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# The botanical shadow of two early Neolithic settlements in Belgium: carbonized seeds and disturbances in a pollen record

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ABSTRACT

Bakels, C.C., 1992. The botanical shadow of two early Neolithic settlements in Belgium: carbonized seeds and disturbances in a pollen record. In: J.P. Pals, J. Buurman and M. van der Veen (Editors), Festschrift for Professor van Zeist. Rev. Palaeobot. Palynol., 73: 1–19.

Carbonized remains show that the early Neolithic, Bandkeramik, inhabitants of Wange and Overhespen, Belgium, grew emmer, einkorn, naked barley and peas. The presence of barley is surprising, because this cereal is unknown from contemporary sites west of the Rhine.

A pollen diagram based on samples obtained from an abandoned river channel less than 200 m away revealed the impact of the Bandkeramik inhabitants on the local vegetation. They damaged both the elm and the lime forests. Cereal fields were not found; they must have been situated some distance away, in clearances within the lime forest.

## Introduction

The two early Neolithic settlements mentioned in the title of this paper are known as Wange and Overhespen. They lie facing one another on either side of a small watercourse, the Kleine Gete. Wange lies on the right bank, Overhespen on the left one. The names of the sites are derived from the names of two modern villages which can be found midway between the Belgian towns of Tienen and St. Truiden (Fig.1).

The area in question is part of the northern borderland of the vast, loess-covered Haspengouw or Hesbaye (Fig.2). It is a well-drained, rolling landscape with a temperate climate. The mean annual temperature at St. Truiden is +9.9°C. The coldest month is January with a mean temperature of +3°C; the warmest month is July with +17°C. The mean annual precipitation amounts to 721 mm (data from the booklet, accompanying sheet 105 W of the Bodemkaart van België 1 : 20,000, 1957).

The settlements were discovered by Dr. M. Lodewijckx of the University of Leuven, who excavated parts of them in the years 1979–1985 (Lodewijckx 1984, 1988). The sites are attributed to the Bandkeramik culture, an early agrarian culture with a strong preference for loess soils (Sielmann, 1972; Bakels, 1978). The vast majority of Bandkeramik sites in the Haspengouw is, however, not to be found near the course of the Kleine Gete. The largest concentration of settlements lies on the stretch of land between the rivers Meuse, Jeker or Geer and Méhaigne. Wange and Overhespen lie quite far from this Bandkeramik centre. Being truly contemporaneous, they may be described as twin settlements. They were in fact an isolated twin, whose life was not wholly unconnected with the rest of the Bandkeramik world, but which nevertheless constituted a kind of outpost. Intensive exploration has so far failed to detect other settlements in the far surroundings*.

My special interest in Bandkeramik economy

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*After the closing of this manuscript one more has been discovered.

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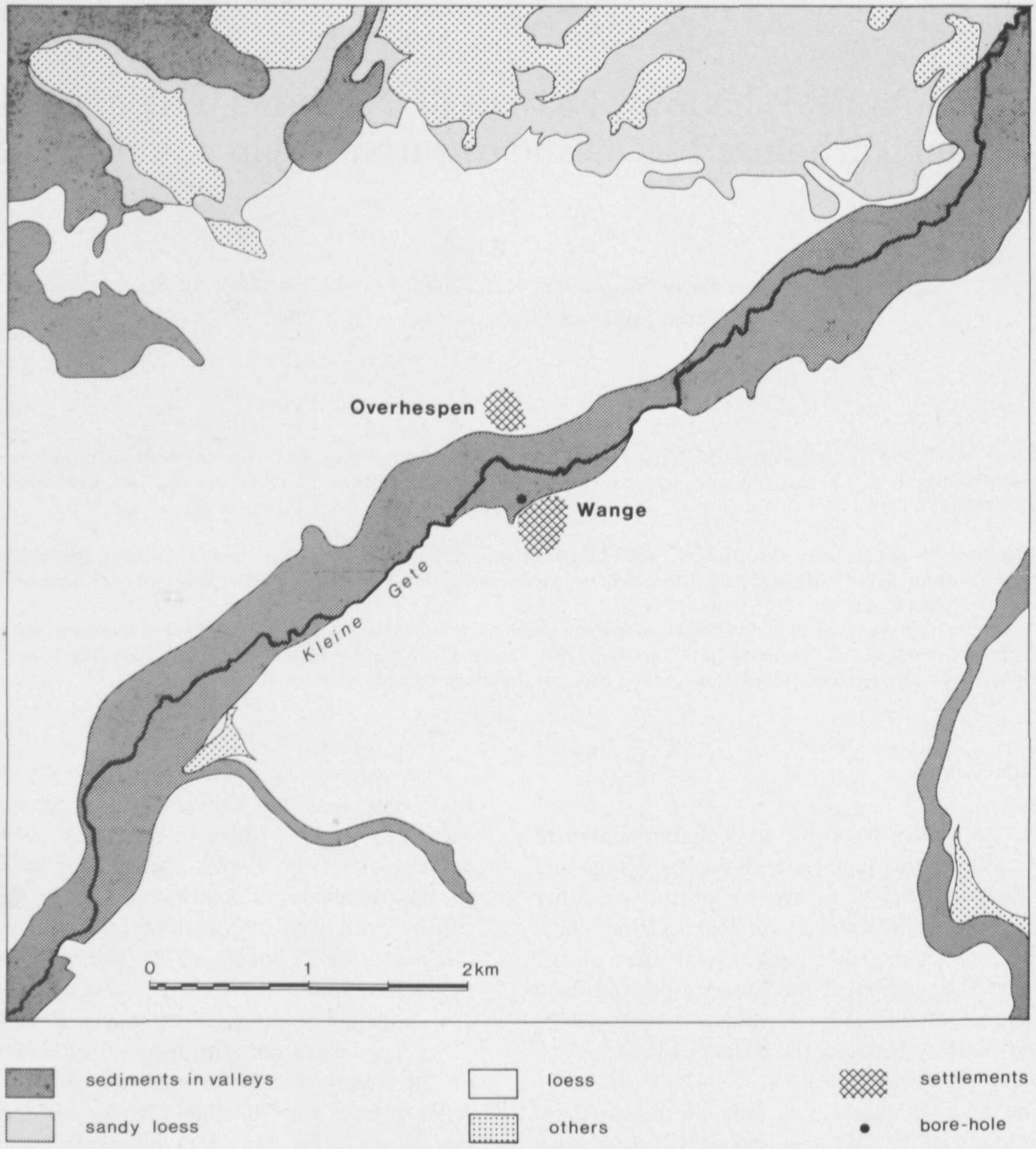



