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POLLEN-ANALYTICAL INVESTIGATIONS IN THE COASTAL DUNE AREA NEAR THE HAGUE, THE NETHERLANDS

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ABSTRACT

This paper deals with the results of field reconnaissance and pollen-analysis of peatbeds occurring in the Dune area near the city of The Hague (The Netherlands). Such peatbeds were known already to occur at the surface as filling of depressions (former beach plains) of the Older Dune system, outside the area covered by Younger Dunes. It could be shown that below the latter a very similar pattern of peat-filled depressions exists.

Pollen-analysis and radiocarbon dating indicate that formation of Old Dune sand took place until about the beginning of our era, though it might in places have been interrupted by a forest-phase at the end of Subboreal times, around 1200 B.C. In part vegetation was characterised by dune-shrub, including not only *Hippophaë* but also commonly *Juniperus*. After the formation of the Older Dunes a period of reafforestation followed, which in the western-most coastal area came to an end by the formation of the Younger Dunes, which event in this area could be dated around 1000–1200 A.D.

1. INTRODUCTION

Though pollen-analytical investigations of Holocene beds have been published from many parts of the Netherlands, the coastal dune area has been neglected so far. This paper is a first attempt to fill at least part of this gap in our knowledge.

It is a well-known feature that in many places along the coast of the western Netherlands two dune systems of Holocene age can be recognized, called Older and Younger Dunes (JESWIET, 1913; VAN BAREN, 1913; TESCH 1920–30). The Older Dunes occur as low NE-SW ridges, and were formed on top of an ancient coastal barrier system. Between these ridges peat-filled depressions occur. The Younger Dunes show much more relief (VANHOUTEN, 1939; BOERBOOM, 1957), revealing more or less distinct systems of parabolae and often attaining a height of 20–40 m.

In the vicinity of The Hague the two dune systems are well represented; the Older Dunes occur at the surface in the eastern part of the area, whereas in the western part they are overlain by Younger Dunes (Fig. 1).

Part of the Younger Dune area is utilized as catchment area for the Dune Water Works of The Hague. Artificial infiltration of river water into the dune-pans is now applied on a large scale, for which preliminary studies had to be made. A map has been compiled showing the occurrence of peatbeds in this area. About 1200 shallow borings

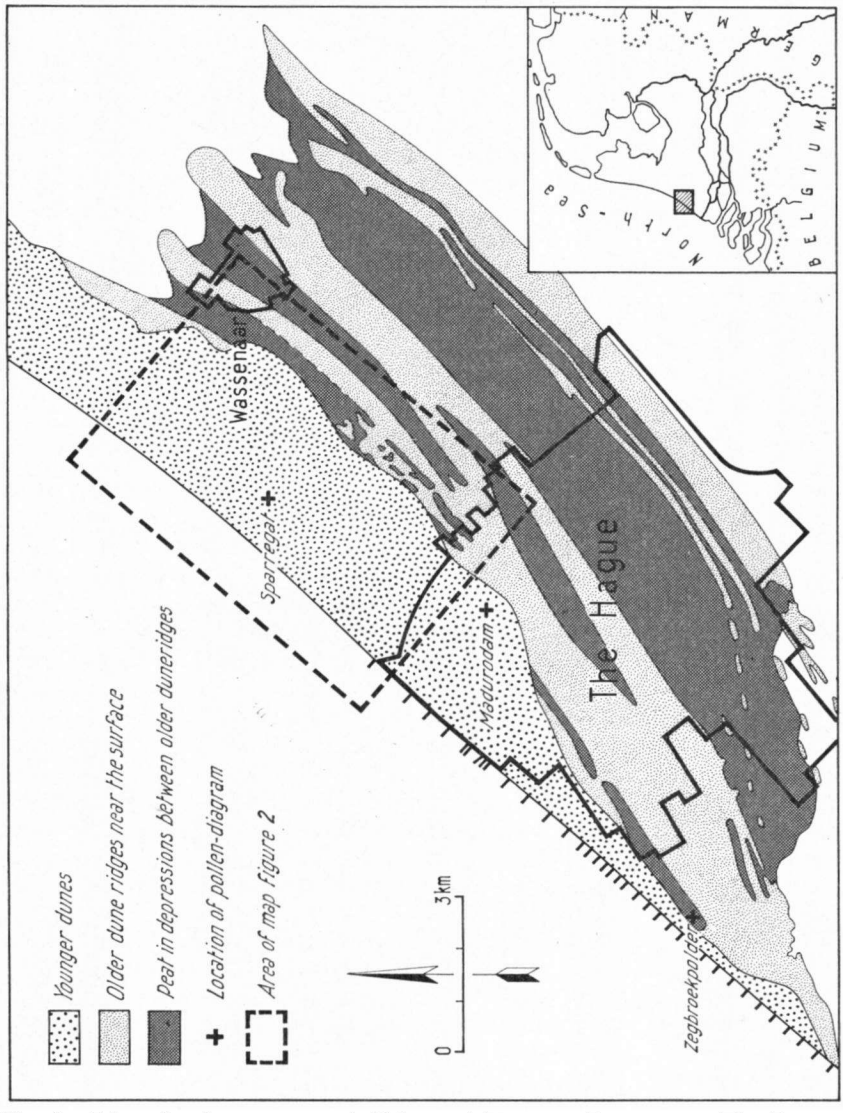

Fig. 1. Map showing pattern of Older and Younger Dunes near The Hague Location of pollen-diagrams (Sources: Geological Map; Haans and Maarleveld 1965; unpubl. data).

