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SOME DATA ON THE HOLOCENE DEPOSITS IN THE MARK AND WEERIJS VALLEYS (PROV. OF NOORD-BRABANT, THE NETHERLANDS)

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ABSTRACT

Descriptions of cores from Holocene sediments in the Mark and Weerijs valleys (Province of Noord-Brabant, The Netherlands) allow the distinction of two groups of profiles. Those of the first group show humous sand at the top, underlain by peat. The sand may be more clayey at the base. In the present paper, this sand is indicated as a type I deposit. In the second group of profiles the peat contains an intercalated fine-sandy clay layer, indicated as a type II deposit. The thickness of this layer varies strongly, and the over- and underlying peat may be partially or wholly absent. Field observations point to a high-water origin of the type I deposits. Micropaleontological data from deposits of type II appear to indicate deposition in a fresh-water environment. Heavy-mineral data from type I and II deposits suggest a common source of origin. Grain size analyses, however, show a marked difference between the two types. This difference in grain-size distribution is attributed to an enrichment of type I deposits by cover sand. Palynological investigation of four complete cores showed that sediments of type I have been deposited in both valleys since the early Middle Ages. In the Mark valley, the deposition of type II started with the Atlantic and continued at least up to the Subatlantic. The formation of this type of deposit in the Weerijs valley appears to be confined to the Subboreal. The earlier sedimentation in the Mark valley is thought to be due to the post-glacial rise of the phreatic surface and to a deeper level of the Mark valley bottom. The presence of type II sediments of Atlantic and Subboreal age intercalated in peat, suggest that this relative rise of the phreatic surface was stronger during the Atlantic and Subboreal.

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INTRODUCTION

During landscape studies, some data concerning the Holocene brook deposits in the Mark and Weerijs (fig. 1) were collected. Since the information on such sediments in the literature is scarce, it seemed worth-while to publish these data.

Pannekoek (1956) and de Jong (1967) discussed brook deposits in general, which they characterize as more or less clay-containing humous fine sands sometimes rich in bog iron. They also pointed out that stagnation of the drainage in such valleys has led to peat formation.

The thesis of de Ploey (1961) contributed valuable information about the adjacent area of the Noorder Kempen in relation to both the morphogenesis of the Mark and Weerijs valleys and the Late Pleistocene and Holocene sedimentation history in the drainage areas of these rivers. According to this author, in the Kempic part of these valleys the relief of the valley bottoms took on its present form in the Late Glacial period. Peat formation occurred in the beginning of the Holocene, and in the valley systems of the Mark and the Weerijs, flat valley bottoms with diffuse drainage developed. There seems to have been almost no erosion in the Holocene. When later climate changes and deforestation increased the discharge and the load of these small rivers, de Ploey's "Holocene alluvium" was deposited, but these sediments were seldom found in the valley systems of the Weerijs.

However, de Ploey neither described this "Holo-

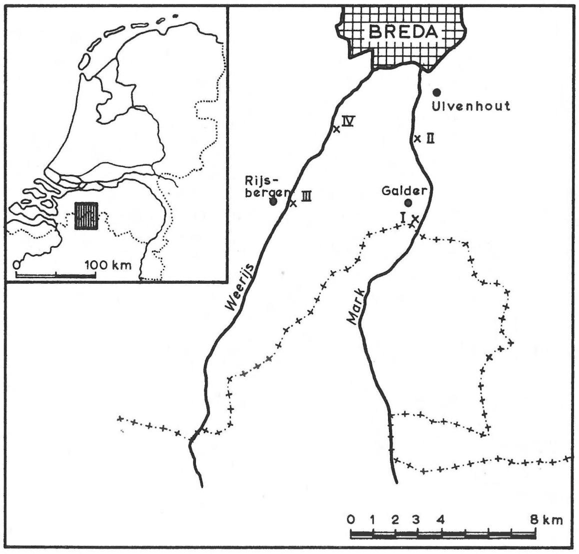

Fig. 1
Location of the palynologically investigated profiles I-IV.

cene alluvium" in detail nor dated it more closely. His illustrations of type-profiles (1961, Plate 24) give the impression that this sediment was only observed overlying Holocene peat in the brook valleys.

In the explanation given on Sheet 50 West of the soil map of The Netherlands 1 : 50.000 (1964), a similar development is indicated for the Netherlands portion of the Mark and Weerijs.

CORE FINDINGS

De Ploey (1961) reports the local occurrence of aeolian shifting of cover sand during the Preboreal and the Boreal. Accumulation of this wind-borne sand very probably took place in topographical depressions. Consequently, the transition from peat to cover sand in cores does not always constitute the lithological indication of the lower limit of the Holocene deposits. For practical reasons, however, the present authors have accepted this lithological transition as such. With the available manpower and boring equipment, it was only occasionally possible to penetrate more than 10 to 20 cm of the sand underlying the peat. In such cases, the sand showed numerous thin peat intercalations. This phenomenon unquestionably points to resedimentation of the wind-borne sand during the commencement of peat formation. But it is clear that at the other locations where the bore could not penetrate the sand at all, thicker layers of wind-borne sand were able to protect a portion of the Holocene deposits from "exposure".

Descriptions of a number of cores taken from the Holocene sediments in both valleys show that two groups of profiles can be distinguished. The profiles of the first group show the following sedimentary sequence: on the Pleistocene sand lies peat which, between 100 to 40 cm under the surface of the ground, shows a transition to very dark brown to greyish-black sandy sediments often containing somewhat more clay at the base of the layer. The present authors have assumed that this sediments represents the so-called brook deposits (de Ploey's "Holocene alluvium"). In the present paper this sediment will be indicated as type I. In the type I deposits the occurrence of a brownish-yellow sandy layer of variable thickness (from 1 to 20 cm) is a frequent phenomenon. The position of the type I sediments suggests that they may be considered as the high-water sediments of the present rivers.

According to the core descriptions of the second group, the peat also contains a fine-sandy clay layer. The underlying peat is sometimes partially eroded, and the peat between the clay layer and the type I deposits is also often absent. This clay layer, which in view of its horizontal discontinuity could better be called a lens, often contains remnants of wood and reed, and frequently large amounts of fine rootlets are widely distributed in it. The colour is greyish-brown to brown, but this variation is sometimes restricted to the upper and lower borders of a lens, the central portion then showing a distinct grey. Clay lenses with a greyish-green to greyish-blue breccious top have been occasionally observed. The clay content within a lens varies widely. The sediment is free of lime and neither shells nor remnants of shells were found in it. These deposits are indicated as type II.

A recent project for canalization and regulation of the Mark and the Weerijs in order to improve the water control in the drainage area of these small rivers, gave the authors the opportunity to study the Holocene fills in exposures. It was found that the occurrence of profiles belonging to the second group sometimes corresponds with depressions in the valley bottom, but it nevertheless remains possible that the type II deposits form a continuous layer in the longitudinal direction of the valley. Unfortunately, a network of borings on which a reconstruction could be based is not available.

