would be necessary to settle this point.

We may conclude that the hill was covered with forest. The oldest forest was an *Ulmion*, at first with some *Pinus*. When the *Ulmion* was completely developed, the soil began to deteriorate, and a *Quercion roboris* took its place. The deteriorisation may here be due to the development of peat round the hill, which in this way was deprived of the supply of eutrophic (ground) water from the surrounding area.

From 490–370 cm a continued impoverishment of the hill vegetation is visible. At 410 cm *Calluna*, up to there but poorly represented, suddenly reaches high percentages. *Betula* too rises strongly. The fact that the wood rests found at 310 cm were determined as *Betula cf. verrucosa*, makes it possible that the pollen too is from *Betula verrucosa*.

Now it can be said, that the vegetation changed from a *Violeto-Quercion* into a *Vaccinio-Quercion*. More grounds for this supposition are found in the disappearance of *Caryophyllaceae*, *Rubiaceae* and *Apiaceae* at the moment that *Calluna* began to rise. For this impoverishment, as stated above, the peat layers round the hill are supposed to be responsible.

On the hill side itself a succession is visible too. From 615–510 cm there is clay in the peat, but upwards the amount continually decreases. A fall of *Quercus* and a come-back of *Ulmus* and *Fraxinus* are noted at 510 cm whilst *Alnus* and *Corylus* simultaneously rise. From 610–510 cm high *Dryopteris* percentages are present. The next stages in a succession look as follows.

First *Carex-Phragmites* peat, later on with much *Dryopteris thelypteris*, after that an *Alnion glutinosae*, perhaps an *Alnion incanae* (510–410 cm).

The same can be said of the surrounding area, on the understanding that on the mineral soils (like river levees) an *Ulmion* will have been present.

Transgressions do not show clearly in this diagram. An indication for a transgression is perhaps to be seen in the rise of *Chenopodiaceae* from 490–445 cm. The appearance of *Sparganium* and *Lemna* in these spectra might be another indication, but more investigations are necessary here to prove the influence of a transgression.

From 410 cm the peat at the hill side itself begins to become more oligotrophic. From 400–360 cm *Scheuchzeria* rests are present, from 360 cm *Sphagnum* rests. In the diagram *Sphagnum* gets a continuous curve from 325 cm.

Curious are the rather high percentages of *Osmunda* in the spectra from 325–275 cm. Is this connected with the rise of *Quercus* in this zone? Has it something to do with the first settlement of men? It is difficult and at any rate at this stagé of our knowledge still impossible to explain.

At 330 cm *Fagus* appears. At 305 cm *Cerealia* start, though with low percentages. At 275 cm *Tilia* disappears, whilst from 270 cm *Quercus* falls definitely. At 250 cm *Cerealia* show a distinct increase. Many herbs appear with at once rather high percentages. The *Fagus* curve becomes continuous and the Alnus percentages rise quickly to values over 60 %.
It is quite justified to put here the boundary line between Subboreal and Subatlanticum. The settlement of men has become a fact too.
From 250–90 cm nothing changes.

Pollen grains from *Linum usitatissimum* have been found from 240–220 cm, i.e. at the time of the expansion of the *Cerealia*. This proves that men brought the flax too with them. HEGI (1925) says that about the beginning of our era *Linum usitatissimum* began to supersede the other *Linum* species used by men and became established throughout Europe. In this way the settlement of men in the western part of the Netherlands must be dated about or after that time.

CONCLUSIONS

a. The **Hi**-profile can be dated as extending from the beginning of the Atlanticum to the present day.
b. However, radio-carbon dating will be necessary.
c. Transgressions may have influenced the successions, but this could not be proved.
d. More investigations of this hill and of other river dunes are necessary.

ACKNOWLEDGEMENTS

The investigation was carried out at the Botanical Museum and Herbarium, Utrecht (Director: Professor Dr. J. Lanjouw), in the year 1962.

The author expresses his indebtness to Professor Dr. F. P. Jonker for his guidance and his never failing interest. He also wishes to thank Dr. C. R. Janssen and Dr. W. Punt, for their valuable support and their many advices, and Mr. Th. Schipper for the drawings.

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