were made for this purpose in this area of 1800 ha. As the peatbedt were shown to occur between about 1 m above to 2 m below presens sealevel, and the present surface of the dune-pans is at about 4–7 m above sealevel, it was sufficient to bore 3–9 m deep.

The map compiled by the Dune Water Works in 1956 showing the peatbeds has served as a basis for Fig. 2.

Three pollen-diagrams, prepared by the second author and giving some insight into history of the dune-vegetation near The Hague, will also be discussed in this paper. One is derived from peatbeds found in a boring in the water catchment area (Meyendel–Sparregat Fig. 4, location Figs. 1, 2), at a spot where two peatbeds occurred (Fig. 2). The lower peatbed of 40 cm consisted of sedge peat containing a fair amount of windblown sand overlain by reed peat, which points to somewhat wetter conditions. The upper peatbed of 18 cm showed a normal succession of reed peat below, overlain by sandy sedge peat. Between the two beds nearly 50 cm of dune-sand was found (Fig. 4).

The two other diagrams come from peatbeds found in borings outside this area (Madurodam Fig. 5 and Zegbroekpolder Fig. 6, location Fig. 1). The peatbed in Madurodam was found below Younger Dune sand, whereas the peatbed at Zegbroekpolder occurs at the surface, as a filling of a depression in the Older Dune landscape.

2. The peat-filled depressions occurring below the younger dunes

As appears from the map (Fig. 2) the pattern of peatbeds below the Younger Dunes in the area investigated is similar to that of the peat-filled depressions in the Old Dune landscape. The range of peat-bogs running almost parallel to the present coastline reflects the position of former beach plains, which were separated by dune-topped coastal barriers.

In the area of investigation several systems of former beach plains can be recognized. The peat-samples for pollen-analytical and radiocarbon investigation of boring Meyendel–Sparregat were collected in the NW-most system (Fig. 2).

The depths at which peatbeds are found vary a great deal over rather short distances. On the other hand the average depth of the peatbeds in the various localities does not show significant variations, and it is difficult to observe any general tendency in the depth of the peatbeds. In the NW-most range the greatest depth is as a rule found at the NW edge of this system, with a gradual rise to the SE. This is shown in section A–B of Fig. 3. Here the gradual rise of the base of the peatbeds to the SE is interrupted in one place only (near the dune-pan of Bierlap).

In a direction parallel to the present coastline variations in depth are generally smaller and little regularity is to be observed. As an example a section the NW-most peat-depression is given in Fig. 3 (section C–D, location Fig. 2).

In our opinion the greater depth of the peat in the NE part of this section does not reflect a general tendency of lowering of the peat in this direction, for a parallel section situated more inland, shows a rise of the peatlevel towards the NE. In our opinion the shift of section C-D to a more central part of the depression as a result of its broadening near beach mark 93, accounts for the observations made.

