

## THE INFLUENCE OF THE DEVELOPMENT OF A WEICHSELIAN COVERSAND RIDGE ON THE DRAINAGE OF A RIVER VALLEY IN NOORD-BRABANT (THE NETHERLANDS); A GEOMORPHOLOGICAL AND PALYNOLOGICAL STUDY<sup>1</sup>

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### ABSTRACT

Heijnens, M. H. L. G. & J. M. Tijssen 1982 The influence of the development of a Weichselian coversand ridge on the drainage of a river valley in Noord-Brabant (The Netherlands); a geomorphological and palynological study – *Geol. Mijnbouw* 61: 191-199.

Pollen analysis of cores from an area with a river valley that is blocked by a coversand ridge shows that the three beds of which the ridge consists were deposited respectively before the Lateglacial, during the Earlier Dryas stadial, and after the Allerød interstadial.

During the first part of the Lateglacial the valley was only partly obstructed and occupied by a local Cyperaceae vegetation. Later, from the Earlier Dryas stadial onward, the valley became completely blocked and that resulted in a change in drainage pattern.

The pollen diagrams show a local lacustrine environment, caused by the progressing obstruction of the valley. Wetter and drier phases are recorded in the sediments and mark the climatic development during the Lateglacial.

### INTRODUCTION

The hydrography in the Dutch province of Noord-Brabant is partly determined by a number of long, SW-NE oriented ridges, that are commonly regarded as younger coversand ridges (Fig. 1). VAN DORSSER (1956) has pointed out that in the western part of Brabant these ridges obstructed South-North oriented valley systems and forced the drainage in a more northeastern direction at the end of the Lateglacial.

To collect additional data on the development of coversand ridges and to assess their influence on the hydrography a clear-cut example of a river valley that is blocked by a sand ridge was studied near Cromvoirt, SW of 's-Hertogenbosch, between 1975 and 1978.

Near Cromvoirt a South-North oriented former river valley is cut in the sediments of the Helvoirt Plateau. This valley, called here the Helvoirt River Valley, is closed at its northern end by a wide sand ridge (Fig. 2). This is also the case with a small erosion gully, west of the Helvoirt River Valley.

Geomorphological and palynological research has been

carried out to determine the development of the ridge, the time of obstruction of the Helvoirt River Valley, and the impact on the environment and landscape development. The locations of cross-sections and profiles used in this article are shown in Fig. 2.

### CROSSECTIONS

The crosssections AA' and BB' (Fig. 3) show the structure of the sand ridge west of Cromvoirt. The southern part of the ridge rests here on loamy deposits that belong to the Helvoirt

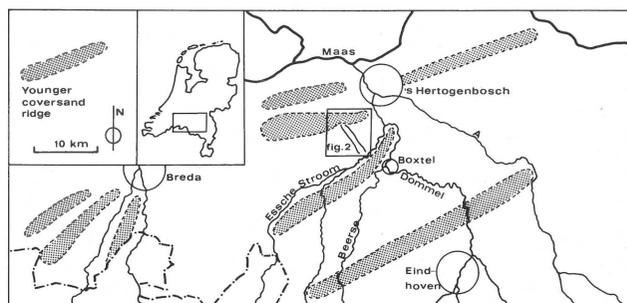


Fig. 1  
Location of younger coversand ridges in Noord-Brabant.

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*Profiles and laboratory methods*

To collect information on the development of the ridge and the time of obstruction of the Helvoirt River Valley the profiles Duinoord, Loverense Brug and Zandhorst were palynologically examined. In addition to Buurman's (1970) earlier work organic sediments in the Helvoirt River Valley and in the erosion gully were studied to determine the time and the conditions under which the sedimentation took place (profiles Zwijnsbergen and Distelberg).

The samples were treated with KOH, HF and acetolysis. The material was then mounted in silicone oil of 2000 cs and all pollen grains in each slide were counted. Apart from the pollen diagrams of the profiles mentioned, the unpublished