Fig.1. The Bandkeramik settlements in their setting. Map after sheet 105 W of the soil map of Belgium.

induced me to offer to perform the botanical analyses connected with the archaeological excavations. The investigation comprised the analysis of soil samples taken from prehistoric features and the analysis of a core of peat taken from the valley of the Kleine Gete.

## The results of the soil sample analysis

Soil samples were taken from the fill of pits dug in the Bandkeramik settlements. These pits, which were dug for several purposes not reviewed here, were filled, whether or not intentionally, with all

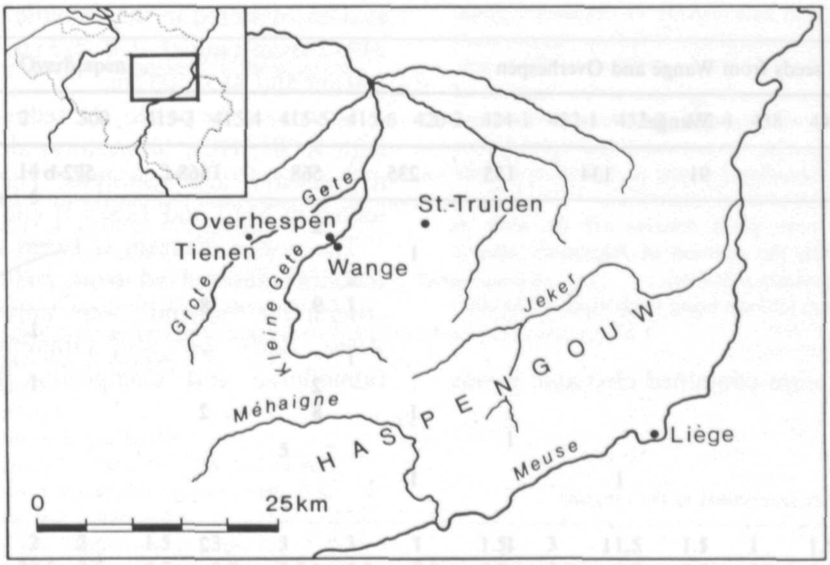



Fig.2. The situation of Wange and Overhespen.

kinds of domestic waste. This waste often comprises charred plant matter. The soil is well-drained and riddled with animal burrows; because of this all botanical matter, with the exception of carbonized material, has perished. It is sometimes possible to detect pollen in such sediments, but unfortunately, no reliable amounts of pollen could be extracted from the fill of the pits at Wange and Overhespen. The few pollen grains encountered, of Compositae liguliflorae for instance, were regarded with suspicion (see on this subject e.g. Bottema, 1975; Bakels, 1988).

In total, 17 soil samples were taken at Wange and 28 at Overhespen. The volume analysed was mostly 1–3 $dm^3$. To have taken larger samples would have been impractical because all samples had to be water-sieved by hand. The matrix consisted of a sticky loess–loam, which could not be processed by flotation. The smallest mesh used was 0.25 mm. The residue contained charcoal and carbonized seeds and fruits. Only the latter category has been analysed.

Eight out of the 17 Wange samples and 16 out of the 28 Overhespen samples contained seeds. The species and the numbers encountered are listed in Table I. The list shows a typical Bandkeramik spectrum. The cereals emmer (*Triticum dicoccum*) and einkorn (*Triticum monococcum*) are found at almost every Bandkeramik site. Pea (*Pisum sativum*) is not uncommon either, and the remains of hazelnuts (*Corylus avellana*) and sloe plums (*Prunus spinosa*) are common finds too.

Most of the herbs belong to the species that are typical of the western European Bandkeramik range (Knörzer, 1971; Bakels and Rousselle, 1985). Only *Vicia sepium* is rather rare. A parallel is known from the Bandkeramik site Aubechies in the Belgian Hainaut. All herbs mentioned are commonly found in association with cereals and cereal chaff. Therefore, they are usually interpreted as field weeds, in spite of the fact that some of them, like *Stachys sylvatica*, are hardly found in this kind of habitat today. These plants, which grow at the edges of forests, are seen to be indications of the small size of the Bandkeramik fields. The zone of contact with the surrounding forest was relatively large and the crops received more shade than nowadays (Bakels, 1978; Bakels and Rousselle, 1985).

The fruit of lime (*Tilia*) and the seeds of ivy (*Hedera helix*) are thought to have been brought into the settlement with branches.