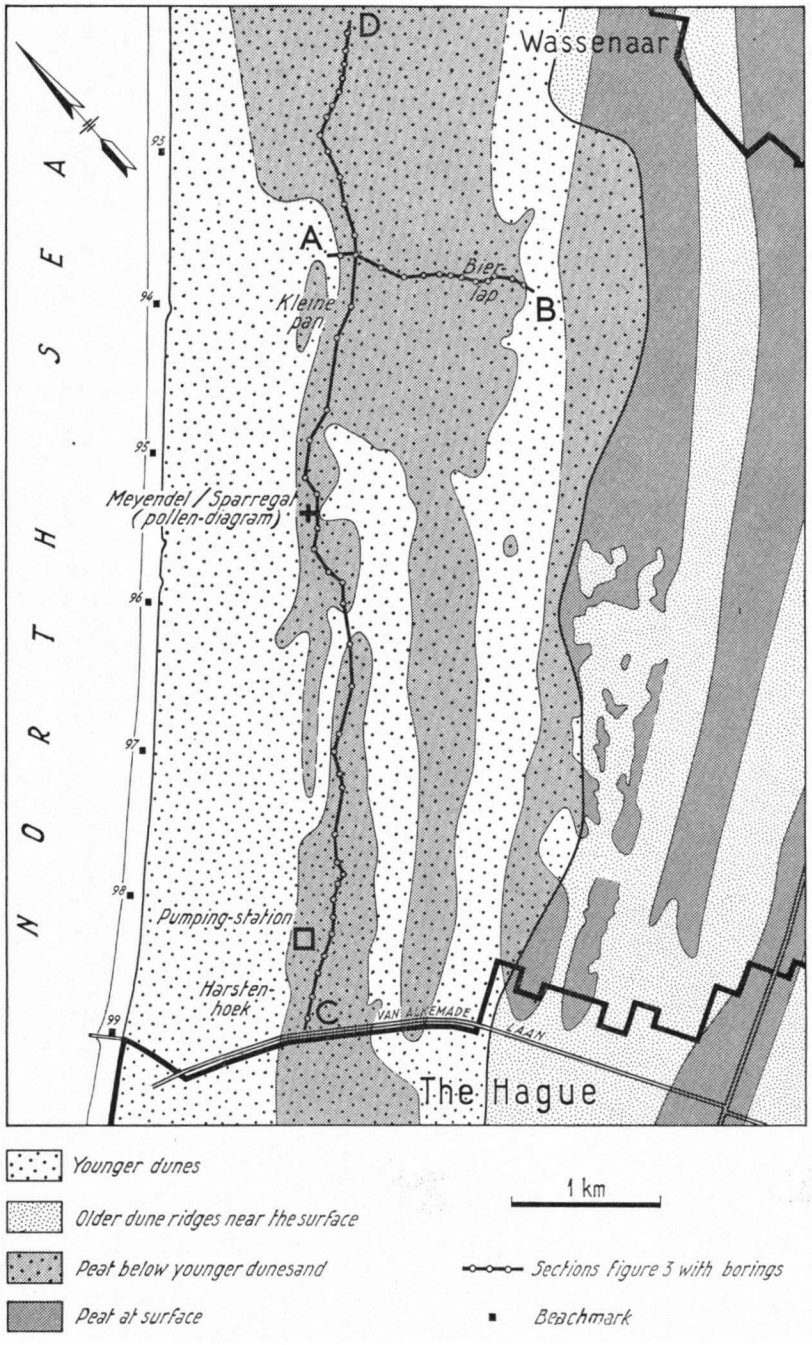

Fig. 2. Map showing repartition of peatbeds in area north of The Hague (location Fig. 1). Location of sections Fig. 3.

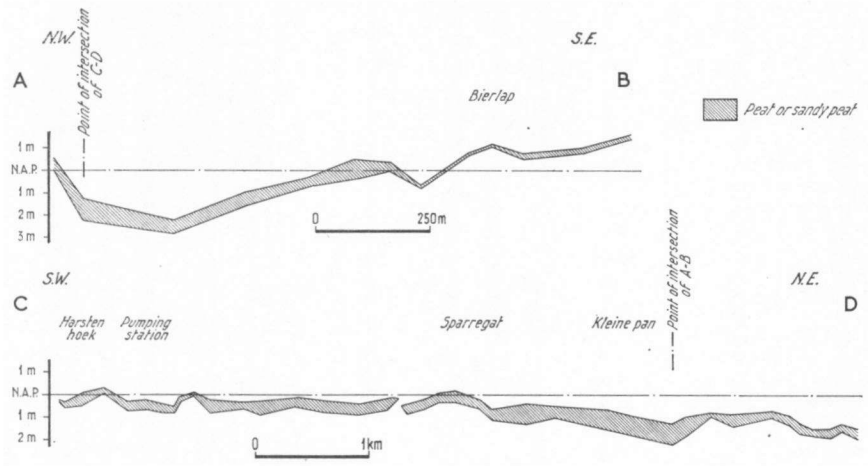

Fig. 3. Cross section A–B and section C–D parallel to coast showing position of peatbeds below Younger Dune sand in area north of The Hague (location Fig. 2).

The thickness of the peat also varies greatly locally. As a rule a thickness of 20–55 cm is found, a thickness exceeding 1 m being exceptional. Along the margins of the peat formations thickness is generally low, increasing towards the centre.

In some cases two, rarely even three, peatbeds are found on top of each other, with dune-sand intercalated between them, pointing to changes in aeolian sedimentation.

3. Pollen-diagrams and radiocarbon datings of some peatbeds in the dune area

3.1. *Methods*

All samples, studied pollen-analytically, have come from undisturbed cores, taken with the "Dachnowski-sampler". Preparation in the laboratory was executed according to the abbreviated acetolysis method, preceded by boiling with diluted HF. Macroscopic remains have served to determine the kind of peat involved, but samples were not big enough to permit palaeocarpological studies.

As it can be expected that in a coastal dune-area open vegetation has played an important role, at least during some phases of the past, our purpose was to choose a basic pollensum which might give an indication as to the relationships between forest, shrub-vegetation and open landscape in the area. For this reason the pollen-diagrams were not, as is otherwise usual in Holocene sections, based on a tree-pollensum, but on a basic sum comprising trees, shrubs and terrestrial herbs. As much of the sediments examined consisted of reed and sedge peath, local overrepresentation of *Gramineae* and *Cyperaceae* was likely to occur. Therefore their pollen was excluded from the sum, as was also done with pollen and spores of telmatic and aquatic plants.

