PALYNOLOGY OF THE PEAT DEPOSITS ALONGSIDE THE LEUVENUM BROOK

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1. INTRODUCTION

The wide valley of the Leuvenumse Beek (Leuvenum Brook) in the northern Veluwe originated from a lobe of the Riss (Saale) ice-sheet which pushed up the ridges bordering the depression *(Fig. 1)*.

Fluvioglacial deposits (kame terrasses, MAARLEVELD 1962) are to be found on the margin of these ridges and in several places the cover sand or gravelly solifluction layer of the valley is underlain by a heavy stratified fluvioglacial clay (CROMMELIN & MAARLEVELD 1952). This layer is particularly moisture retentive, so that the overlying soil becomes soaked and marshy and overgrown with a carr association interspersed with grasses and sedges.

During the Würm Glacial and Late Glacial periods water flowed down from the ridges and accumulated in the valley. But when the permafrost began to thaw in the Holocene and forest growth started, the water became dammed by the vegetation but not altogether impeded. It trickled down from the slopes and oozed into the depression, accumulating in the narrow channel of the brook. Peat began to grow at the same time in the lowest places along the banks.

2. COMPOSITION OF PEAT AND VEGETATION

At present the Leuvenum Brook is bordered by a dense belt of alder-birch woodland, here and there on peat soil The peat layer, overlying cover sand, reaches a maximum depth of 1.75 m. The deposit starts with birchwood rich in grasses and sedges. The character of the vegetation did not greatly change during peat development, but as the climate improved thermophilous species sprang up in addition to the birch. The entire peat deposit consists of swamp brushwood. It seems evident that the water level rose at the same rate as the growth of the deposit.

According to MOERMAN (1934) the water level of the brook and valley was artificially lowered from the 17th century onward. This must have had an effect on the vegetation and peat growth. Unfortunately the younger peat layers have been disturbed or are absent. It is a well-known fact that during World War I most of the peat in this area that could be used was cut for fuel (VAN ZINDEREN BAKKER 1948).

At the site where Diagram III was sampled the carr is moribund. The birch trees have died or look very unhealthy, *Sphagnum* is spreading and the brushwood contains a considerable amount of *Myrica gale*. Obviously bog development is starting or regenerating, the present vegetation being a transitional