The only great surprise is the presence of naked barley (*Hordeum vulgare* var. *nudum*). This plant is not normally found in Bandkeramik sites west of the Rhine. It is not found in the centre of the

TABLE I

Carbonized fruits and seeds from Wange and Overhespen

| Plant remains | Wange[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 91 | 134 | 135 | 235 | 568 | 568-f | 572-b | 572-o |
| *Triticum monococcum* | | | | | 2 | | | |
| *Triticum dicoccum* | | | | 1 | | | | |
| *Triticum monococcum* or *dicoccum* | | | | | 9 | 8 | | |
| *Triticum* sp. | | | | | | | | |
| *Hordeum vulgare* var. *nudum* | | | | | 2 | | | |
| Cereals indet. | | | 1 | 1 | 8 | 2 | | 1 |
| *Pisum sativum* | | | 1 | | | | | |
| *Corylus avellana* | | | | 1 | | | | |
| *Prunus spinosa* | | | | | | | | |
| *Bromus* sp. | 1 | 1 | 1 | | | 2 | | |
| *Bromus secalinus* | | | | | 4 | | | |
| *Chenopodium album* | | | | | 1 | | | |
| *Lapsana communis* | | | | | 1 | | | |
| *Polygonum convolvulus* | | | | | | | | |
| *Polygonum lapathifolium* | | | | | 1 | | | |
| *Phleum* sp. | | | | | | | | |
| *Vicia sepium* | | | | | | | | |
| *Stachys sylvatica* | | | | | | | | |
| *Rumex* cf. *sanguineus* | | | | | | | | |
| *Galium* cf. *spurium* | | | | | | | | |
| Papilionaceae indet. | | | | | | | 1 | |
| *Hedera helix* | | | | | | | | |
| *Tilia* sp. | | | | | | | | |
| Indeterminatae | | | | | | | 1 | |
| Sample size ($dm^3$) | 2.5 | 3 | 3 | 2 | 2 | 1 | 1 | 1.5 |
| Remains/$dm^3$ | 0.4 | 0.3 | 1.0 | 1.5 | 14.0 | 12.0 | 2.0 | 0.7 |

| Plant remains | Overhespen | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 300 | 415-3 | 415-4 | 415-5 | 415-6 | 420-3 | 424-1 | 432-1 | 432-2 | 432-4 | 438 | 440-1 | 447 | 484 | 511 |
| *Triticum monococcum* | | | | | | | | | | | | | | | | |
| *Triticum dicoccum* | | 1 | | | | | | | 1 | | | | | 4 | | |
| *Triticum monococcum* or *dicoccum* | 2 | | | | | 3 | 6 | | | | | 1 | | 1 | | |
| *Triticum* sp. | 1 | | 1 | | | | | | | | 1 | | | | | |
| *Hordeum vulgare* var. *nudum* | 1 | | | | | | | | | | | | | | | |
| Cereals indet. | 18 | 2 | | 1 | | 1 | 1 | 1 | | 1 | | | 1 | 2 | 1 | 1 |
| *Pisum sativum* | 2 | | | | | | | | | | | | | | | |
| *Corylus avellana* | | 1 | | | | | | | 1 | | | | | | | |
| *Prunus spinosa* | | | | | | 1 | | | | | | | | | | |
| *Bromus* sp. | 10 | | | | | | | | | | | | | | | |
| *Bromus secalinus* | 1 | 1 | | | | | | | | | | | | 2 | | |
| *Chenopodium album* | 5 | 1 | | | | 1 | | | | | | | | 2 | | |

TABLE I (*continued*)

| Plant remains | Overhespen | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 300 | 415-3 | 415-4 | 415-5 | 415-6 | 420-3 | 424-1 | 432-1 | 432-2 | 432-4 | 438 | 440-1 | 447 | 484 | 511 |
| *Lapsana communis* | 14 | 1 | | 1 | | | | | | | | | | 2 | | |
| *Polygonum convolvulus* | 5 | | | | | | | | | | | | | 1 | | |
| *Polygonum lapathifolium* | | | | | | | | | | | | | | | | |
| *Phleum* sp. | | | | | | 2 | | | | | | | | 2 | | |
| *Vicia sepium* | | | | | | 1 | | | | | | | | | | |
| *Stachys sylvatica* | 1 | | | | | | | | | | | | | | | |
| *Rumex* cf. *sanguineus* | | | | | | 1 | | | | | | | | | | |
| *Galium* cf. *spurium* | 1 | | | | | | | | | | | | | | | |
| Papilionaceae indet. | | | | | | | | | | | | | | | | |
| *Hedera helix* | | | | | 5 | | | | | | | | | | | |
| *Tilia* sp. | | | | | | | | | | 1 | | | | | | |
| Indeterminatae | | | | | 2 | | | | | | | | | | | |
| Sample size ($dm^3$) | 2 | 2 | 1.5 | 3 | 3 | 3 | 1 | 1.5 | 3 | 1.5 | 1.5 | 1 | 1.5 | 3 | 1.5 | 1.5 |
| Remains/$dm^3$ | 30.5 | 3.5 | 0.7 | 0.7 | 2.3 | 3.3 | 7.0 | 0.7 | 1.0 | 0.7 | 0.7 | 1.0 | 0.7 | 5.3 | 0.7 | 0.7 |

[1] f = contents of vessel, b = top, o = bottom.

Bandkeramik world in central Europe either and must be seen as a peripheral cereal. The barley is present at both Wange and Overhespen and must be considered a normal component of the domestic waste because it is as common (or scarce, depending on which way you look at it) as the other species. It must be concluded that naked barley was a normal crop here, perhaps as common as emmer and einkorn.

From a pedological point of view there are no obvious reasons why the inhabitants of Wange and Overhespen should have turned towards the growing of barley. The conditions are not fundamentally different from those elsewhere in the Haspengouw. Above I mentioned the somewhat isolated position of the twin-sites. Possibly the inhabitants developed customs which did not develop elsewhere. It is even possible that the cultivation of barley was triggered by non-Bandkeramik influences. There were indeed contemporaneous non-Bandkeramik cultures; their pottery is known and has been found at Bandkeramik sites, including Wange and Overhespen. These cultures, known as Limburg, La Hoguette and Blicquy, are thought to have had connections with or even to have had roots in France and the early Neolithic people of France are known to have cultivated naked barley (Marinval, 1988; Bakels, 1990).