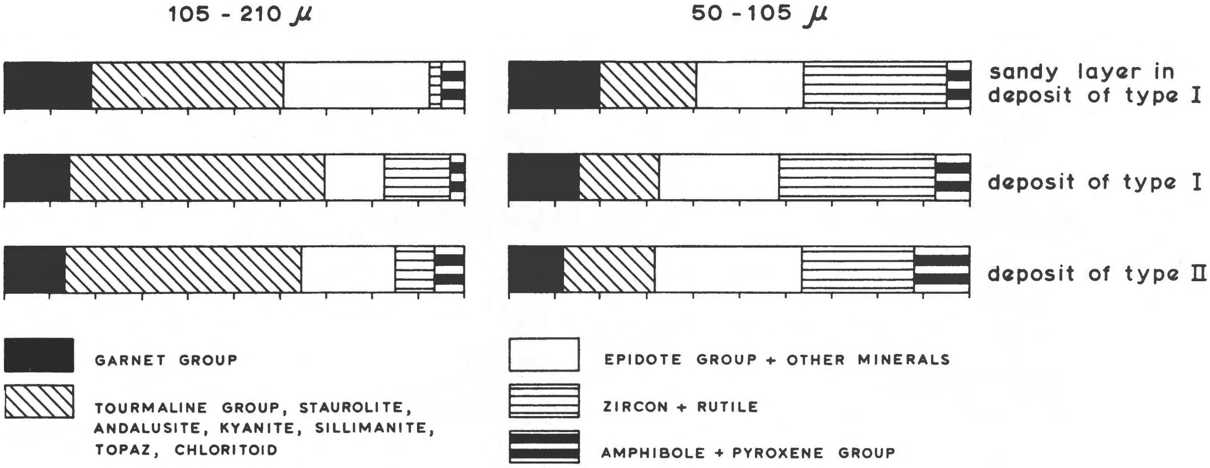

Fig. 2a

Fig. 2b
Exposure of the Holocene sediment in the vicinity of profile III.

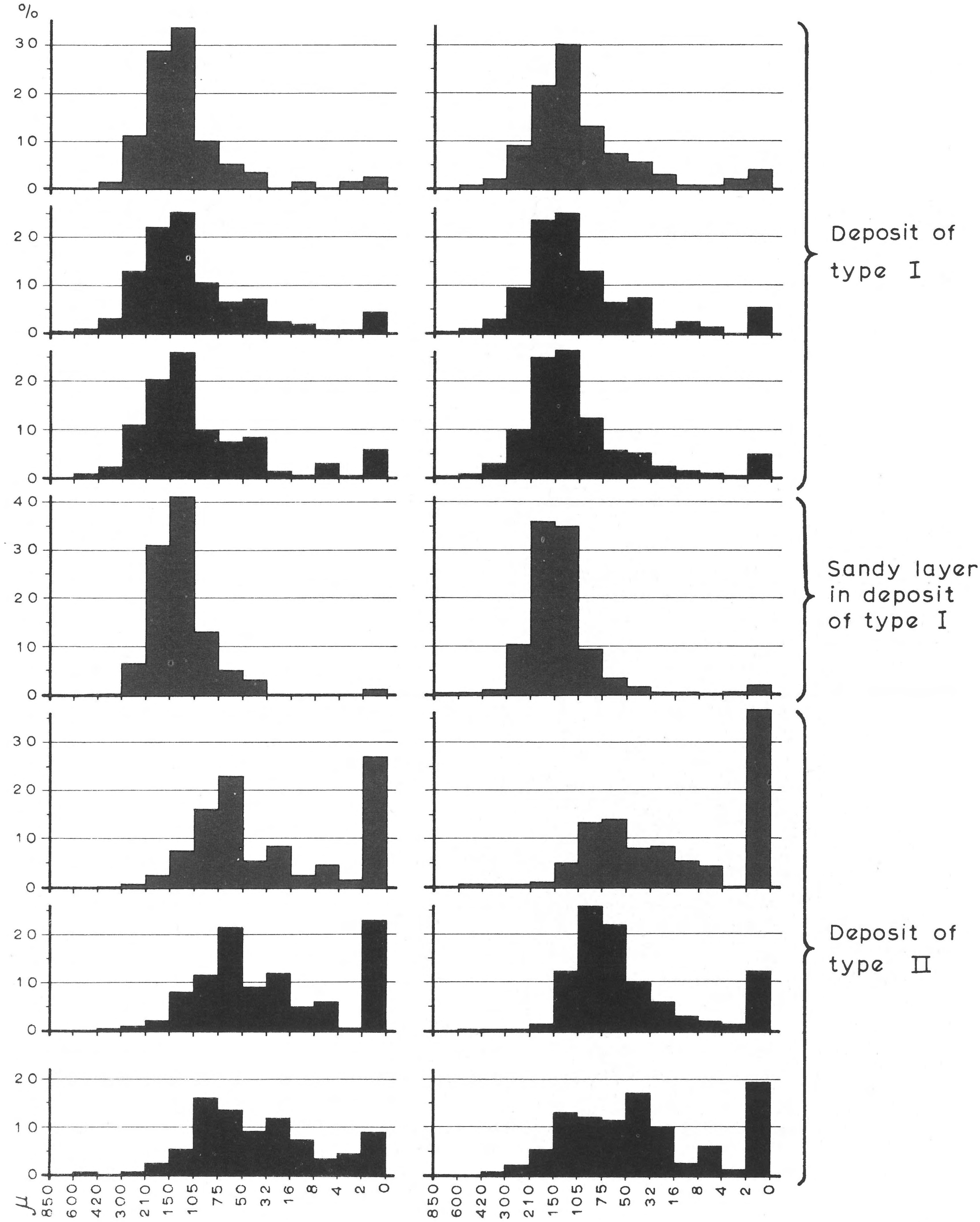
%
30
20
10
0
40
Deposit of type I
Sandy layer in deposit of type I
Deposit of type II
μ
850
600
420
300
210
150
105
75
50
32
16
8
4
2
0