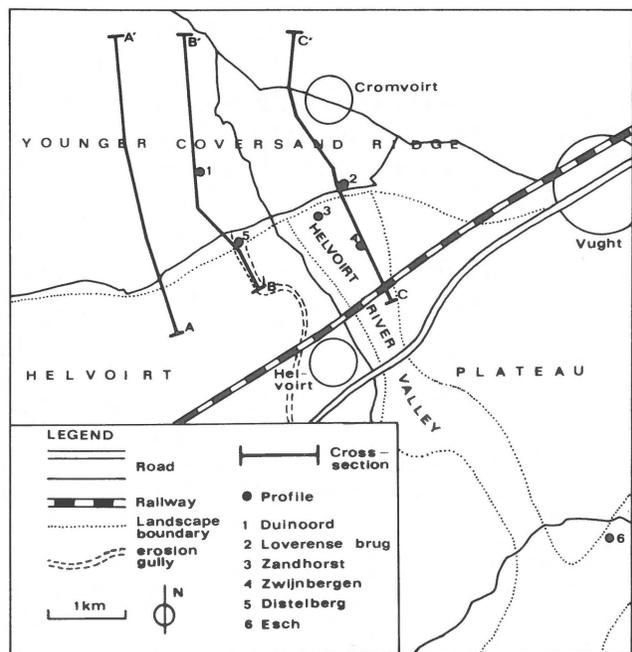


Fig. 2  
Location of cross sections and profiles.

Plateau. The northern edge of this plateau is probably determined by erosion (Bodemkaart van Nederland 1:50.000, 1969). Apart from the top layer, which consists of man-made soils and Holocene drift sands, the ridge consists of sterile sands without loam. At many locations thin peat and loam layers are intercalated. Also iron-rich horizons, which mark granulometric changes, are frequently present. On the basis of these features the sands can be divided into three beds: Cromvoirt-O, -I and -II. The Cromvoirt-O deposits constitute the core of the ridge. The lithological characteristics of all these beds indicate an eolian sedimentation. These characteristics will be presented in a later publication together with those of other deposits in the region.

Crosssection BB' shows also a part of the erosion gully, deeply incised in the sediments of the Helvoirt Plateau and filled in with organic deposits. It is assumed that the erosion gully and the Helvoirt River Valley belong to the same drainage system.

Crosssection CC' shows the structure of the ridge in the vicinity of Cromvoirt and the adjacent part of the Helvoirt River Valley. A sandy peat bed, connected with organic deposits in the Helvoirt River Valley, could be traced across the ridge. Since the mineral valley floor has a slope of about 25 cm per km, the sand deposit below the peat bed must be part of the ridge. Possibly this basal accumulation obstructed the Helvoirt River Valley initially. At any rate deposition of the sands over the peat bed definitely dammed the valley.

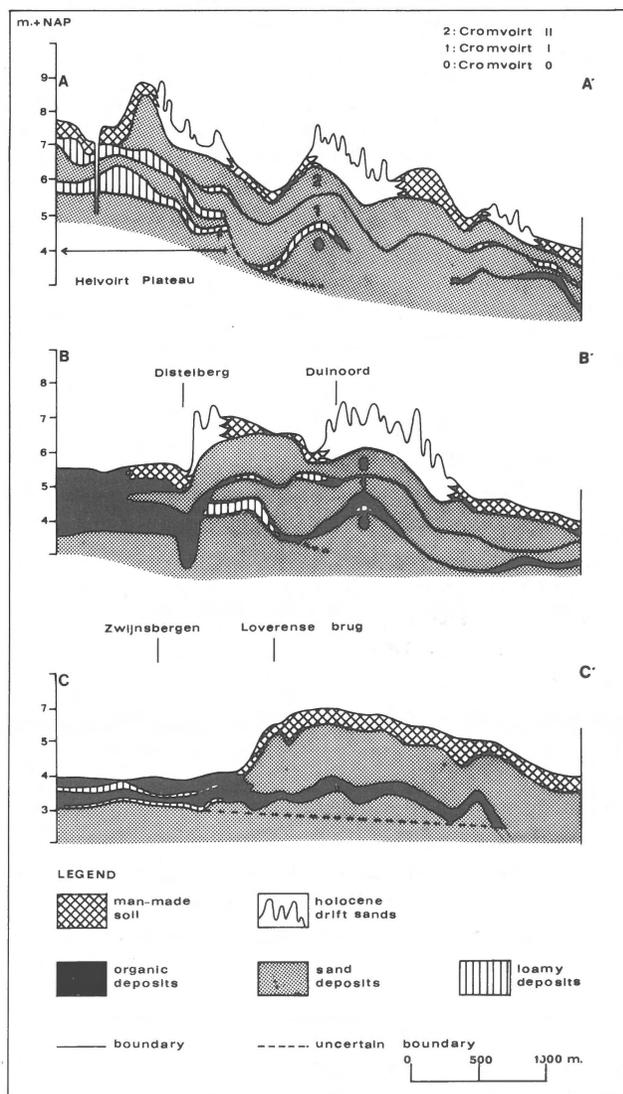


Fig. 3  
Cross sections.

pollen diagram Esch, prepared by B. Polak, will be used to date a possible new valley formation after the Helvoirt River Valley was closed. That diagram was constructed in 1964 and is available at Stiboka, the Dutch Soil Survey Institute (Wageningen). Profile Esch belongs to organic deposits in the valley of the Essche Stroom, east of the junction with the Helvoirt River Valley.