The main diagram (A) shows the relationship between trees,

shrubs and terrestrial herbs. Diagram part B gives the specification of individual pollen-types of these main groups as far as they were considered of special interest. Both diagram A and B have been based on the basic pollensum, comprising 150–200 specimens per sample.

Diagram part C shows the curve of Gramineae and Cyperaceae, based on a pollensum consisting of the basic sum plus Gramineae plus Cyperaceae. Likewise in diagram part D a curve for Dryopteris is given, based on a sum consisting of basic sum plus Dryopteris. This curve is found only in diagram Madurodam, as in the other sections Dryopteris was scarce. Sample numbers according to the files of the Palaeobotanical Laboratory of the Geological Survey will be found at the extreme right of the pollen-diagrams.

3.2. *Pollen-zonation*

The system of pollen-zonation applied at the Geological Survey (ZAGWIJN, 1959; JELGERSMA, 1961) has been used in this paper too (cf. Fig. 7). As changes in the composition of the forests form the basis of this zonation its application in the dune area pertains only to these phases, when forest governed the landscape. Otherwise radiocarbon datings are required to obtain the necessary time-scale.

3.3. *Pollen-diagram Meyendel–Sparregat* (Fig. 4)

A radiocarbon dating of the base of the lower peatbed resulted in an age of about 700 years B.C. The accurate value as well as the sample number of the Groningen laboratory will be found in Fig. 4. All radiocarbon dates have been checked for Suess-effect and therefore the sample-number has been preceded by GRN.

The pollen-diagram of this bed is characterized by fairly high amounts of shrubs and herbs. *Juniperus* and *Hippophaë* are both fairly well represented and may point to prevailing dune-shrub vegetation at that time. *Myrica*, also commonly present, probably inhabited the boggy depressions of the dune landscape. Though the pollen-diagram indicates that at this time no dense forest canopy existed in the vicinity, wooded patches of *Quercus*, *Corylus*, *Alnus* and *Betula* may have occurred.

It is noteworthy that *Fagus* is present in low values only, much lower than in contemporaneous sediments of the coastal area, outside the dunes proper (cf. diagram Zegbroekpolder, Fig. 6); for this reason a pollen-analytical dating is not possible.

Among the herbs *Plantago lanceolata* is well represented. This may point to human influence, as elsewhere, but it should be noted that at present this species is a common inhabitant of natural dune pastures in the coastal area of The Netherlands (BOERBOOM, 1960). As *Cerealia* are very scarce it seems more likely that the frequency of *Plantago lanceolata* pollen in this bed points to similar conditions then, and not to human influence.

The pollen spectra from the upper peatbed (2–20 cm above sealevel), dated around 300 A.D., show a different picture. Generally speaking, trees are predominant, among which *Quercus*, *Fraxinus*, *Corylus*, *Betula*