Fig. 3

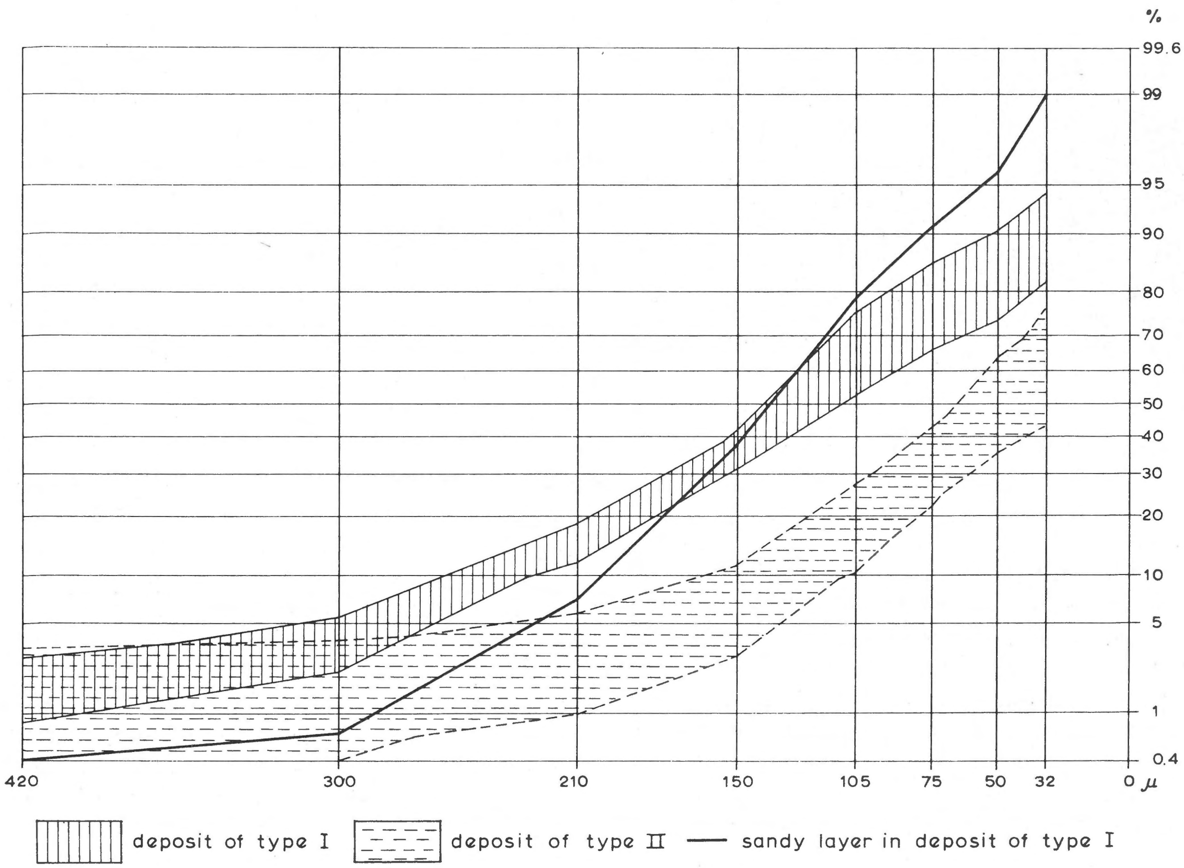

Fig. 4
Cumulative curves of sediments of type I (7), type II (7), and the sand layer in type I (1).

The sometimes partial erosion of the peat under the clay lenses indicates that type II was, at least locally, deposited from running water. To study the conditions of deposition of the sediments of type II, several complete cores were taken in each valley, and material of types I and II was also sampled in various places for further investigation.

MICROPALAEONTOLOGICAL and MINERALOGICAL DATA

Some of the type II samples were examined for ostracods and diatoms as indications of the depositional environment. In the section from 150 to 110 cm below surface in profile I (fig. 6) and 165 to 100 cm below surface in profile II (fig. 7) D. van Harten, of the Geological Institute of the University of Amsterdam, found no ostracods (oral communication). An analysis made by M. Jansma, of the Laboratory for Physical Geography of the University of Amsterdam, likewise yielded no diatoms in these sections. Only at a depth of about 105 cm below surface in profile II (fig. 7) a few shell fragments were found. The clay from 127-85 cm of profile III (fig. 8), to the contrary, contained diatoms. Although many specimens were found to be crushed, the number of intact specimens of various species were sufficient to permit the conclusions that this sediment must have been deposited in a fresh-water environment (Jansma, 1965). It also should be mentioned that, in addition to species occurring in waters with little movement, *Meridion circulare,* a species living pelagically in water with currents, was often found.

In exposures made during the project, mentioned above, samples from both types of deposit as well as

Fig. 5
Sporadic layering in type II deposits. (x 1.5)

from the sand layer, frequently found in type I, were taken for analysis of the transparent heavy minerals. This analysis was limited to the 50 to 105 and 105 to 210 micron fractions, because the grain-size distribution indicated (see under Granulometric Data) that in type I and in the intercalated sand layer the particles of 105 to 210 microns consistently formed the most important sand fractions, whereas in type II the majority of the grams was often between 50 and 105 microns. Figure 2a shows the mineral spectra of the samples obtained from an exposure similar to that shown in figure 2b. The results suggest that the material of both types and of the intercalated sand layer in type I originated from a common supply area.

GRANULOMETRIC DATA

The grain-size distribution of a number of samples of both types of sediment is shown in figures 3 and 4. There is a distinct difference in granulometric distribution between types I and II. Type I shows pronounced sorting: 40 to 60 per cent of the material falls between 105 and 210 microns. Type II has a higher clay content. When the sand fractions of this sediment show a peak, this lies between 50 and 105 micron. The lower degree of sorting is evident. The content of particles below 50 microns varies between 35 and 65 per cent, but in type I this value does not rise above 25 per cent.

The grain-size distribution of the sand often occurring as a thin layer in or at the base of type I was also determined. Its frequency distribution appeared to be characteristic for cover sand. Figure 3 shows the striking agreement in distribution between this material and that of type I.

As mentioned, the sediments of type I represent the high-water deposits of the present Mark and Weerijs rivers. The question arises whether the cover-sand distribution of type I is primary or secondary. In other words, is this frequency distribution solely the result of the granular composition of the transported material and the variation in transport capacity during high-water conditions or must it partly be ascribed to another mechanism?

The presence of a sometimes sharply bordered, yellowish-brown thin layer of sand with a grain-size distribution resembling that of the sediments of type I, shows that the supply of this material took place under "catastrophic" conditions. Deposition of wind-borne sand at an appreciably slower rate during quieter periods could also have taken place. Furthermore, the age of the type I sediments (see under Palynological Data) is also consistent with the assumption that the frequency distribution of type I was strongly influenced by an appreciable enrichment with aeolian-shifted cover sand. For the pollen diagrams show that deposition of the sediments of type I started early in the Middle Ages. Deforestation in this period resulted in an intensification of wind-borne transport, which would explain this enrichment.

The group of type II samples show a less uniform distribution. The core findings indicate that, due to erosion, the peat under these deposits is sometimes entirely or partially absent. This phenomenon, together with the presence of *Meridion circulare* among the diatoms, points to sedimentation from running water. The observations in the field do not permit a more detailed explanation because of the absence of recognizable sedimentation structures in the cores. In all probability, the absence of these structures is a secondary phenomenon caused by intense root growth. The relatively high humus content of the samples (2.3 to 7.4%) points in this direction. Microscopical examination of several undisturbed samples embedded in artificial resin showed either a completely homogeneous texture or a completely random occurrence of texturally differing parts. Only once, in a polished section, we locally observed a wavy, fine layering showing some structural agreement with the familiar undulating marsh laminations