#### Construction of the pollen diagrams

If pollen diagrams are to be used for chronological purposes then regional values must be compared. Therefore the results are presented in so called Iversen diagrams in which the local pollen types are excluded.

To assess the effect of local or regional origins of Cyperaceae pollen each diagram is divided into three parts. The curves in the left and middle parts are based on a pollensum including Cyperaceae (P1), those in the right part on a pollensum without Cyperaceae (P2). It is obvious from the diagrams that the values of supposedly regionally dispersed pollen types are suppressed by those of Cyperaceae. This is especially so in the lower parts of the diagrams Zandhorst and Zwijnsbergen (Figs 6 and 7). It is assumed that this is due to the local presence of Cyperaceae (cf. JANSSEN & IJZERMANS-LUTGERHORST, 1973).

In the descriptions of the regional pollen assemblage zones (next paragraph) and for the discussion of the diagrams (next chapter) the middle and right parts of the diagrams will be used.

#### Zonation

For the division of each diagram into site pollen assemblage zones the rules of the Guide to Stratigraphic Classification (HEDBERG, 1978) were applied. Besides site pollen assemblage zones, regional pollen assemblage zones (rpa-zones) were distinguished, based on similarities in the trends of pollen curves in all the diagrams. Rpa-zones are listed and defined in Table I. Local zones are supposed to reflect a stage in the local vegetation developments, whereas the rpa-zones are more likely to reflect the regional developments. The recognition of rpa-zones allows a correlation of the local zones in time and a dating of the deposits (Table II).

Although the rpa-zones must be described on the basis of the pollen of regionally distributed species (CUSHING, 1967), this is not necessarily the case for all the pollen types used here. *Thalictrum* and *Filipendula* are probably only locally present. Despite the fact that these taxa are rather large pollen producers the diagrams show low percentages, suggesting a regional (or extra-local) origin. Therefore it is assumed that *Thalictrum* and *Filipendula* can be used to describe rpa-zones. In contrast, *Menyanthes* and *Selaginella selaginelloides* are poor pollen producers. The high values of these pollen types in some diagrams indicate a local presence and these types should not be used for the description of rpa-zones. However, *Menyanthes* and *Selaginella selaginelloides* are mainly restricted to one (sub)zone in all the diagrams. Supposedly their presence is determined by local conditions that are in turn determined by regional developments (e.g. climate), which makes them useful for the recognition of rpa-zones.

Table I  
Regional pollen assemblage zones.

#### PINUS-BETULA ZONE.

Filipendula-curve diminishes and becomes discontinuous. Continuous Artemisia-curve, values slightly higher than in preceding zone. AP values somewhat lower than in preceding zone. AP consists mostly of *Betula* and *Pinus*. *Betula* dominates. No pollen of thermophilous trees.

#### FILIPENDULA ZONE.

Continuous curve of *Filipendula*. *Thalictrum* and *Menyanthes* sporadically present. Continuous curve of *Artemisia*, low values. AP dominated by *Betula*; in the upper part of the zone *Pinus* also important. *Salix* values low. No pollen of thermophilous trees.

#### THALICTRUM-MENYANTHES ZONE.

Maximum of *Thalictrum* and of *Menyanthes*. Continuous *Artemisia*-curve with maxima; values higher than in following zone. AP dominated by *Betula* and/or *Salix*. *Pinus* values very low. No pollen of thermophilous trees.

#### FILIPENDULA-PINUS SUBZONE.

AP dominated by *Betula*. *Pinus* values increased. Low *Artemisia* values.

#### FILIPENDULA-BETULA SUBZONE.

AP dominated by *Betula*. *Pinus* values low. *Artemisia* curve decreases.

#### THALICTRUM-ARTEMISIA SUBZONE.

Maximum of *Artemisia*. Minimum of *Betula*.

#### BETULA SUBZONE.

Maximum of *Betula*. Minimum of *Artemisia*.

#### SELAGINELLA SUBZONE.

Spores of *Selaginella sel.* Present in the whole subzone, often in large numbers. Maximum of *Artemisia* and of *Salix*. *Betula*-curve rises.