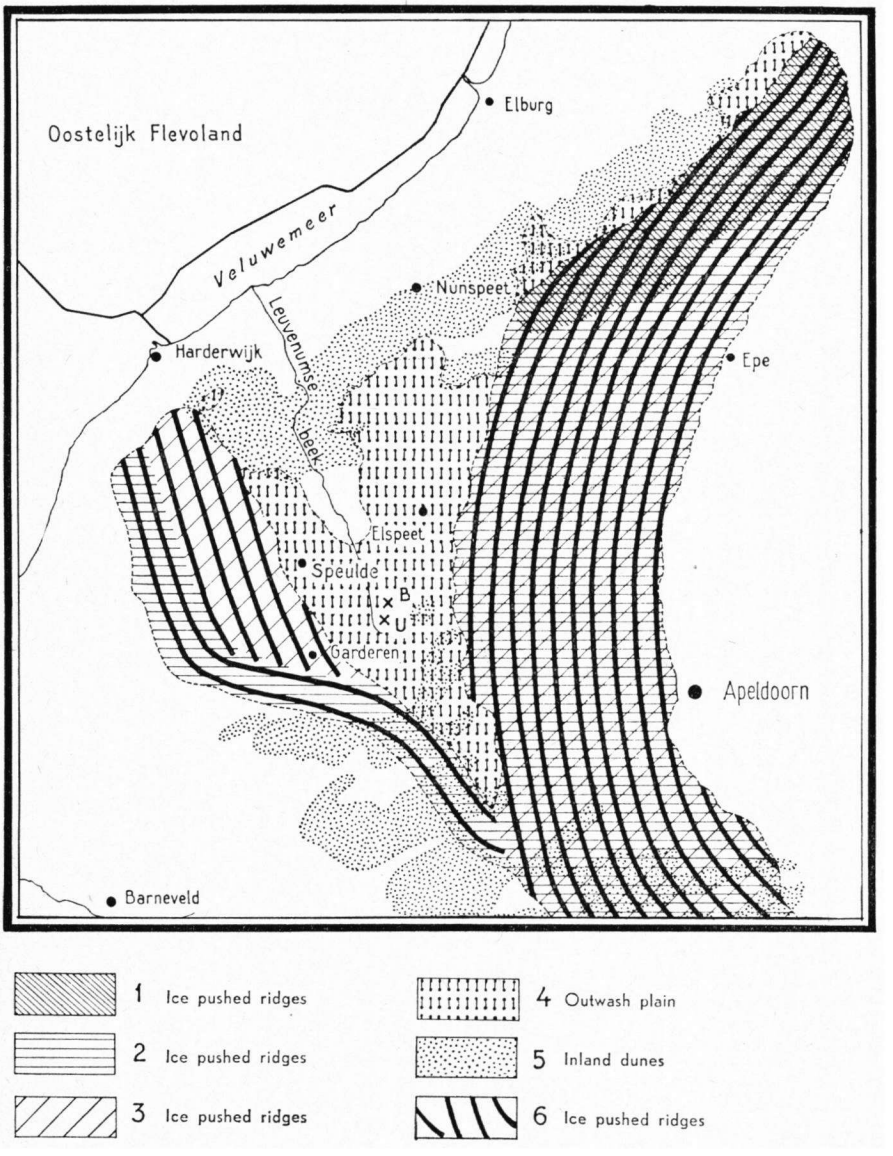


Fig. 1. Map of the northern Veluwe

stage. The lowering of the water level must have affected the woodland vegetation which under the prevailing climatic and hydrological conditions is dus to merge into a sphagnum bog. The present vegetation has the characteristice of the *Frangulo-Salicetum* and has developed from a *Sphagno-Alnetum* (DOING 1962).

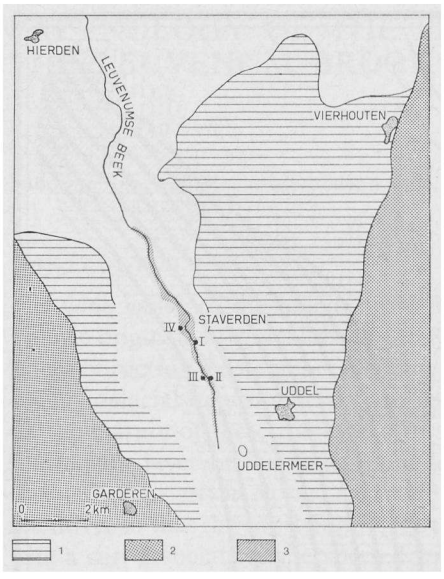
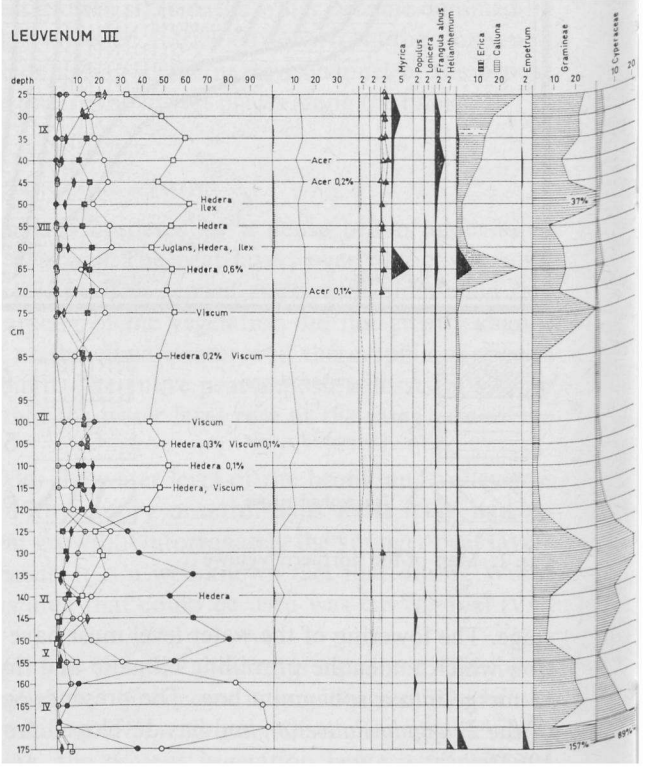