## The pollen diagram

Well-drained loess landscapes tend to be poor in sites favouring the preservation of pollen. Moreover, those places where organic deposits did accumulate in the past, such as abandoned rivulet channels, are more often than not covered with eroded loess. These colluvia can be so thick that soil surveys fail to detect the peat beneath. The deposit described here does not appear on sheet 105 W Landen of the soil map (1 : 20 000) of Belgium. It was detected by Prof. Dr. P.M. Vermeersch of the University of Leuven, during a rather short series of trials. Further coring showed that the peat growth had taken place in a 70 m wide cut-off of the Kleine Gete. This channel lies 100 m from Wange and 400 m from Overhespen. At the deepest point found, the lithostratigraphy is as follows:

| | |
|---|---|
| 0–163 cm | Loam |
| 163–208 cm | Calcareous gyttja; more or less gradual transition to |
| 208–240 cm | Carr peat with *Alnus* wood, *Alnus glutinosa* seeds and *Urtica dioica* seeds; gradual transition to |

240–474 cm Telmatic peat with patches of calcareous gyttja; abundant concentrations of fern sporangia; seeds of *Typha latifolia, Carex acutiformis, Carex* spp. and *Eupatorium cannabinum*; a few remains of *Cirsium, Lycopus europaeus, Lythrum salicaria* and *Moehringia trinervia*; around 210, 280 and 430 cm many *Urtica dioica* seeds; at 460 cm a *Corylus avellana* nut; gradual transition to

474–529 cm Telmatic peat; plant remains are the same as above, with the addition of *Filipendula ulmaria* and *Menyanthes trifoliata*.

529–565 cm Sandy loam (565 cm being the bottom of the core)

The top layer of loam contained charcoal; it was also encountered in the telmatic peat at depths of 240–250 cm (some), 270–275 cm (much), 320 cm, 390 cm and 485–500 cm.

To extract the pollen, the sediments were treated with KOH, HCl, bromoform/alcohol sp. gr. 2.0, if necessary, and acetolysis. The results are presented in Fig.3 and Tables II and III.

The pollen diagram is based on a pollen sum that includes upland trees and herbs only. The criteria for "upland" were applied very strictly. *Alnus*, *Salix*, but also Gramineae, Compositae tubuliflorae and Compositae liguliflorae were

TABLE II

Upland pollen types not mentioned in the diagram

| Depth (cm) | Taxa |
|---|---|
| 150 | Chenopodiaceae 2.0, Cerealia 2.0, *Plantago lanceolata* 1.0, *Polygonum aviculare* 5.0, *Centaurea cyanus* 1.0, *Riccia* 1.0 |
| 160 | Cerealia 0.3, *Plantago lanceolata* 1.3, *Sanguisorba officinalis* 0.3 |
| 165 | Chenopodiaceae 1.0, *Rumex acetosa*-type 0.5 |
| 170 | Chenopodiaceae 0.4 |
| 175 | *Populus* 0.3, Cerealia 0.3, *Plantago lanceolata* 0.9, *Polypodium* 0.9 |
| 180 | Cerealia 0.3 |
| 185 | *Picea* 0.3, *Populus* 0.3, Ericales 0.3 |
| 190 | *Campanula* 0.6 |
| 195 | Chenopodiaceae 0.3 |
| 200 | *Viburnum* 0.3 |
| 210 | *Rumex acetosa*-type 0.3 |
| 220 | Chenopodiaceae 0.3 |
| 235 | *Crataegus* 0.2, *Polypodium* 0.2 |
| 240 | Chenopodiaceae 0.6 |
| 245 | Chenopodiaceae 0.3, *Rumex acetosa*-type 0.3, *Riccia* 0.3 |
| 250 | *Virburnum* 0.3, *Sambucus* 0.3, *Plantago major* 0.3 |
| 255 | *Ligustrum* 0.3 |
| 260 | *Picea* 0.3, Chenopodiaceae 0.3, *Polypodium* 0.3 |
| 263 | *Polypodium* 0.3 |
| 266 | Ericales 0.3 |
| 270 | Chenopodiaceae 0.3 |
| 275 | *Polypodium* 0.3 |
| 305 | *Centaurea jacea* 0.3 |
| 310 | *Rumex acetosa*-type 0.3 |
| 315 | *Trifolium*-type 0.3 |
| 325 | *Lotus corniculatus* 0.6 |
| 340 | Chenopodiaceae 0.4 |
| 355 | *Rumex acetosa*-type 0.3 |
| 365 | *Rumex acetosa*-type 0.3 |
| 375 | *Acer* 0.6 |
| 395 | *Cornus sanguinea* 0.3 |
| 430 | *Rumex acetosa*-type 0.9 |
| 460 | *Melampyrum* 0.3 |
| 470 | *Viburnum* 0.5 |
| 480 | *Rumex acetosa*-type 0.7 |
| 520 | *Rumex acetosa*-type 0.7 |
| 540 | Chenopodiaceae 0.7, *Ononis*-type 1.4, *Helianthemum* 1.4 |