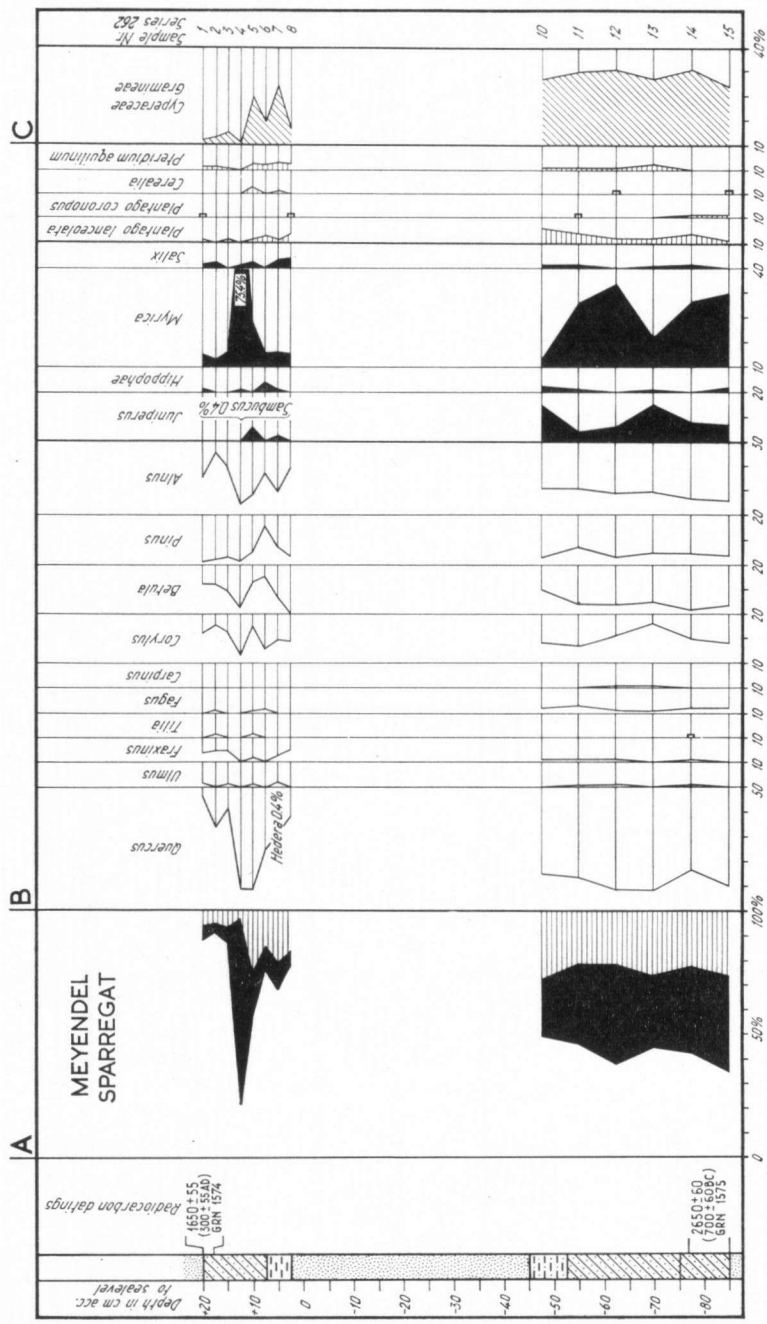

Fig. 4. Pollen-diagram Meyendel–Sparregat (location Figs. 2, 3; legend Fig. 5).

and *Alnus* are most important. *Fagus* is extremely scarce, much scarcer than in contemporaneous diagrams from the inland.

The very high peak of *Myrica* in the middle of the bed is considered a local feature only. Dune shrubs (*Juniperus*, *Hippophaë*) are but scarcely represented, mostly in the lower part of the bed. A similar trend is shown by the curve of *Plantago lanceolata.*

In the middle of the peatbed human influence can be traced in the diagrams by a maximum of *Cerealia* at + 10 cm and perhaps also by the marked decrease in *Quercus* and increase in *Betula* and *Corylus* around this level. These are features well-known from pollen-diagrams of the "landnam"-type (IVERSEN, 1941), though, it is true that the phenomenon is largely obscured in the pollen-diagram discussed here by the strong local expansion of *Myrica* just above this level.

3.4. *Pollen-diagram Madurodam* (Fig. 5)

Even though no radiocarbon datings are available, it is likely that this peatbed roughly dates from the same period as those of Meyendel. The basal spectrum obtained from humic sand shows very high values for *Hippophaë* and *Juniperus*. Evidently dunal shrub formed the main vegetation in this area then. The next few spectra (240–255 cm below surface) show a picture similar to that shown by the upper peatbed at Meyendel: rather dense forest as evidenced by the relatively high values of tree-pollen, but still some traces of dunal shrub. *Fagus* is still rather scarce, however. Presumably this part belongs to pollen-zone V a.

The uppermost two spectra likewise show a predominance of trees, but now *Juniperus* and *Hippophaë* are absent. Moreover *Fagus* and *Carpinus* are fairly well represented, which definitely points to pollen-zone V b. As furthermore *Cerealia* of the *Secale*-type show high values, a more precise attribution to sub-zone V b_2 ($\pm$ 700 A.D.–$\pm$ 1200 A.D.) is possible. The presence of *Centaurea cyanus* in the uppermost sample moreover indicates a fairly late dating within this sub-zone, say around 1200 A.D.

3.5. *Pollen-diagram Zegbroekpolder* (Fig. 6)

A gyttja-filling 160 cm thick found in the third peat-filled depression south of The Hague and occuring outside the Younger Dune area, has been investigated pollen-analytically.

The base of the deposit was fixed by radiocarbon dating at about 1200 B.C. (JELGERSMA, 1961). Another point of reference is found in the level of 50–60 cm below surface, which pollen-analytically can be shown to represent the level of the Dunkirk I transgressional phase, elsewhere dated around 500–250 B.C. (VAN STRAATEN, 1957).