Fig. 2. Leuvenum Brook (after G. C. Maarleveld)
1 = Fluvioglacial; 2 = Pushed preglacial; 3 = Peat. I, II, III, IV = location of samples.



3. THE DIAGRAMS

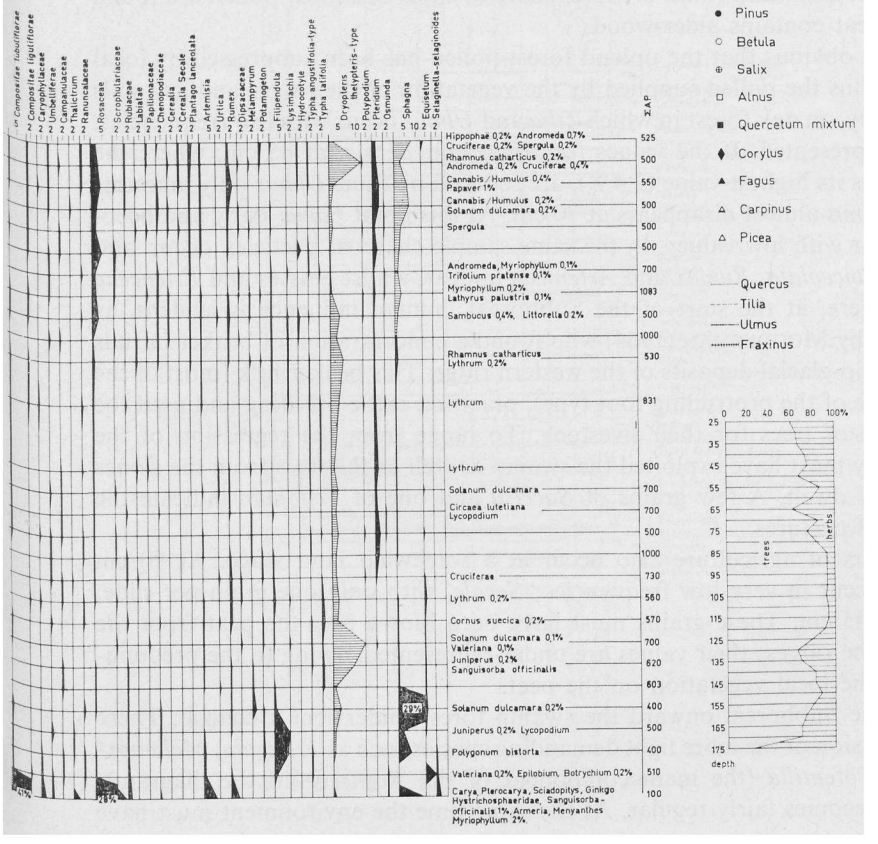
Four profiles were sampled alongside the brook and one in a side-stream completely overgrown with peat (a meandering depression in a meadow).

Only two of the four sequences are shown diagrammatically in addition to that of the overgrown side-stream; the others proved to be contaminated, especially in the upper layers.

Diagram III and that of the overgrown side-stream start with a birch forest interspersed with grasses and sedges. Profile IV also begins in the same period, but the diagram is not shown because the upper section has been disturbed.