TABLE III

Local and indifferent pollen not mentioned in the diagram

| Depth (cm) | Taxa |
|---|---|
| 150 | *Cirsium* 1.0, *Filipendula* 1.0, Cruciferae 2.0, *Ranunculus* 1.0, Caryophyllaceae 1.0, *Sphagnum* 6.9 |
| 160 | *Cirsium* 0.7, Cruciferae 1.0, *Ranunculus* 0.3, *Sphagnum* 1.6 |
| 165 | Cruciferae 2.1, *Lythrum* 0.5, *Sphagnum* 1.0 |
| 170 | *Cirsium* 0.7, *Filipendula* 0.4 |
| 175 | *Humulus* 0.3, *Cirsium* 0.3, Papilionaceae indet. 0.3, *Sphagnum* 0.6 |
| 180 | Cruciferae 1.0, *Lythrum* 0.3, *Ranunculus* 0.3 |
| 185 | *Filipendula* 0.3, Cruciferae 0.3, *Ranunculus* 0.3, *Polygonum persicaria*-type 0.3 |
| 190 | *Ranunculus* 0.3, *Sphagnum* 0.6 |
| 195 | *Sphagnum* 0.3 |
| 200 | Cruciferae 0.3 |
| 210 | *Lysimachia* 0.3, *Caltha* 0.9 |
| 225 | *Filipendula* 0.3, *Lysimachia* 0.3, *Caltha* 0.3 |
| 230 | *Humulus* 0.3, *Lysimachia*-cluster, varia 0.3 |
| 240 | Cruciferae 0.6, *Lythrum* 0.6 |
| 245 | *Lythrum* 0.6, *Thalictrum* 0.3, varia 0.3 |
| 255 | *Humulus* 0.3, *Allium* 0.3, varia 0.3 |
| 260 | *Sphagnum* 0.3 |
| 275 | *Lysimachia* 0.3 |
| 277 | *Sphagnum* 0.8, varia 0.3 |
| 280 | *Lysimachia* 0.3, *Pediastrum* 0.3 |
| 295 | *Humulus* 0.3, *Cirsium* 0.3 |
| 300 | *Filipendula* 0.7, *Pediastrum* 0.4, varia 0.4 |
| 305 | *Lysimachia* 0.3, *Valeriana* 0.3 |
| 310 | *Cirsium* 0.3 |
| 315 | *Filipendula* 1.3, *Lysimachia* 0.3, varia 0.9 |
| 320 | *Filipendula* 0.3, varia 0.6 |
| 325 | *Humulus* 0.3, varia 0.3 |
| 335 | *Valeriana* 0.3 |
| 345 | *Lysimachia* 0.3, Caryophyllaceae 0.3 |
| 350 | varia 0.3 |
| 360 | *Filipendula* 0.6 |
| 365 | *Humulus* 0.3, *Ranunculus* 0.3 |
| 370 | *Filipendula* 0.3, *Thalictrum* 0.3, Caryophyllaceae 0.3 |
| 375 | *Thalictrum* 0.3 |
| 385 | *Filipendula* 0.3, Rubiaceae 1.0 |
| 390 | *Lysimachia* 0.4 |
| 405 | *Valeriana* 0.3 |
| 415 | Caryophyllaceae 0.3 |
| 430 | *Humulus* 0.3, *Filipendula* 0.3 |
| 435 | *Humulus* 0.9, *Filipendula* 0.3, *Mentha*-type 0.3 |
| 440 | *Humulus* 0.9, *Filipendula* 0.3, *Lythrum* 0.3, *Mentha*-type 0.9, *Thalictrum* 0.3, *Sphagnum* 0.3 |
| 445 | *Mentha*-type 0.3, *Thalictrum* 0.3, *Solanum dulcamara* 0.5 |
| 450 | *Filipendula* 1.3, *Ranunculus* 0.3 |
| 460 | *Filipendula* 0.3, *Lysimachia* 0.3, *Caltha* 0.3 |
| 470 | *Filipendula* 0.2, *Mentha*-type 0.2, Orchidaceae 0.2 |
| 480 | *Filipendula* 0.3, *Ranunculus* 0.6, *Lysimachia* 0.6, *Sphagnum* 0.3, varia 0.3 |
| 490 | *Filipendula* 1.0, *Thalictrum* 0.3, *Ranunculus* 0.3, *Valeriana* 0.3, Caryophyllaceae 0.3 |
| 500 | *Filipendula* 1.8, varia 0.6 |
| 510 | *Filipendula* 0.4, *Mentha*-type 0.4, varia 0.4 |
| 520 | *Filipendula* 13.9, *Mentha*-type 5.9, *Thalictrum* 1.0, *Ranunculus* 0.3, *Vicia*-type 0.3, varia 1.0 |
| 540 | *Filipendula* 20.0, *Thalictrum* 0.7, *Stachys* type 0.7, *Sphagnum* 2.0, *Pediastrum* 0.7, varia 0.7, fossil pollen 9.3 |
| 560 | *Filipendula* 2.9, *Stachys*-type 1.0, *Pediastrum* 2.9, varia 2.9, fossil pollen 2.9 |

excluded. They formed part of the local marsh vegetation. The use of such a restricted basis results in an upland herb curve with low percentages. In the uppermost part of the diagram the curve may not reflect the actual situation, because Compositae liguliflorae, for instance, certainly belonged to the upland flora at those times, but it is impossible to meet all desiderata in one pollen diagram. Moreover, the curves of taxa that were excluded from the pollen sum do show the fluctuating percentages of local pollen types.

The diagram is divided into ten local pollen zones.

*Zone 1*

This zone is characterized by a dominance of *Pinus*, but *Betula* and *Artemisia* values are comparatively high. The borderline between zones *1* and *2* is set at the beginning of the decrease in *Pinus*, the rise in *Corylus*, and the beginning of the continuous *Quercus* and *Corylus* curves. The end of this zone is radiocarbon dated to just after 8650 ± 160 BP (GrN-14592).

*Zone 2*

The dominance of *Pinus* changes into a dominance of *Corylus*, *Quercus* and *Ulmus*, with some *Hedera*. *Alnus* is already present, but in such small amounts that it cannot yet have formed part of the local vegetation. The beginning of a continuous *Tilia* curve and the appearance of *Fraxinus* mark the boundary between zones *2* and *3*.

*Zone 3*

*Corylus* is dominant, together with *Quercus* and *Ulmus*. *Tilia* and *Fraxinus* are present. A date of 8020 ± 100 BP (GrN-14591) was obtained for the beginning of this zone. The end is marked by the rise of *Tilia* and the decline of *Corylus*.

*Zone 4*

The pollen assemblage of zone *4* resembles that of zone *3*, but the *Tilia* values are higher. The transition to zone *5* is set at the beginning of the fall in *Ulmus* and the sharp rise in the *Tilia* curve.