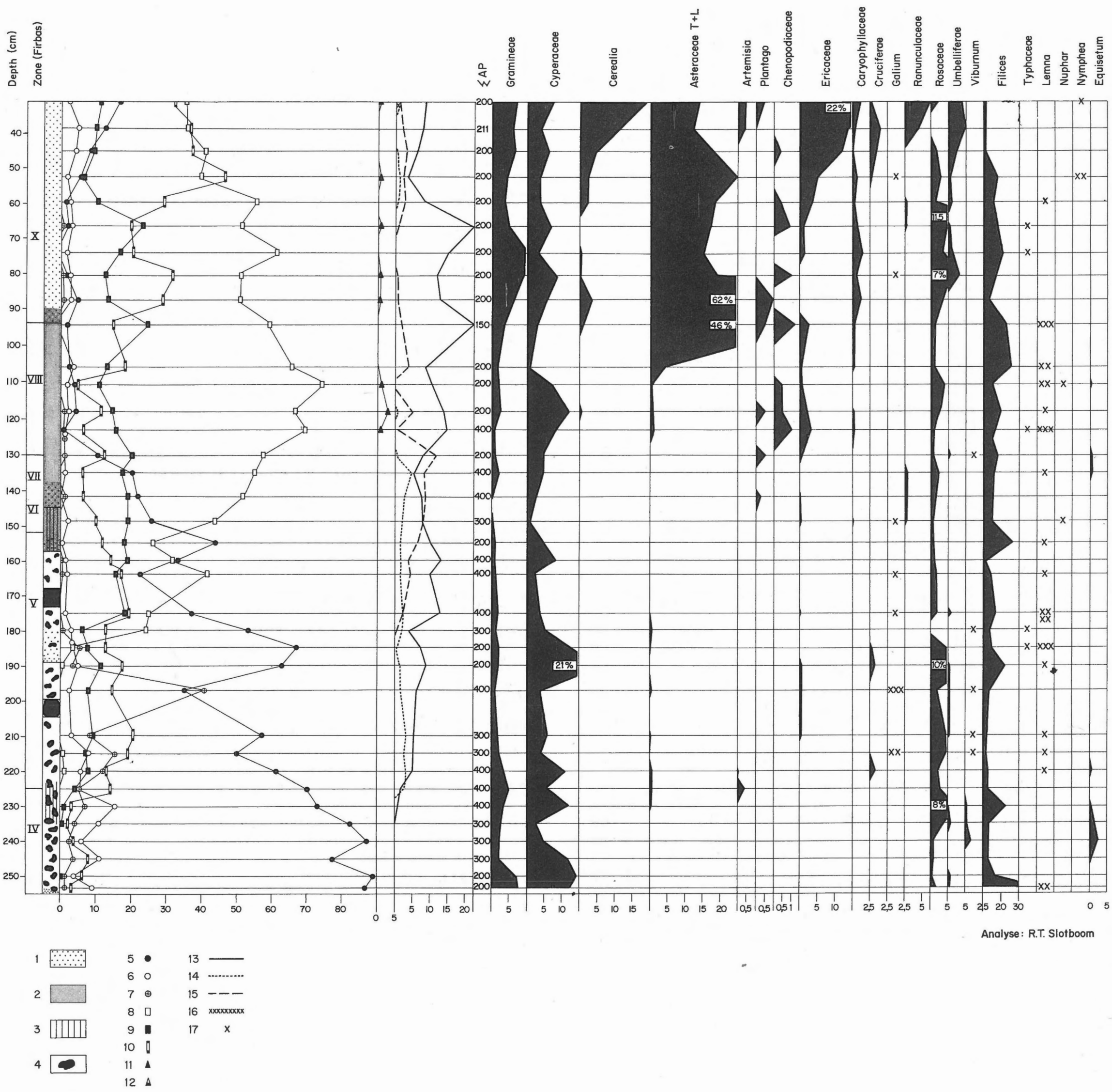

Fig. 6
Pollen diagram of profile I.
1) sand, 2) clay, 3) *Phragmites* peat, 4) wood, 5) *Pinus*, 6) *Betula*, 7) *Salix*, 8) *Alnus*, 9) *Quercetum mixtum*, 10) *Corylus*, 11) *Fagus*, 12) *Carpinus*, 13) *Quercus*, 14) *Ulmus*, 15) *Tilia*, 16) *Fraxinus*, 17) one pollen grain.

(fig. 5). The humus content of this material was also extremely low, i.e. 0.3 per cent. The cumulative curves of the type II samples (fig. 4) show a strong resemblance to those of suspended detritic river materials (D o e g l a s, 1950). Evidently, when the type II sediments were deposited, the current velocity was usually so low that all the suspended material could settle out.

PALYNOLOGICAL DATA

The locations of the four profiles subjected to pollen analysis are shown in figure 1. The pollen content of the minerogenic matter is derived not only from the vegetation in the immediate vicinity of the profiles but probably also from the vegetation of the entire drainage area of the Mark and the Weerijs. In view of the rather limited size of this area, it is assumed that the pollen composition is uniform.

Profile I, map sheet Ginneken nr. 50B, coordinates: 390.9 and 113.1; surface: about 4.25 m above sea-level (Fig. 6).

cm below surface

0 – 95	humous sandy deposits, increasingly clayey toward the base
95 – 145	clay, sandier from 135 to 145
145 – 157,5	clay with *Phragmites*, sandier at the base
157,5 – 168	forest peat
168 – 174	wood
174 – 186	forest peat, sandier at the base
186 – 189	sand
189 – 200	forest peat with *Carex*
200 – 205	wood
205 – 253	forest peat with *Carex* and *Eriophorum*
253 –	sand

From 253 to 225 cm, the deposits are Preboreal (zone IV). Thereafter, *Pinus* decreases but *Corylus* and the *Quercetum mixtum* increase. Up to the definitive *Pinus-Alnus* intersection at about 157 cm, the deposits belong to the Boreal (zone V). The transition from the Boreal to the Atlantic (zones VI and VII) coincides with the occurrence of the mineral sediments of type II in the profile. The Subboreal (zone VIII) starts at the decline of *Tilia* and the rise of the *Fagus* curve at a depth of 130 cm. In zone VIII, *Plantago* is present. The diagram shows no distinct *Fagus* maximum and *Carpinus* rarely occurs. On the basis of these findings it may be concluded that zone IX is absent. The rise of the *Corylus* curve at a depth of 95 cm marks the beginning of zone X and is roughly synchronous with the transition from type II deposits to those of type I.

Profile II, map sheet Ginneken nr. 50B, coordinates 396 and 113.5; surface: about 2.75 m above sea-level (Fig. 7).

cm below surface

0 – 77	humous sandy deposits, increasingly clayey toward the base
77 – 110	clay
110 – 124	peaty clay *(Carex)*
124 – 165	clay
165 – 199	forest peat (wood, remain of leaves and *Phragmites*)
199	sand

In this profile, too, peat formation began in the Preboreal (zone IV). *Pinus* predominates and the percentage of herbs is low. The forests were dense. The boundary between the Preboreal and the Boreal (zone V) lies at a depth of about 177 cm. Beyond this depth the curves of the *Quercetum mixtum* and *Corylus* show a rise. The boundary of the Boreal toward the Atlantic (zones VI and VII) lies at the *Pinus-Alnus* intersection at a depth of 161 cm. In this diagram, too, the beginning of the sedimentation of minerogenic matter coincides with the transition from the Boreal to the Atlantic. The sudden rise in the *Alnus* and *Tilia* curves indicates a hiatus in the upper part of zone V. Starting at 107 cm, *Fagus* gives an uninterrupted curve. This is the lower limit of the Subboreal (zone VIII). This diagram, too, lacks a distinct *Fagus* maximum and there is almost no *Carpinus*. It is evident that here too zone IX was removed by erosion. The increase of *Corylus* and cultivated plants at a depth of about 77 cm marks the beginning of zone Xa. The sharp increase of *Pinus* at a depth of 53 cm forms the beginning of zone Xb.