Table II  
Correlation of regional and local biostratigraphy and chronostratigraphy.

REGIONAL POLLEN ASSEMBLAGE ZONES		LOCAL (SITE) POLLEN ASSEMBLAGE ZONES					CHRONOSTRATIGRAPHY	
		DUINOORD	LOVERENSE BRUG	ZANDHORST	ZWIJNSBERGEN	DISTELBERG		
					ZWIJ-4			
PINUS-BETULA ZONE				ZAH-3		DIS-3	LATE DRYAS STADIAL	
FILIPENDULA ZONE	FIL.-PINUS SUBZ.			ZAH-2b		DIS-2b	ALLERØD INTERSTADIAL	
	FIL.-BETULA SUBZ.	DUI-2		ZAH-2a	ZWIJ-3	DIS-2a		
THALICTRUM-MENYANTHES ZONE	THAL.-ART. SUBZ.			ZAH-1c	ZWIJ-2	DIS-1c	EARLIER DRYAS STADIAL	
	BETULA SUBZ.	DUI-1b	LOB-2	ZAH-1b	ZWIJ-1	DIS-1b	BØLLING INTER-STADIAL S.S.	BØLLING INTER-STADIAL S.L.
	SELAGINELLA SUBZ.	DUI-1a	LOB-1	ZAH-1a		DIS-1a	EARLIEST DRYAS STADIAL	
						DIS-0		

### Dating

A continuous curve of *Artemisia* and the absence of pollen of thermophilous trees are common characteristics of all the rpa-zones, indicating, in our opinion, Lateglacial conditions. The *Selaginella*- the *Betula*- and the *Thalictrum-Artemisia*-rpa-subzones are supposed to represent the Earliest Dryas stadial, the Bølling interstadial s.s. and the Earlier Dryas stadial. The two subzones into which the *Filipendula*-rpa-zone is divided are supposed to represent the birch- and the pine-phase of the Allerød interstadial. The *Pinus-Betula*-rpa-zone possibly represents the start of the Late Dryas stadial. However, none of the examined profiles has been radio-carbon dated yet.

### PALYNOLOGICAL RESEARCH; DIAGRAMS

#### Duinoord (Fig. 4)

The Cromvoirt-O, -I and -II sands are separated here by two organic layers (crosssection BB'). Three local zones are distinguished, corresponding with regional pollen zones (see Table II). A striking feature is the high values of *Artemisia* in the upper part of zone DUI-1b.

The pollen diagram indicates that the lower organic layer was formed during the Earliest Dryas stadial and the Bølling interstadial s.s. The upper one dates possibly from the birch-

phase of the Allerød interstadial. The Cromvoirt-O, -I and -II sands therefore have to be deposited respectively before the start of the Lateglacial, during the Earlier Dryas stadial and after the birch-phase of the Allerød interstadial.

#### Loverense Brug (Fig. 5)

The peat layer of crosssection CC' is examined in profile Loverense Brug. The diagram is divided into two zones, LOB-1 and LOB-2, which corresponds with the *Selaginella*- and the *Betula*-rpa-subzone. The upper spectrum, with a high maximum of *Artemisia*, may correspond with the *Thalictrum-Artemisia*-rpa-subzone.

The diagram indicates a formation of the peat layer during the Earliest Dryas stadial, the Bølling interstadial s.s. and possibly at the start of the Earlier Dryas stadial. Like the Cromvoirt-O sands in profile Duinoord, the sand accumulation below the peat layer must have been deposited before the start of the Lateglacial. The overlying sands date, at least partly, from the Earlier Dryas stadial.

#### Zandhorst (Fig. 6)

Profile Zandhorst is located at the boundary of the Helvoirt River Valley and the coversand ridge. Two organic layers, consisting of gyttja and sandy peat, are separated by humic sand. The upper organic layer grades into sterile sands without loam.

Table II shows the comparison of the local zones with regional pollen zones. The appreciable amounts of *Pinus* pollen in zone ZAH-1a deviates from the description of the compared regional pollen assemblage zone.

The diagram indicates that the lower organic layer was deposited during the Earliest Dryas stadial and the Bølling interstadial s.s. and the upper organic layer during the Allerød interstadial. The overlying sands were deposited after the Allerød interstadial, like the Cromvoirt-II sands in profile Duinoord. The intercalated humic sand was deposited during the Earlier Dryas stadial, like the Cromvoirt-I sands in profile duinoord. The diagrams Loverense Brug and Zandhorst show that there is a threefold structure of the sand ridge in the vicinity of Cromvoirt that is similar to those shown in cross-sections AA' and BB', further west.