The spectra from the base of the deposit show high amounts of trees (*Quercus*, *Alnus*) and it is likely that forest prevailed in the area. The fact that *Fagus* is represented in values of about 1–2 % points to the second half of the Subboreal, pollen-zone IV b, which is in good agreement with the radiocarbon dating. From 130 cm below surface upwards an increase of shrub-vegetation can be observed especially

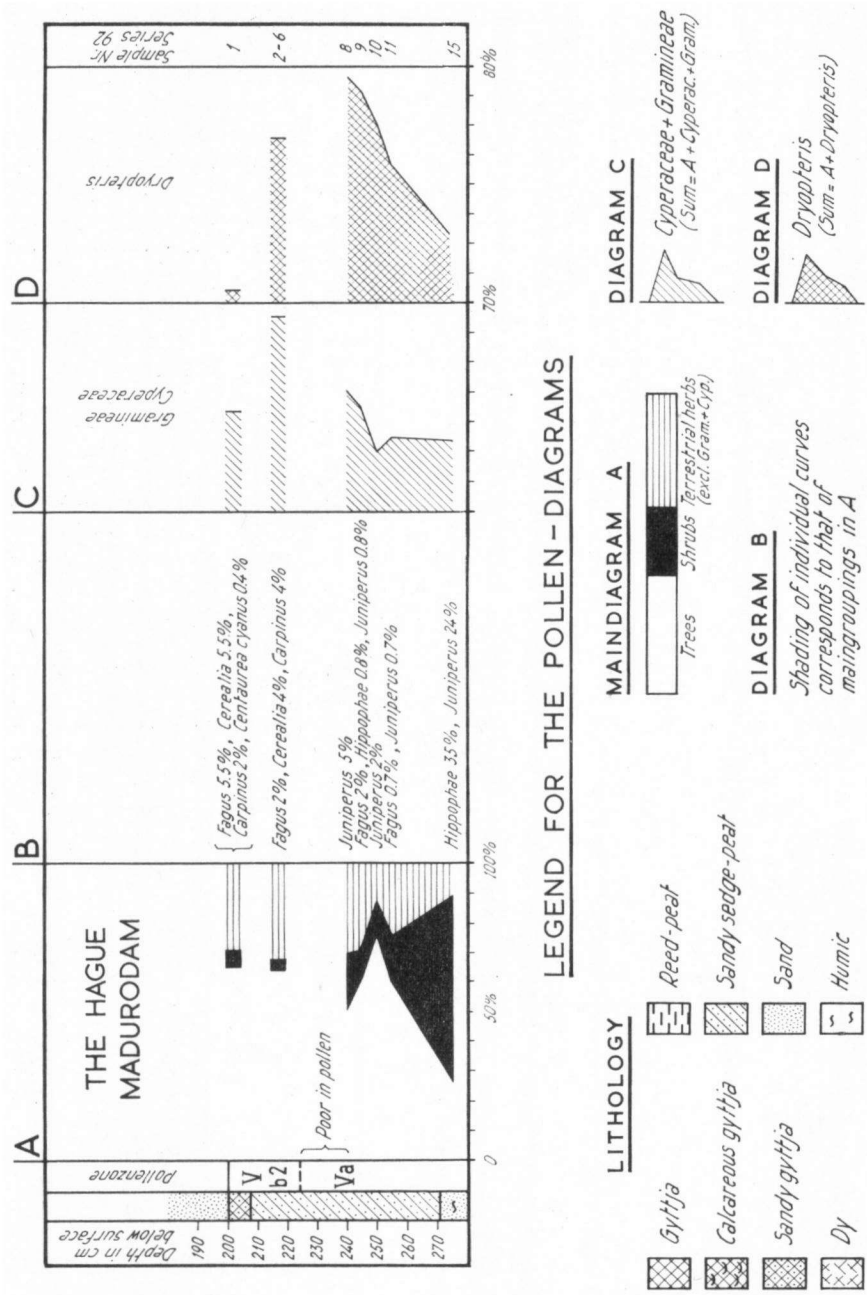

Fig. 5. Pollen-diagram Madurodam (location Fig. 1).