*Zone 5*

*Ulmus* drops to much lower values whereas *Tilia* rises. The beginning of zone *5* is radiocarbon dated to 6450 ± 100 BP (GrN-10720). The end is constituted by a sharp decline in *Tilia*, by the stabilization of *Ulmus* values and the beginning of the rise in the curves of *Quercus*, *Fraxinus* and *Corylus*.

*Zone 6*

The rise in the *Corylus* curve changes into a fall, while *Quercus* values rise to dominance. *Tilia* has fallen back to its values in zone *4*. *Fraxinus* seems to flourish. In this zone *Alnus* has its first, low, maximum. For zone *6* a radiocarbon date of 6360 ± 120 BP (GrN-10719) was obtained. A rise in the *Ulmus* curve and the end of the rise in *Quercus* mark the borderline between zones *6* and *7*.

*Zone 7*

*Quercus* is dominant whilst *Alnus*, with an undergrowth of *Urtica*, dominates the local vegetation on the valley floor. In this zone the telmatic peat changes to alder carr peat. The beginning is dated 6150 ± 140 BP (GrN-10013). The boundary between zones *7* and *8* is set at the decrease in *Quercus* and a corresponding increase in *Tilia*. It coincides with a change in lithology and a hiatus in the sequence cannot be excluded.

*Zone 8*

*Quercus* is less dominant than in zone *7* and *Tilia* is more important. *Ulmus* seems to flourish again. The values recorded for *Fraxinus* are the highest of the whole diagram. *Alnus* and *Urtica* percentages are still very high. The end of zone *8* is dated 5610 ± 100 BP (GrN-10713). The boundary is set at the decline in *Ulmus* and *Fraxinus*, a further decline in *Quercus* and a rise in *Corylus*.