The presence of pollen of *Nymphaea*, *Nuphar*, *Myriophyllum* and *Potamogeton* indicates lacustrine conditions during the deposition of the examined sediments. As mentioned before the notable differences in the trends of the curves at the left and at the right side of the diagram in the zones ZAH-1a, -1b and -1c are supposed to be caused by the local presence of Cyperaceae during the Earliest Dryas stadial, the Bølling interstadial s.s., and the Earlier Dryas stadial.

#### Zwijnsbergen (Fig. 7)

The filling of the Helvoirt River Valley consists of two layers of peat, separated by a thin layer of loam. At the base of the filling a thin layer of humic loam is present (crosssection CC'). In profile Zwijnsbergen only the lower peat layer and the lower part of the upper peat layer were palynologically examined.

The diagram is divided into four local zones. The zones ZWIJ-1, -2 and -3 can be compared with regional pollen zones (Table II). Zone ZWIJ-4, which is characterised by the presence of thermophilous trees and of Cerealia and by the dominance of *Pinus*, does not correspond with any of the described regional pollen assemblage zones.

The diagram indicates that the lower peat layer was formed during the Bølling interstadial s.s., the Earlier Dryas stadial and the Allerød interstadial. The filling of the Helvoirt River Valley probably started earlier, but the loam at the base is not examined. The upper peat layer is supposed to be formed much later, at the beginning of the nineteenth century, when plantations of pine began. The topographical map (Chromotopografische kaart 1:25.000, 1924) shows peat digging pits in the Helvoirt River Valley at the beginning of this century. The hiatus between the upper and the lower peat layer therefore can be ascribed to peat digging.

The presence of *Myriophyllum*, *Potamogeton*, *Menyanthes* and *Nuphar* in zone ZWIJ-1, -2 and -3 indicates lacustrine conditions in the Helvoirt River Valley during the Lateglacial. This is in accordance with the results of BUURMAN (1970). Again, as in diagram Zandhorst, the differences between the curves on the left and on the right side of the diagram in the

zones ZWIJ-1 and -2 are supposed to be caused by local occurrence of Cyperaceae during the Bølling interstadial s.s. and the Earlier Dryas stadial.

#### Distelberg (Fig. 8)

Profile Distelberg is located at the boundary of the Helvoirt Plateau and the coversand ridge. The profile forms part of the organic filling of the erosion gully and consists of lime gyttja and peat. The sediments are overlain by Cromvoirt-II sands (crosssection BB').

The diagram is divided into four major local zones. The zones DIS-1, -2 and -3 can be compared with regional pollen assemblage zones (Table II) and will represent together the greater part of the Lateglacial. Zone DIS-0 contains only a few herb pollen types and no *Selaginella selaginelloides* is recorded. This zone is supposed to represent the Upper Pleniglacial. The increase in the number of herb pollen types at the transition of DIS-0 to DIS-1 in this diagram reflects the first amelioration of the climate at the start of the Lateglacial. At the transition from DIS-2a to DIS-2b the diversity of the NAP declines, probably a reflection of a diminishing light intensity in the birch-pine woods during the Allerød interstadial. A striking feature is the presence of *Picea*, *Carpinus*, *Ulmus* and *Tilia* pollen in the zones DIS-0 and DIS-1a. It is assumed that these are secondary pollen. Secondary pollen are also present in the lower parts of the diagrams Zwijnsbergen and Zandhorst.

The diagram indicates that the filling of the erosion gully started in the Upper Pleniglacial and continued until the beginning of the Late Dryas stadial. The sediments are all deposited under lacustrine conditions, as is indicated by the presence of aquatic pollen types. As the alternation of lime gyttja and peat depends on the moisture regime (BUURMAN, 1970), wetter and drier periods may be recorded in the sediments. This is supported by the occurrence of high amounts of pollen of *Potamogeton* in the lower layer of lime gyttja and by the occurrence of maxima of *Myriophyllum* and *Nymphaea* pollen in the upper lime gyttja layer. A local presence of Cyperaceae is not quite certain: although the percentages of pollen of Cyperaceae are high in the lower parts of the diagram, the curves on the left and on the right side of the diagram are quite similar.