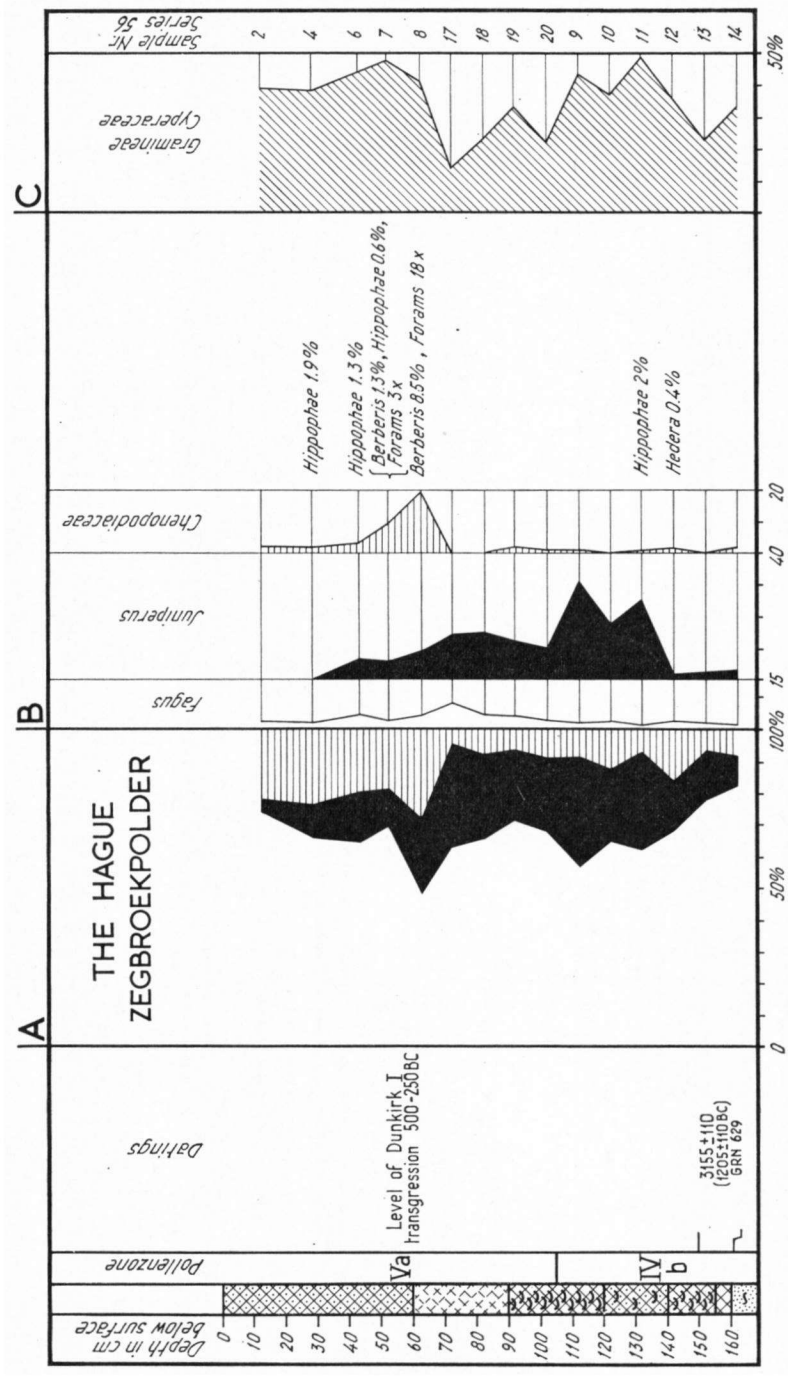

Fig. 6. Pollen-diagram Zegbroekpolder (location Fig. 1; legend Fig. 5).

of *Juniperus*, together with an increase in sandiness of the beds. It might be inferred that in the area forest was partly replaced by a dune-shrub vegetation. Higher up in the diagram the percentages of shrub-pollen gradually decrease again and the topmost spectrum does not show traces of dune shrubs anymore. The trend of the *Fagus*-curve, showing a rise about halfway the diagram, points to deposition during pollen-zone V a (first half of Subatlantic) of the part 0–100 cm of the deposit. In this connection it should be noted that the level 40–60 cm below surface shows a marked increase in *Chenopodiaceae*, as well as the occurrence of *Foraminifera*. The level thus shows a temporary change to saltwater conditions of the otherwise fresh environment. Now in the coastal areas of the western Netherlands a marked transgression phase can be observed within pollen-zone V a (ZAGWIJN, unpublished; JELGERSMA, 1961), which is identical with the well-known "Pre-Roman" or Dunkirk I phase (VAN LIERE, 1948; BENNEMA, 1954; TAVERNIER, 1954; PANNEKOEK, 1956). From this it can be concluded that the marine influence found in the Zegbroek-polder marks the ingression of the sea in this depression during the Dunkirk I phase.

A comparison of this diagram with those of the contemporaneous beds at Meyendel and Madurodam shows that in the latter localities the values for shrubs and herbs are generally higher than at Zegbroek-polder. Probably there the character of the dune landscape was more distinct.

4. CONCLUSIONS

The pollen-diagrams from peatbeds below Younger Dune sand in the area north of The Hague (Meyendel, Madurodam) indicate that in Early Subatlantic times an open dune-shrub vegetation with *Juniperus* and *Hippophaë* was predominant, which was gradually replaced by oak-forest in the first centuries A.D. Deposition of Older Dune sand took place up to this time. Later, at least locally, *Fagus* and *Carpinus* expanded in this forest. Pollen-analysis of the Madurodam section, which is near the eastern limit of the Younger Dunes, indicates that their formation in this area took place at least after 700 A.D., probably even after 1000–1200 A.D. No pollen-data are as yet available to give an impression of vegetation prevailing during the formation of the Younger Dune sands.

This rather late dating of the beginning of Younger Dune formation is in good accordance with a number of archaeological datings from other areas (BRAAT, 1947; TRIMPE BURGER, 1960).

The pollen-diagram Zegbroekpolder from the area south of The Hague indicates prevailing forest in Late Subboreal times and presumably a standstill of aeolian deposition, expansion of duneshrub at the Subboreal-Subatlantic boundary and subsequently reafforestation in the centuries preceding the beginning of our era. On the whole the dunal character of vegetation in the period discussed is less distinct than in the area north of The Hague.