DIAGRAM III

The bottom layer at 1.75 m, mixed with cover sand, might still be considered as belonging to the Younger Dryas period, with 22% of trees. Heliophilous elements occur in low frequencies, e.g. *Helianthemum oelandicum*, *Artemisia*, *Sanguisorba officinalis*, and *Selaginella selaginoides*. The grass and sedge values are high.



Most noticeable is the occurrence of a number of grains of tertiary origin: *Carya*, *Pterocarya*, *Ginkgo*, and *Hystrichospheridae*. The fairly high amount of *Pinus* may also be connected with these exotics; one *Pinus haploxylon* was found, together with a few other deviating types of *Pinus*.

It has already been stated that the cover sand of the valley contains fluvioglacial components originating from the kame terrasses. The tertiary pollen grains are derived from the fluvioglacial, which is rich in such elements (POLAK 1963).

The next sample at 170 cm is characteristically Preboreal with a distinct dominance of *Betula* (97.5%). The great amount of birch pollen partly originates from local growth; anthers were found filled with *Betula* pollen. The same sample is rich in fungal hyphae and contains some charcoal. The occurrence of one grain of *Epilobium* might be significant in this connection.

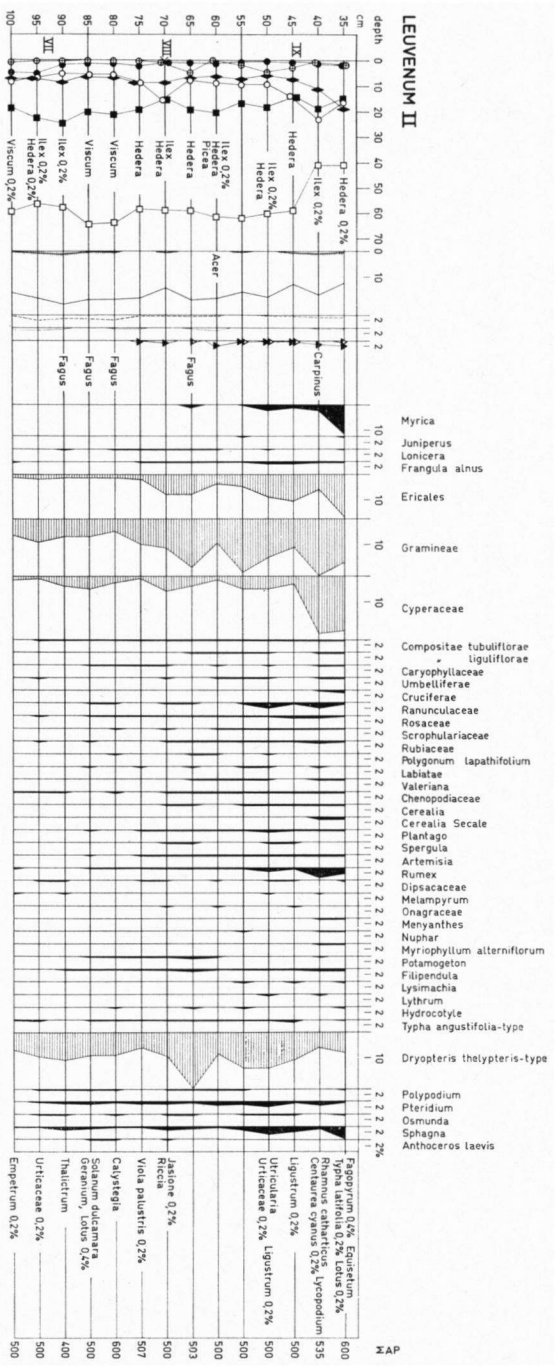
The values for birch remain high until *Pinus* rises and becomes dominant. At the same time the first thermophilous trees appear; *Alnus*, *Quercus* and *Corylus*. The hazel, prefering upland soils, does not reach high maxima, but *Pinus* invades the swamp; the stomata are found in the peat.