## DISCUSSION

The coversand ridge of Cromvoirt consists of three beds of sand (crosssections, Fig. 3). The core of the ridge, consisting of Cromvoirt-O sands, existed already at the start of the Lateglacial (diagrams Duinoord, Loverense Brug). This initial ridge expanded during two phases: during the Earlier Dryas stadial by the deposition of Cromvoirt-I sands and after the Allerød interstadial by the deposition of Cromvoirt-II sands (diagrams Duinoord, Distelberg, Zandhorst). During the Bølling inter-

stadial s.l. and the Allerød interstadial peat and loam layers were locally formed. A similar threefold structure is described by PAULISSEN & MUNAUT (1969) for a comparable dune in the vicinity of Opgrimbie, situated some 80 km to the Southeast in Belgium.

The start of the sedimentation in the Helvoirt River Valley and in the erosion gully west of it at the transition of the Upper Pleniglacial to the Lateglacial, which took place under lacustrine conditions (diagrams Distelberg, Zandhorst, Zwijsbergen), suggests an obstruction by the Cromvoirt-O core. However, the loamy deposit at the base of the filling of the Helvoirt River Valley and the presence of supposedly secondary pollen in the lower parts of the diagrams Distelberg, Zwijsbergen and Zandhorst point more to partly stagnation of water than to total obstruction at the start of the Lateglacial. In any case the Helvoirt River Valley became totally blocked during the Earlier Dryas stadial by the deposition of Cromvoirt-I sands (diagram Loverense Brug). The hiatus between the peat beds in the Helvoirt River Valley (diagram Zwijsbergen) can not be due to erosion, as was suggested by BUURMAN (1970), because the valley was already closed. Probably the hiatus is caused by peat digging.

Although lacustrine conditions prevailed during the Lateglacial, wetter and drier periods are recorded by sediment types and pollen content of the profiles of the erosion gully (profile Distelberg) and of the Helvoirt River Valley (BUURMAN, 1970). Lime gyttja is deposited during the (wetter) Bølling s.l. and Allerød interstadials, while peat formation occurred during the (drier) Earlier and Late Dryas stadials.

Cyperaceae vegetations are supposed to be present in the Helvoirt River Valley during the Bølling interstadial s.l. and the Earlier Dryas stadial (diagrams Zandhorst, Zwijsbergen). Diagram Distelberg shows fewer indications for a local Cyperaceae vegetation in the erosion gully, which was probably too deep. This may be the case too in the central parts of the Helvoirt River Valley. Diagram Zwijsbergen and the diagrams Helvoirt-I, -II and -III of BUURMAN (1970) provide a base for a provisional description of the Lateglacial aquatic vegetation development in the Helvoirt River Valley. At the start of the Lateglacial *Potamogeton*, *Myriophyllum* and *Typha angustifolia* were common. During the Bølling interstadial s.s. and the Earlier Dryas stadial *Menyanthes* expanded. During the Allerød interstadial *Nuphar* and *Nymphaea* were part of the open water vegetation.

As we have seen the Helvoirt River Valley became obstructed by a coversand ridge during the Lateglacial and a change in the drainage pattern must have taken place. Figure 1 suggests an initial course of the Essche Stroom, Beerse, and Dommel through the Helvoirt River Valley. It is assumed that the recent drainage pattern, which lies more to the East, came

into existence after the obstruction of the Helvoirt River Valley and the formation of the coversand ridge towards the South. In this respect pollen diagram Esch of B. Polak is of interest. The diagram (not included here) indicates a start of the sedimentation in the valley of the Essche Stroom, east of the junction with the Helvoirt River Valley, during the Late Dryas stadial, well after the obstruction of the Helvoirt River Valley. In Western Brabant analogous changes in drainage pattern caused by coversand ridges are pointed out by VAN DORSSER (1956). As the area discussed is located in the Central Graben, there is the possibility of tectonic influence on the change in the drainage pattern. This, however, has not been taken into consideration.