Perhaps this can be attributed to a greater distance from the former coastline, though perhaps also the vicinity of the estuary of the Meuse (the Helinium of Roman times) may have played a role, where groundwater conditions may have been more conducive to the preservation of forest than in drier areas farther away from the river-mouth. As to the character of the dune vegetation it can be remarked that the pollen-diagrams presented in this paper only reflect the presence of dune-shrub. In contrast to such communities found in the present Younger Dunes, which are rich in lime, not only *Hippophaë* has been found but commonly also *Juniperus*. This, together with the presence of *Pteridium* and *Myrica*, points to a less calcareous character of the Old Dune sand.

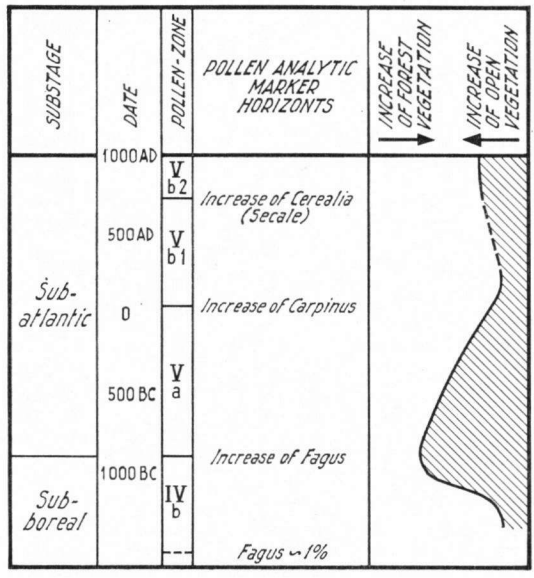

Fig. 7. Table of Late Holocene vegetational history in Dune area of The Hague, as compared with time-scale and pollen-zonation.

In Fig. 7 the conclusions discussed here concerning the alternation of forest and open dune vegetation in this area have been graphically schematized as compared with the pollen-zonation and absolute datings.

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REFERENCES

BAREN, J. VAN. 1913. De vertikale bouw der Zeeduinen in Nederland: 1–20. Leiden.

BENNEMA, J. 1954. Bodem- en zeespiegelbewegingen in het Nederlandse kustgebied. Thesis Wageningen, also in: Boor en Spade **VII**: 1.

BOERBOOM, J. H. A. 1957. Zonering van begroeiing en landschap in het Haagse duingebied. De Levende Natuur **60**:247–259. Also in: Belmontia **II** Ecology fasc. 2 (1958): 10.

———. 1960. De plantengemeenschappen van de Wassenaarse duinen. Meded. Landbouwhogeschool, Wageningen **60** (10): 1–35. Belmontia II Ecol. 7 (1961), 36.

BRAAT, W. C. 1947. Archaeologie, in: Hollands Noorderkwartier. Toelichtingen Geol. Kaart van Nederland, No. 2: 65–78.

HAANS, J. C. F. M. and G. C. MAARLEVELD. 1965. De Zandgronden – Bodem en landschap, in: De Bodem van Nederland.: 195.

IVERSEN, JOHS. 1941. Landnam i Danmarks Stenalder. Danm. Geol. Unders. IIrk – **66**: 1–68.

JELGERSMA, S. 1961. Holocene Sea Level changes in The Netherlands: 1–100. Thesis, also in: Med. Geol. St. C–VI–7.

JESWIET, G. 1913. Die Entwicklungsgeschichte der Flora der holländischen Dünen. Thesis – Zürich.

LIERE, W. J. VAN. 1948. De bodemgesteldheid van het Westland. Versl. Landb. Ond. **59**: 3.

PANNEKOEK, A. J., *a.o.* 1956. Geologische Geschiedenis van Nederland. 's-Gravenhage: 1–154.

STRAATEN, L. M. J. U. VAN 1957. The excavation at Velsen – The Holocene Deposits. Verh. Kon. Ned. Geol. Mijnb. Gen. g.s. **XVIII**: 158–183.

TAVERNIER, R. 1954. Le quaternaire. Prodr. descr. géol. Belg: 555.

TESCH, P. 1920–1930. Duinstudies I–XIII. Tschr. Kon. Ned. Aardr. Gen.: 37–48.

TRIMPE BURGER, J. A. 1960. Geologie en Archaeologie in het Deltagebied. Geol. en Mijnb. **39**: 686–691.

VANHOUTEN, J. 1939. De oppervlaktevormen van het Haagsche duinlandschap. Tschr. Kon. Ned. Aardr. Gen. **56**: 1–50.

ZAGWIJN, W. H. 1959. Het Palaeobotanisch Laboratorium te Haarlem 1953–1959. Jaarversl. Geol. St. 1959: 30–34.