Profile III, map sheet Rijsbergen nr. 50A, coordinates 392.2 and 107.8; surface: about 5 m above sea-level (Fig. 8).

cm below surface

0 – 55	Humous sandy deposits
55 – 85	*Carex* peat with *Sphagnum* and remains of wood, upper part sandy
85 – 127	clay with *Carex* roots
127 – 141	*Carex* peat
141 – 156	clay, at the base sandy
156 – 172	forest peat, remains of wood and leaves with *Carex* and *Phragmites*
172 –	sand

The commencement of peat formation lies in the Subboreal (zone VIII). In this profile the deposition of clay (type II) occurred only in this zone. *Ulmus* is present only in very low percentages. The *Tilia* content varies between 1 and 5.5 per cent, that of *Fagus* around 1 per cent. *Plantago, Cerealea, Rumex* and *Chenopodiaceae* are already represented in the vegetation, and *Carpinus* is present in some spectra. The increase of *Fagus*, the uninterrupted course of the *Carpinus* curve, and the decrease of *Corylus* and *Tilia* make it highly probable that the boundary between the Subboreal and the Subatlantic (zone IX) is located at about 85 cm. Above 60 cm there is a drop in the *Carpinus* percentages and *Corylus* again increases. In zone X the cultivated plants show a further increase. As in the profiles from the Mark, sediments of type I were deposited in this zone.

Profile IV, map sheet Rijsbergen nr. 50A. coordinates: 395.1 and 109.9; surface: about 3 m above sea-level (Fig. 9).

cm below surface

0 – 43	brownish-grey to black humous sandy deposits; between 12 and 43 cm, distinct gley phenomena
43 – 73	clayey peat changing to *Carex* peat, increasingly clayey toward the base, remains of wood at 43 cm
73 – 127	clay; starting at 110 cm, peaty clay, remains of wood and *Ericaceae*
127 – 255	forest peat with *Carex* changing to *Carex* peat
255 –	grey sand

In this profile from the valley of the Weerijs the

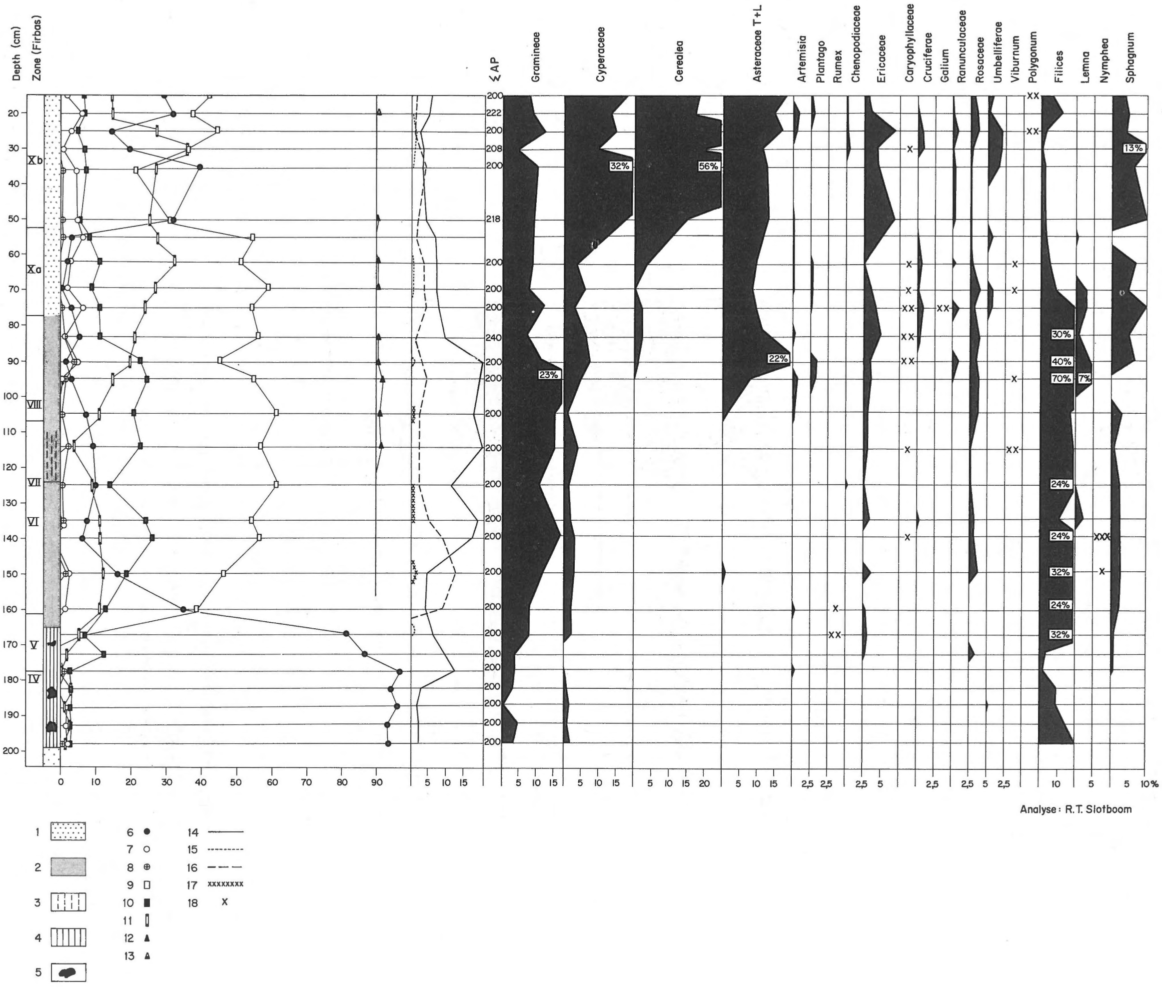

Fig. 7
Pollendiagram of profile III.
1) sand, 2) clay, 3) *carex* peat, 4) *Phragmites* peat, 5) wood, 6) *Pinus*, 7) *Betula*, 8) *Salix*, 9) *Alnus*, 10) *Quercetum mixtum*, 11) *Corylus*, 12) *Fagus*, 13) *Carpinus*, 14) *Quercus*, 15) *Ulmus*, 16) *Tilia*, 17) *Fraxinus*, 18) one pollen grain.

formation of peat began in the Preboreal (zone IV). Between 240 and 193 cm, the peat is of Boreal age (zone V). At 193 cm, *Pinus* shows a sharp decrease, *Alnus* a sharp increase, and *Corylus* a further decrease, together indicating the lower limit of the Atlantic (zones VI and VII). *Fagus* appears at 127 cm, and shortly thereafter cultivated plants such as *Asteraceae, Chenopodiaceae, Plantago* and *Rumex*. The transition from the Atlantic to the Subboreal (zone VIII) can thus be localized at this depth. The sedimentation of type II material from this Weerijs profile, too, appears to have occurred only in this zone, which ends at 71 cm. At a depth of 71 cm, *Fagus* begins to increase, *Carpinus* is present, and *Tilia* decreases further, which is a distinct indication of the commencement of the Subatlantic (zone IX). Above 44 cm is a further increase of the cultivated plants, *Corylus* increases, and *Fagus* decreases (zone X). In this profile, too, the deposition of type I sediments occurred in this zone.