At 120 cm the pine forest changes into an alder swampwood with birches and willow, *Salix* and *Alnus* are local; several clods of willow pollen are found and the peat contains alder-wood.

It seems obvious that the upland forest pollen has been suppressed by local growth. Thus the pollen supplied by the vegetation of the ridges and dry soils of the valley, an oak forest in which *Tilia* and *Ulmus* occur with low frequencies, is underrepresented. If the values for *Alnus* and *Betula*, at 85 cm, where the elm reaches its highest value (2.4%), are reduced by four, *Ulmus* only amounts to 4%. *Ulmus* almost disappears at 70 cm. At this point *Fagus* starts and becomes regular with low values. In the same sample charcoal particles occur and *Plantago lanceolata*, *Rumex* and *Artemisia* appear, whilst grasses and *Ericaceae* expand. Here, at the start of the Subboreal, human influence is evident, as borne out by MODDERMAN (1964) who found a concentration of beaker burials on the fluvio-glacial deposits of the western ridge. This beaker folk (most of the beakers are of the protruding foot type), practised cattle breeding and used the the foliage of trees for their livestock. To judge from the regression of the forests they must have exploited the swamp as well as the trees from the slopes where they dwelt. A few grains of *Succisa* and one of *Trifolium* indicate the presence of pastures.

Indicators of agriculture also occur at a somewhat later stage. At 70 cm Cerealia occur in very low frequencies; *Secale*, with only one grain per slide, occurs at 45 cm. These grains must have been blown into the peat from the slopes of the ridges; their values are under-represented, owing to the predominance of the local vegetation on the peat.

From the Subboreal onward the swamp forest underwent a change. There is an expansion of the more light demanding species such as *Frangula*, *Melampyrum* and *Potentilla* (the main component of the *Rosaceae* in the diagram); *Lonicera* becomes fairly regular. At the same time the environment must have


LEUVENUM II
depth cm
Myrica
Juniperus
Lonicera
Frangula alnus
Ericales
Gramineae
Cyperaceae
Compositae tubuliflorae
Compositae liguliflorae
Caryophyllaceae
Umbelliferae
Cruciferae
Ranunculaceae
Rosaceae
Scrophulariaceae
Rubiaceae
Polygonum lapathifolium
Labiatae
Valeriana
Chenopodiaceae
Cerealia
Cerealia Secale
Plantago
Spergula
Artemisia
Rumex
Dipsacaceae
Melampyrum
Onagraceae
Menyanthes
Nuphar
Myriophyllum alterniflorum
Potamogeton
Filipendula
Lysimachia
Lythrum
Hydrocotyle
Typha angustifolia-type
Dryopteris thelypteris-type
Polypodium
Pteridium
Osmunda
Sphagna
Anthoceros laevis
ΣAP

become wetter, probably as a transition phase to bog formation. *Sphagna*, *Erica*, *Potamogeton* and *Hydrocotyle* increase.

However, it cannot be stated whether bog formation actually took place, because the youngest strata have either been disturbed or removed. The diagram therefore ends in the first zone of the Subatlanticum.

DIAGRAM II

The same trend as in Diagram III can be found in Diagram II, except that the peat starts at a later period, *viz.* well into the Atlanticum. It obviously originated from a diversion of the bed of the brook.

Ulmus occurs in very low frequencies; its highest value is 1.2% and it usually remains below 1%, so that there is no clear *Ulmus* fall. *Tilia* reaches somewhat higher values, the maximum being 2.2%, *Alnus* and *Betula* are local. The peat contains a fair amount of stalks, leaves and spores of *Hypnaceae* and spores of liverworts. It is rich in ferns; *Osmunda* occurs fairly regularly.