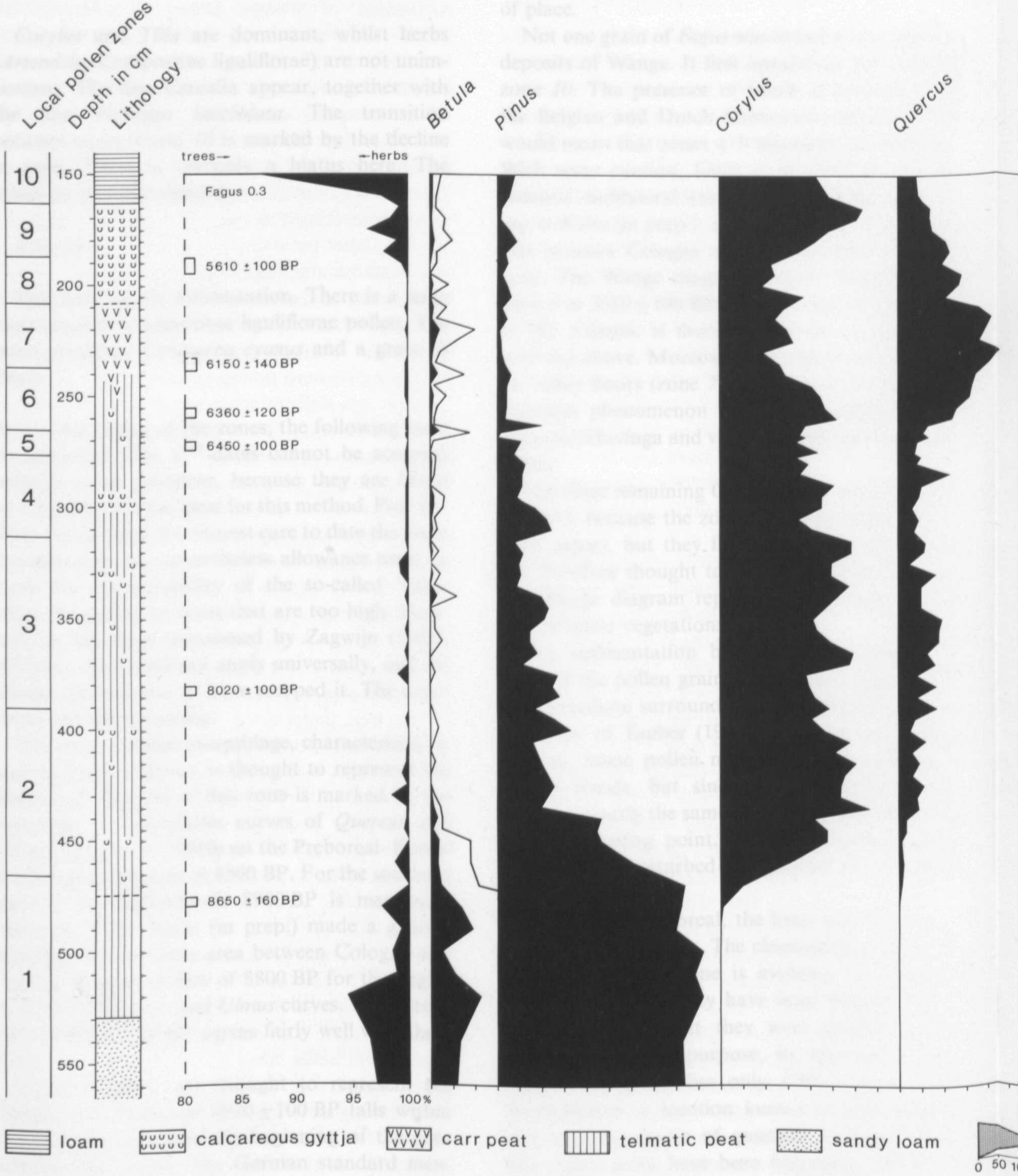
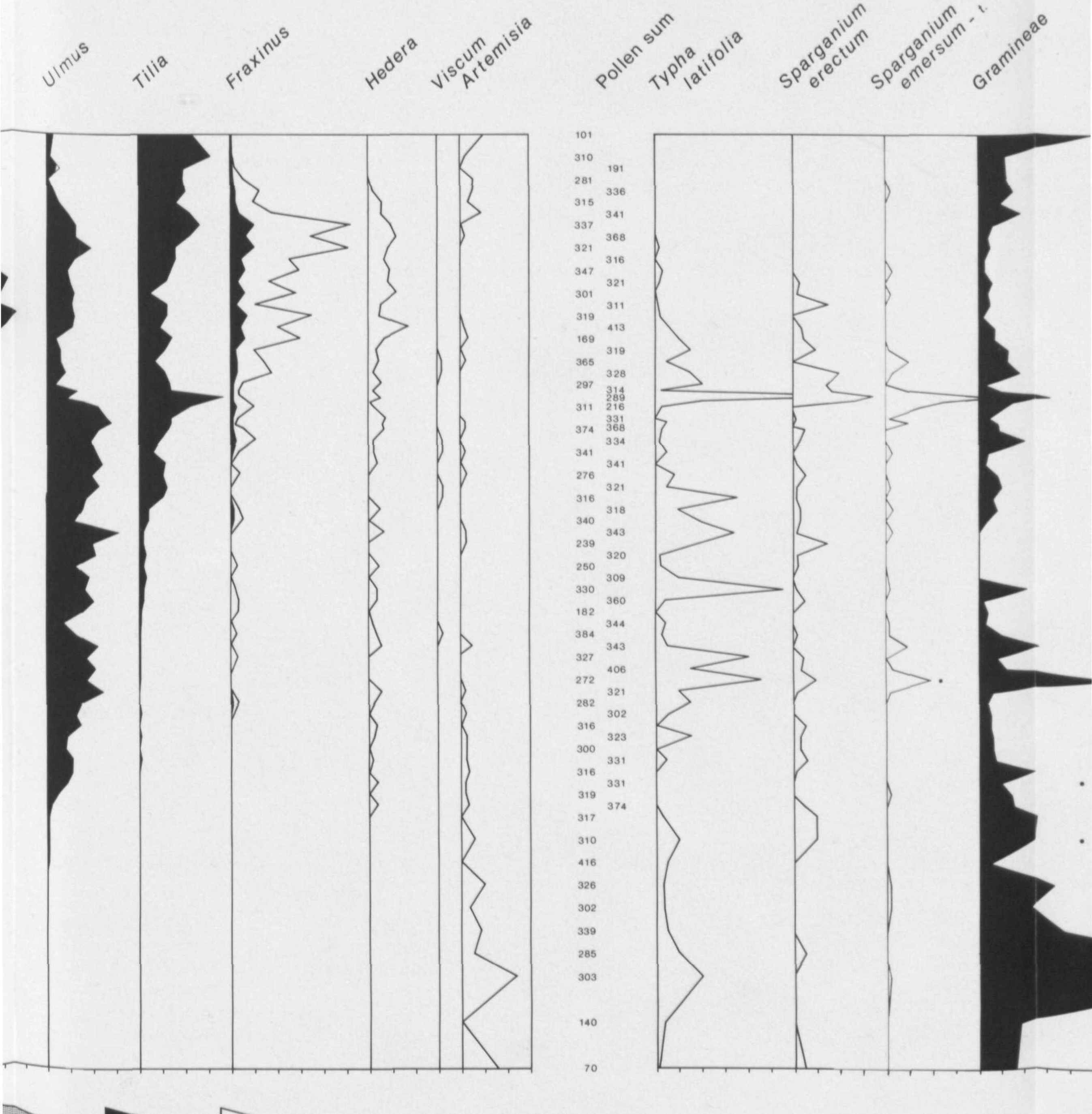
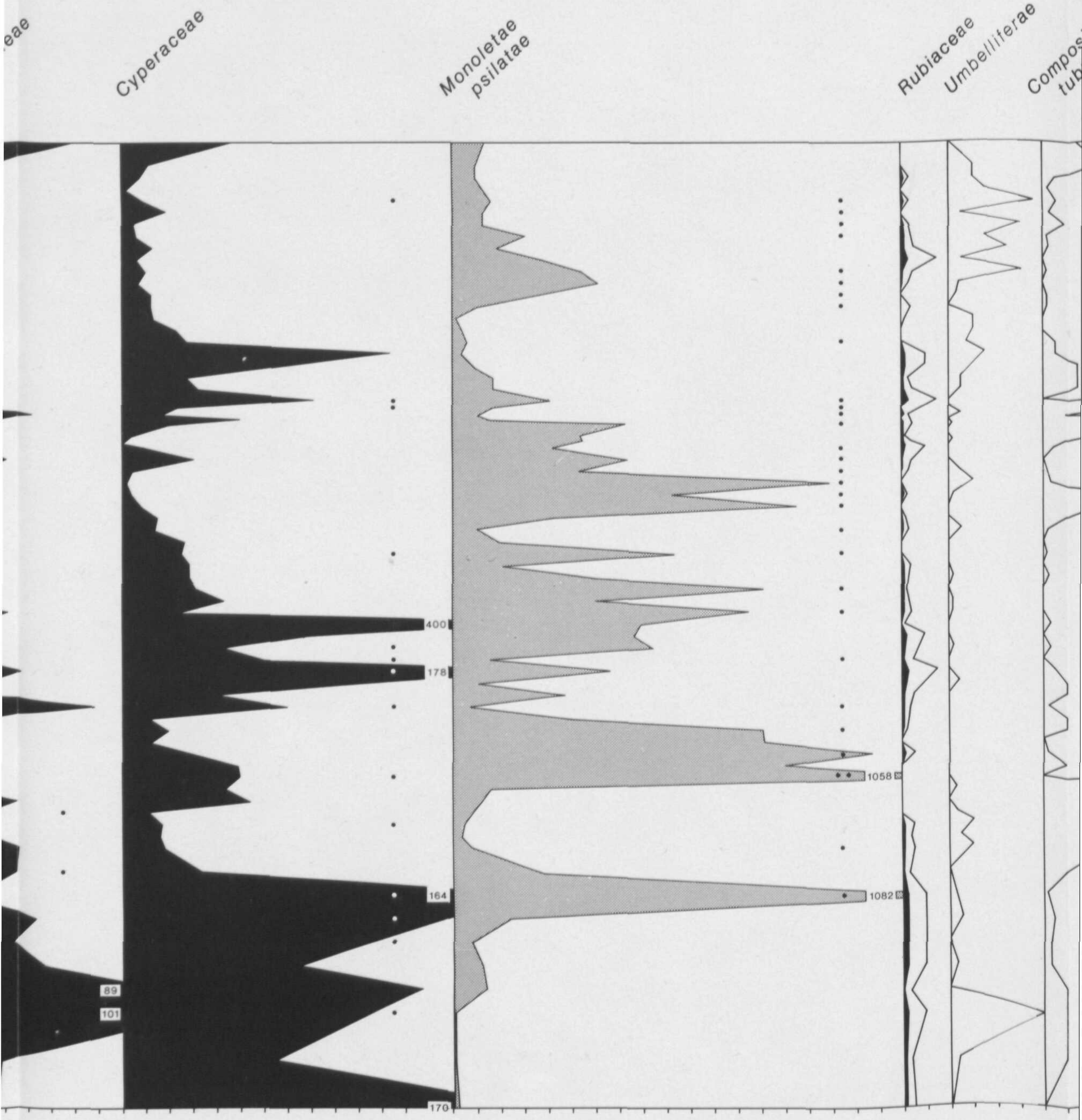