In order to obtain a clearer picture of the changes in the vegetation, groups were formed of the components occurring in dry as well as in wet places. The dry components include *Corylus, Pinus, Quercus, Ericaceae, Cerealea* and *Asteraceae*. The *Asteracea* are placed among the dry components because there is reason to believe that they formed part of the vegetation on drier soils. The wet components are represented by *Alnus, Cyperaceae, Filices* and *Hydrophytes (Lemna, Menyanthes, Nymphea, Typha)*. Experience has shown that the *Filices* occur very locally, but usually under swamp conditions. The frequency of a given component within the "wet" and "dry" groups is shown as percentages per spectrum. Figures 10 and 11 show the diagrams obtained in this way for profiles II and IV.

From these diagrams, the authors have drawn the following conclusions. During the Atlantic, in which period clay was formed in profile II (Mark) and peat in profile IV (Weerijs), the forests on the higher

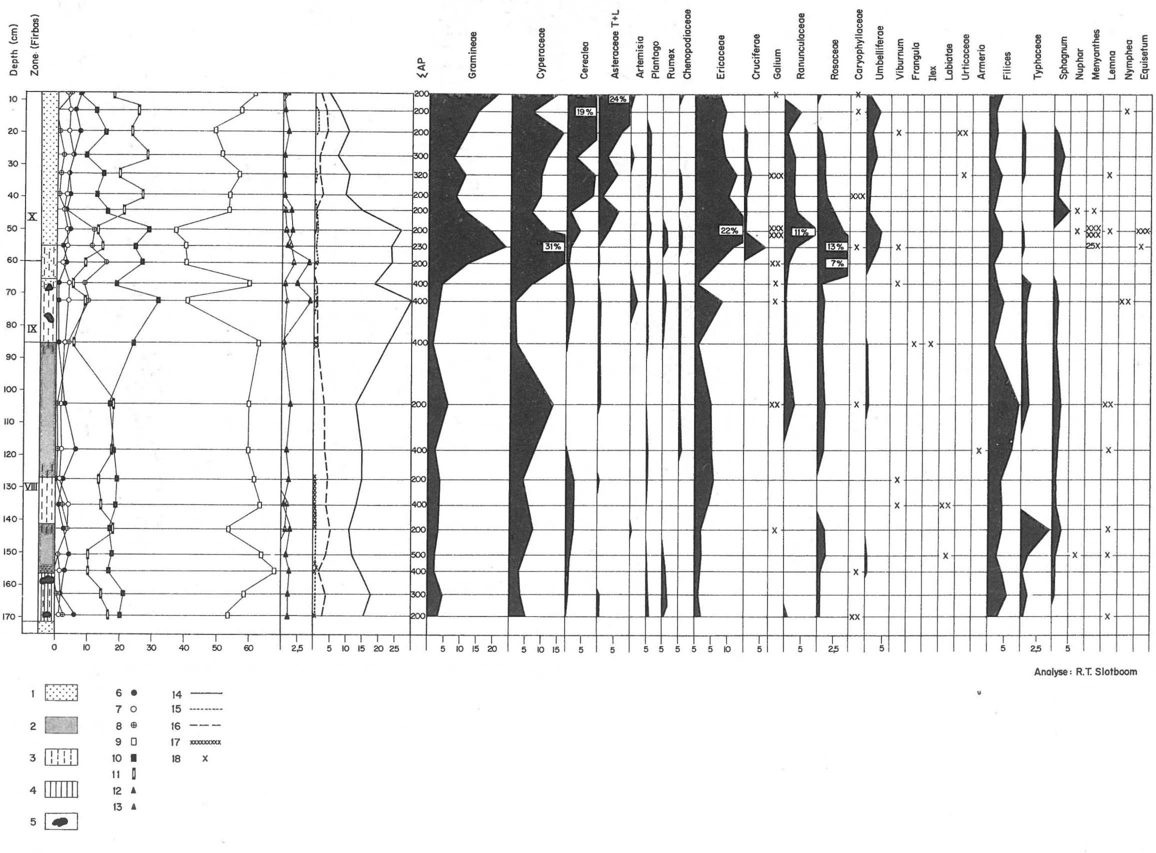

Fig. 8
Pollen diagram of profile III. See legend, Fig. 7.

grounds were dense. In the valleys themselves, an Alnetum occurred. In the valley of the Mark the percentage of *Alnus* pollen reached values of 47 to 65, in that of the Weerijs 95 to 100. Profile II (Mark) indicates that during the last part of the Atlantic, even the forests on the higher grounds were less dense. This difference in lithology between the Mark and the Weerijs areas during the Atlantic is explained by the assumption that part of the valley bottom of the Mark, lay below the level of the ground-water, whereas in the valley of the Weerijs such areas were negligibly small. As a result, a very dense Alnetum growth could develop in the latter valley, but in the valley of the Mark the transition from a diffuse to a linear drainage led to less favourable conditions for the development of such dense alder stands.

In the Subboreal, too, the height of the ground-water level appears to have been the most important regulatory factor in the development of the vegetation and the mineral sedimentation. In the Mark