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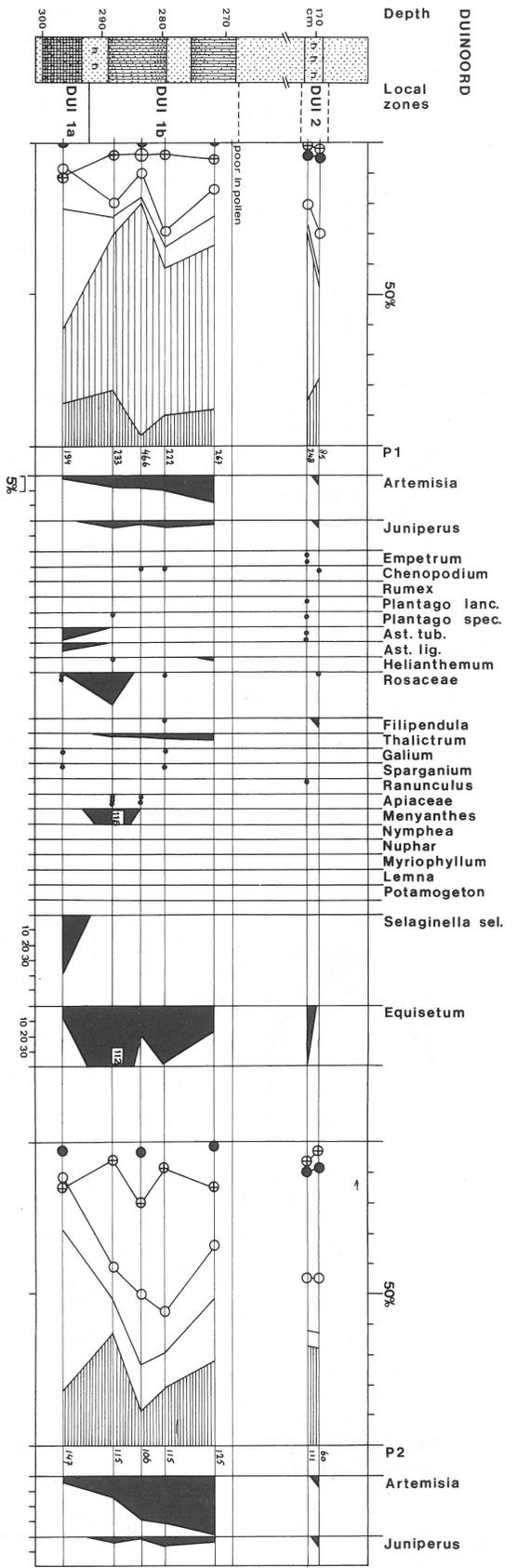


Fig. 4  
Pollen diagram Duinoord (legend under Fig. 8).

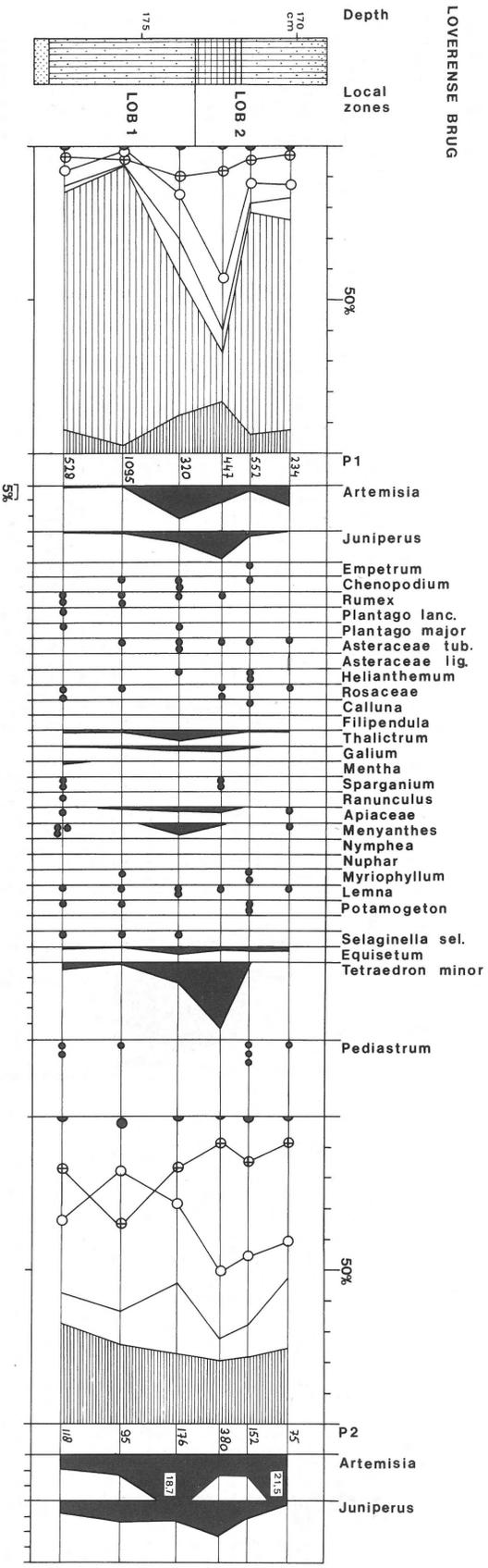


Fig. 5  
Pollen diagram Lovense Brug (legend under Fig. 8).