At 60 cm there is an infiltration of charcoal particles: the slide contains one grain of *Epilobium*. At 80 cm the first weeds appear in low values (*Plantago Artemisia*, *Rumex*) and at 75 cm. *Fagus* becomes continuous. The first Cerealia (one grain of *Hordeum*) occur at 55 cm; *Triticum* is present with one grain at 50 cm and both species remain regular with very low values, the uppermost two samples containing a maximum of 1.2% of *Secale*. *Fagopyrum* and *Centaurea cyanus* also occur; if they do not originate from contamination, which is fairly likely, this would indicate the second Subatlantic period.

As in section III, the swamp forest becomes more open in the upper levels; light-demanding species expand, in addition to precursors of bog formation.

DIAGRAMS I AND IV

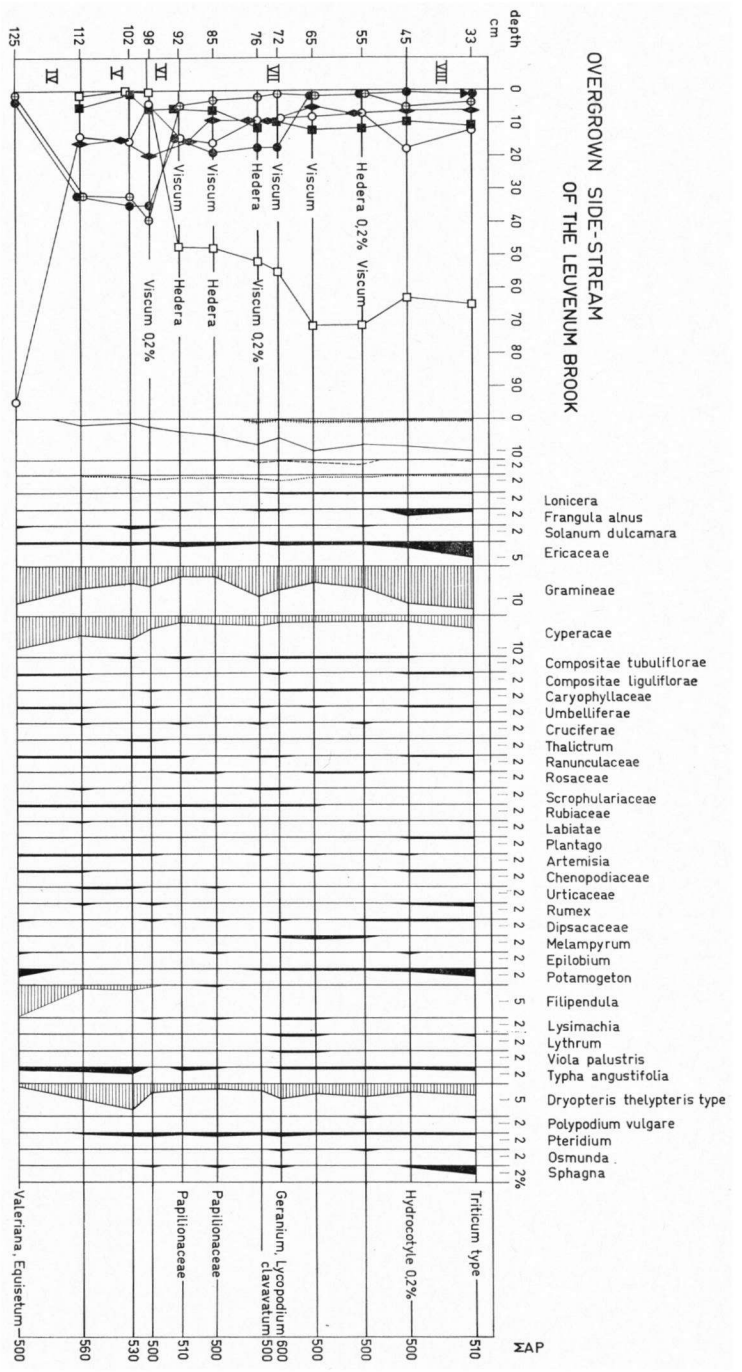
As stated above, these diagrams are not included owing to contamination.