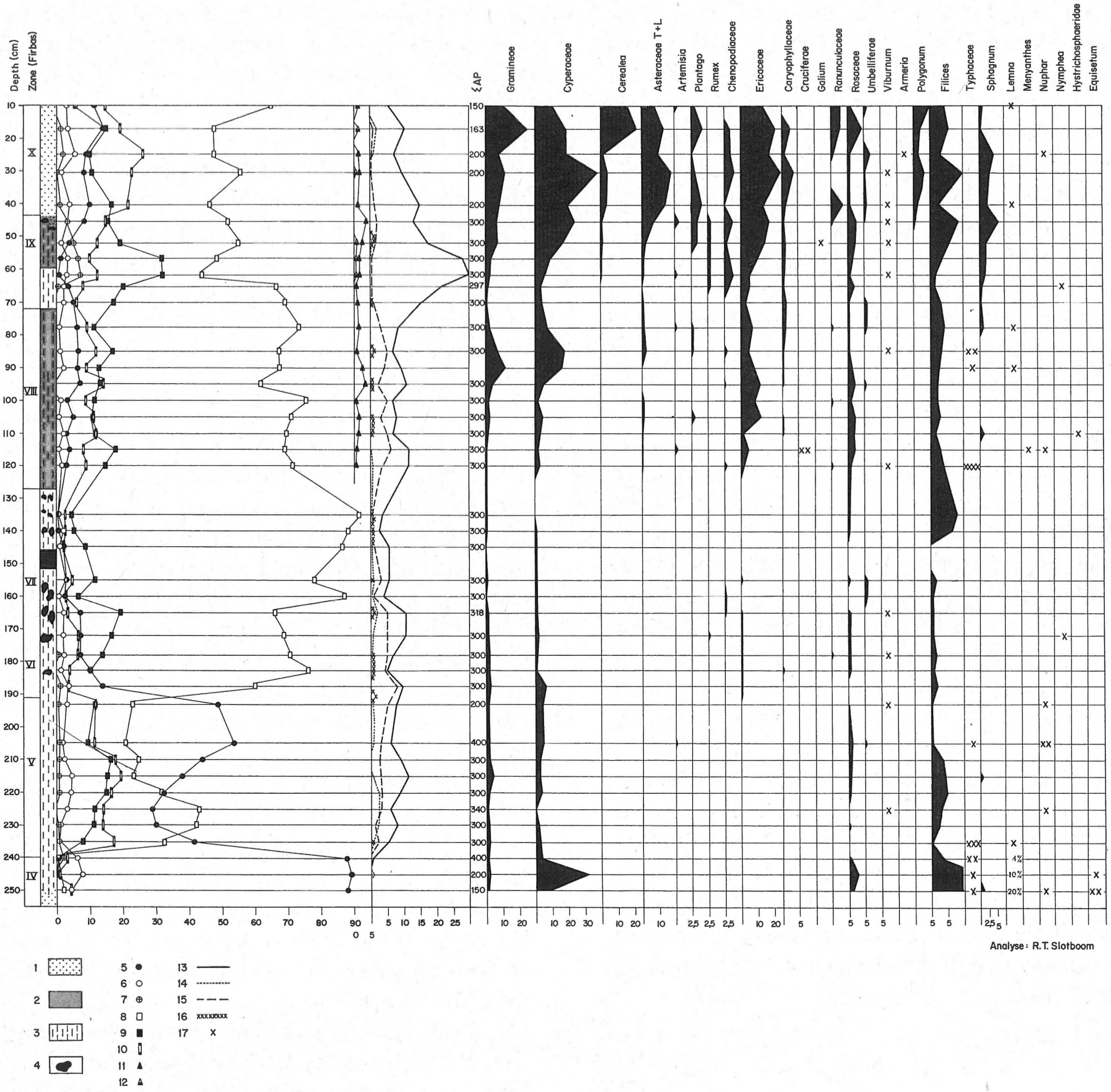

Fig. 9
Pollen diagram of profile IV.
1) sand, 2) clay, 3) *Carex* peat, 4) wood, 5) *Pinus*, 6) *Betula*, 7) *Salix*, 8) *Alnus*, 9) *Quercetum mixtum*, 10) *Corylus*, 11) *Fagus*, 12) *Carpinus*, 13) *Quercus*, 14) *Ulmus*, 15) *Tilia*, 16) *Fraxinus*, 17) one pollen grain.

valley the Alnetum became somewhat less dense and the deposition of type II sediments continued. In the Weerijs valley type II sediments were deposited, accompanied by a decrease of *Alnus* favouring *Cyperaceae* and *Filices*. Apparently, the ground-water level rose so much in the Atlantic that here during the Subboreal the same situation prevailed as in the Mark valley during the Atlantic. It can be seen from both figure 10 and figure 11 that in the course of the Subboreal the forests on the higher, drier places became consistently less dense.

It is remarkable that in the pollen diagrams of the Mark no human influences can be detected causing the reduction in the density of the forests which started toward the end of the Atlantic. *Cerealea* does appear in zone VIII of profile II (fig. 10) as an indicator of human activity, but the hiatus in the upper part of this zone (zone IX is entirely absent) makes the presence of *Cerealea* somewhat inconclusive. The present authors are of the opinion that the idea that the decrease in the density of the forests is primarily related to an excessively high ground-water level, is in better agreement with their data. This process of natural thinning was probably later intensified by man's agricultural practices.

In the Weerijs valley, peat formation took place in zone IX. Figure 11 shows that this was accompanied by a slight increase of Alnetum on lower-lying grounds and an increase of *Quercus* on the higher parts of the landscape. As mentioned, zone IX is missing in figure 10. It is also absent in profile I, due to erosion. The core findings show that in the valley of the Mark, remnants of a clayey peat layer occur between the deposits of types I and II. The present authors therefore assume that in this valley, too, peat formation at least locally occurred. In the context of the foregoing, this means that zone IX reflects a period with less rise in the ground-water level. At the end of this period and during zone X, deposition of type I occurred in both valleys. On higher grounds the forests became less dense in the sense of a decrease of *Quercus*. The marked increase of *Cerealea* makes it likely that in this change man now played an important role.

CONCLUSIONS

1. Descriptions of cores of the Holocene sediments in the Mark and Weerijs valleys fall into two groups of profiles. The first group shows the following succession in the upward direction: peat, sand (type I); the second group: peat, sandy clay (type II), peat sand (type I). In the latter group the peat under and/or above type II may be partially or entirely absent.
2. Diatoms in some of the samples of type II sediments indicate sedimentation under fresh-water conditions. The absence of the skeletons of these micro-organisms in the older type II deposits in the Mark profiles (profiles I and II) is remarkable.
3. The results of some heavy-mineral analyses show that types I and II do not differ significantly, but rather show a remarkably strong agreement. This suggests that both types consist mainly of material derived from the same supply area.
4. The grain-size distribution of type I and II deposits show marked differences. That of type I, which from field observations can be said to form the high-water deposits of the rivers shows strong agreement with this distribution in cover sand. This phenomenon is ascribed to enrichment of type I with wind-borne cover sand. With respect to the sediments of type II, the grain-size distribution together with the field observations and the diatom association suggest sedimentation under fluvial conditions.
5. In both valleys the deposition of type I sediments took place in the same period, i.e. the Subatlantic. The formation of type II deposits in the two valleys was only partially synchronous. In the valley of the Weerijs, deposition began in the Subboreal and ended during the transition from the Subboreal to the Subatlantic. In the valley of the Mark, to the contrary, these sediments were deposited as early as the beginning of the Atlantic. The absence of zone IX in the two pollen diagrams of the Mark makes it difficult to identify here the end of the deposition.
6. The great difference in time between the beginning of the deposition of type II sediments in the Mark and Weerijs valleys and the parallelism between the mineral sedimentation in the valleys on the one hand and the vegetational development in the landscape on the other, is ascribed to the