Fig.3. The pollen diagram.

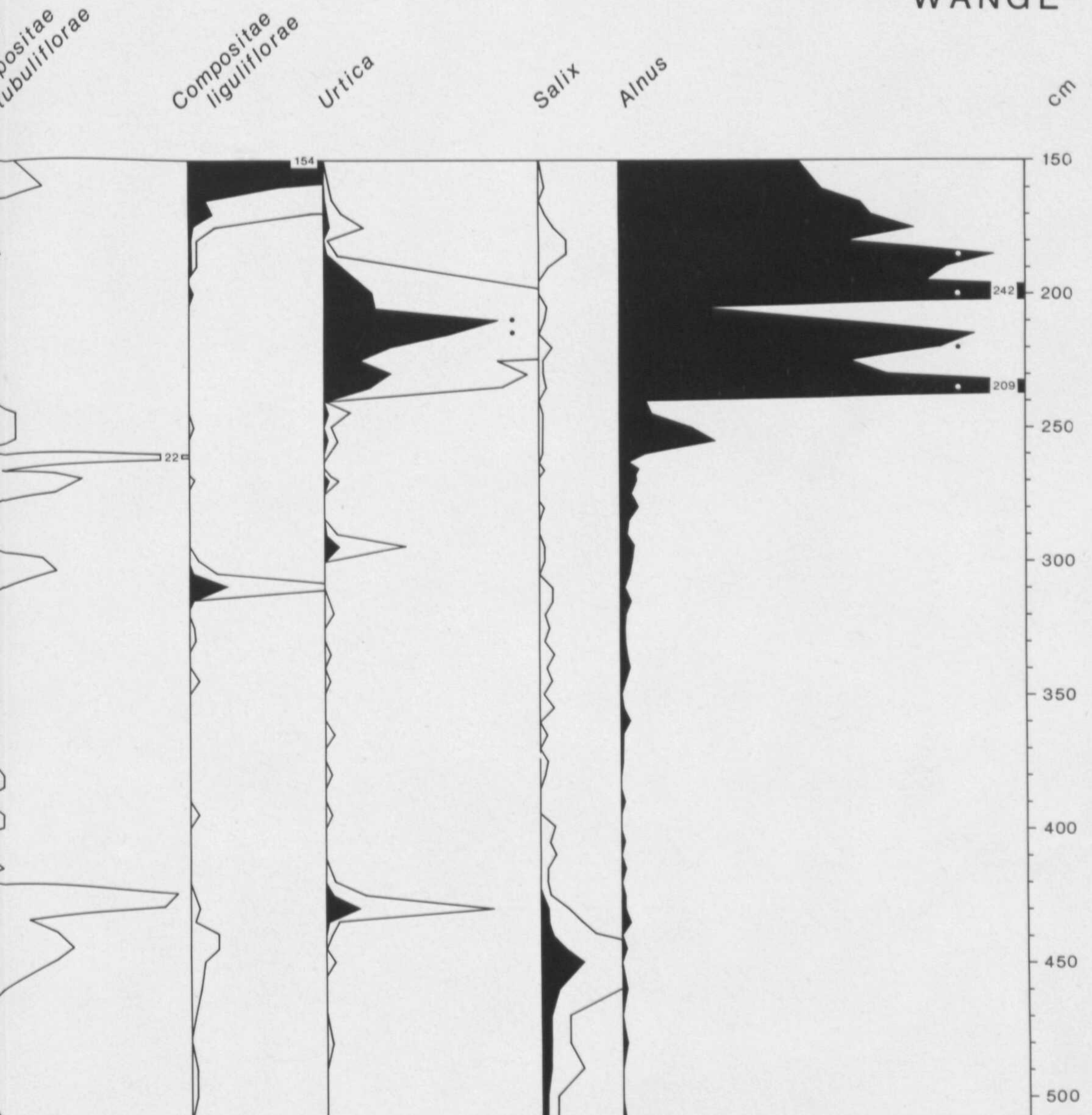



• clusters of pollen / spores



eae
Cyperaceae
Monoletae psilatae
Rubiaceae
Umbelliferae
Compos
tub
400
178
164
170
89
101
1058
1082

# WANGE



Compositae tubuliflorae
Compositae liguliflorae
Urtica
Salix
Alnus
cm
154
242
209
22
150
200
250
300
350
400
450
500
550