Sequence I is very rich in wood which sometimes filled the core of the Dachnowsky auger and often compressed the peat to such a degree that the succession was disturbed. The same applies to sequence IV.

The latter starts in the Preboreal at 175 cm with 90% of *Betula*. The birch occurred locally; the peat contains coneshales and pollen-filled anthers. *Betula* is succeeded by *Pinus*, and local growth can again be assumed from the occurrence of the stomata in the peat. At 105 cm *Alnus* becomes dominant and from 105 cm onward the samples are disturbed.

OVERGROWN SIDE-STREAM OF THE LEUVENUM BROOK

When surveying the Uddeler Meer, Mr. Krane of the Soil Survey Institute detected a meandering depression in a meadow which proved to be an unused side-stream of the Leuvenum brook which was overgrown with peat. The peat has the same composition as that bordering the recent brook. The upper layers


OVERGROWN SIDE-STREAM
OF THE LEUVENUM BROOK
depth cm
125
112
102
98
92
85
76
72
65
55
45
33
0 10 20 30 40 50 60 70 80 90 0
XI
X
IX
VIII
VII
VI
V
IV
Viscum 0,2%
Hedera
Viscum
Hedera
Viscum
Hedera
Viscum 0,2%
Viscum
Hedera 0,2%
Viscum
Lonicera
Frangula alnus
Solanum dulcamara
Ericaceae
Gramineae
Cyperaceae
Compositae tubuliflorae
Compositae liguliflorae
Caryophyllaceae
Umbelliferae
Cruciferae
Thalictrum
Ranunculaceae
Rosaceae
Scrophulariaceae
Rubiaceae
Labiatae
Plantago
Artemisia
Chenopodiaceae
Urticaceae
Rumex
Dipsacaceae
Melampyrum
Epilobium
Potamogeton
Filipendula
Lysimachia
Lythrum
Viola palustris
Typha angustifolia
Dryopteris thelypteris type
Polypodium vulgare
Pteridium
Osmunda
Sphagna
Valeriana, Equisetum
Papilionaceae
Papilionaceae
Geranium, Lycopodium clavavatum
Hydrocotyle 0,2%
Triticum type
500 560 530 500 510 500 500 600 500 500 500 510
ΣAP

are absent or disturbed; analysis was possible up to the beginning of the Subboreal.

As can be seen from the diagram, peat formation starts in the Preboreal with a local birch growth. The Boreal in the next sample starts with a dominance of *Pinus* and high values for *Salix*, *Salix* maintains relatively high values throughout the diagram. As in the other diagrams, the Atlantic is well developed, after which there is a slight indication of an *Ulmus* fall. The two uppermost samples might be placed in the Subboreal. The first weeds appear, *viz. Plantago*, *Rumex* and *Chenopodiaceae*; *Frangula*, *Ericaceae*, *Potamogeton* and *Sphagna* expand.

The same tendency occurs as in Diagram III; together with a few indicators of human activities, a wetter environment coincides with a thinning of the carr forest.

4. CONCLUSIONS

The bed of the Leuvenum Brook was enclosed in the Preboreal, when dense birch woods dammed the free flow of water into the wide valley between ice-pushed ridges. Swamp-wood peat has been deposited at several low places along the brook, where fluvioglacial clay occurs in the subsoil. The composition of the peat does not change very much during development.

The peat could be sampled and analysed up to the beginning of the Subatlanticum, the younger layers having either been disturbed or removed.

Indicators of human interference start at the Subboreal and continue up to the end of the diagram. However, the weed values are fairly low, the weeds having been suppressed by the local carr association. This agrees very well with what was stated by MODDERMAN (1964), who found concentrations of beaker burials on the slopes of the western ridge along the valley. The weed pollen and the pollen of the *Quercetum mixtum* originates from the ridges and is diluted with pollen from the local swamp vegetation.

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