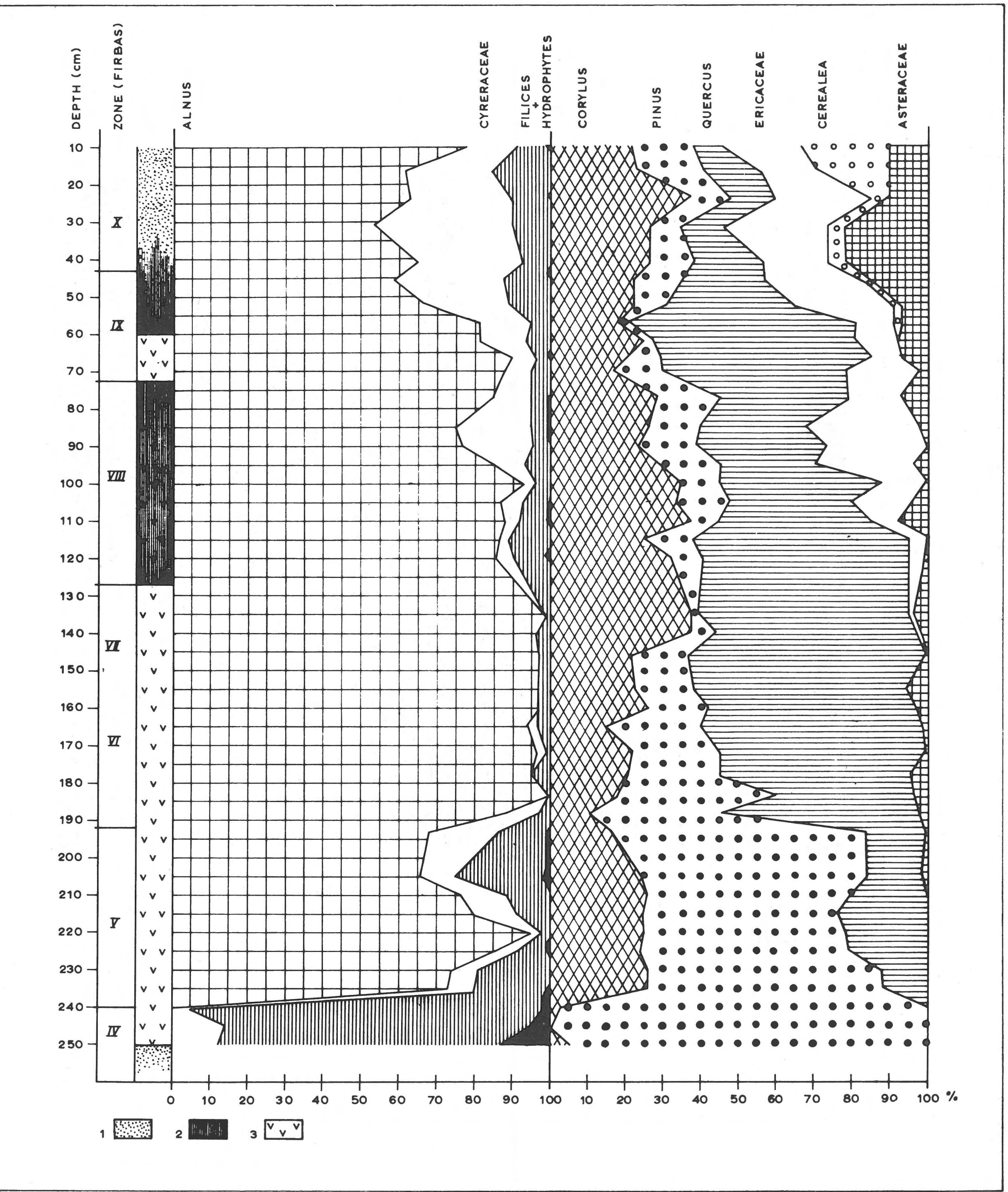

Fig. 10
Profile II. The lefthand column shows the changes in the vegetation within the group of the "wet" components, the righthand column those within the group of the "dry" components.

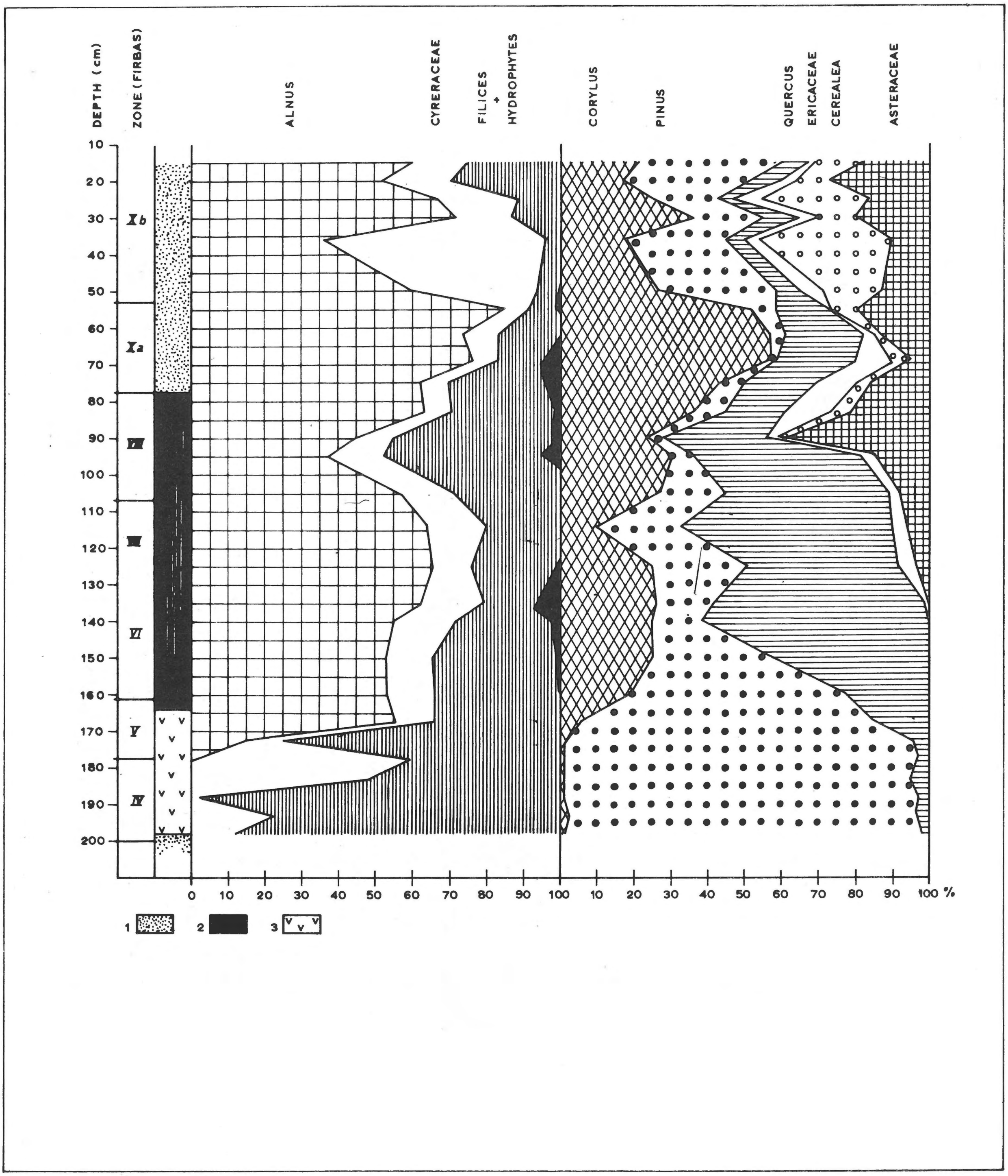

Fig. 11
Profile IV. The lefthand column shows the changes in the vegetation within the group of the "wet" components, the righthand column those within the group of the "dry" components.

relative rise of the phreatic surface during the Holocene. The Atlantic and Subboreal type II deposits intercalated in eutrophic peat suggest that this rise was greater in the Atlantic and Subboreal.

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