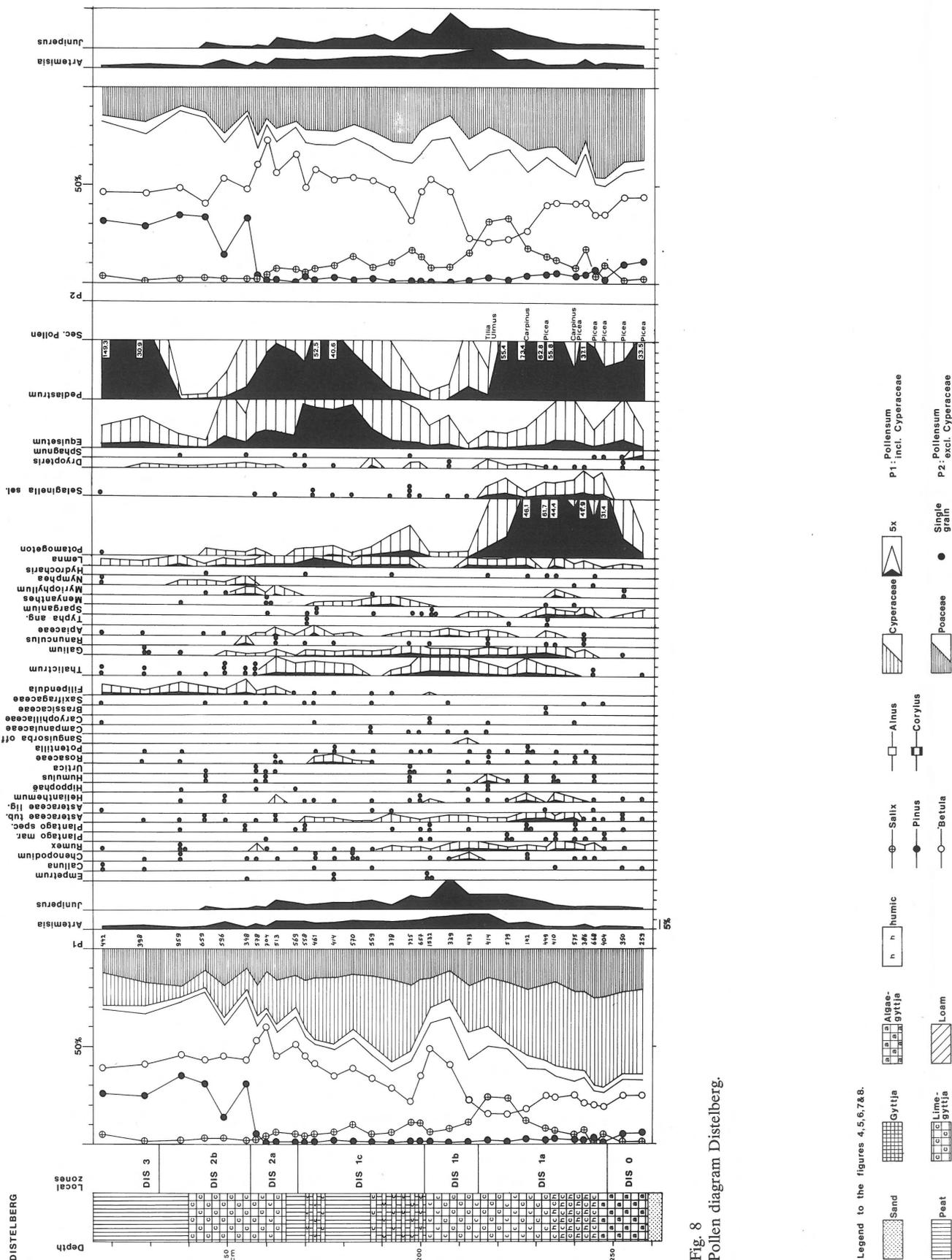


Fig. 8  
Pollen diagram Distelberg.

Legend to the figures 4, 5, 6, 7, & 8.

- Sand
- Gyttja
- Lime-gyttja
- Peat
- humic
- Salix
- Pinus
- Betula
- Alnus
- Corylus
- Cyperaceae
- Poaceae
- 5x
- P1: Pollensum incl. Cyperaceae
- P2: Pollensum excl. Cyperaceae
- Single grain
- Loam