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# SOME POLLEN DIAGRAMS FROM THE CLAY DISTRICT IN THE PROVINCES OF GRONINGEN, FRIESLAND AND NORTH-HOLLAND (NETHERLANDS)

(Pl. XX–XXIV, figs. 57–59)

The position of the profiles from wich the pollen diagrams to be discussed in this paper were prepared is indicated in the Figs. 57 and 59. It is true that the Opende profile lies some km outside the clay district; but since the diagram from this profile provides information on the invasion of the sea in the area north of that site it has been included in this discussion. It should be stressed that the discussion is confined to the results of the palynological investigation. For a survey of the

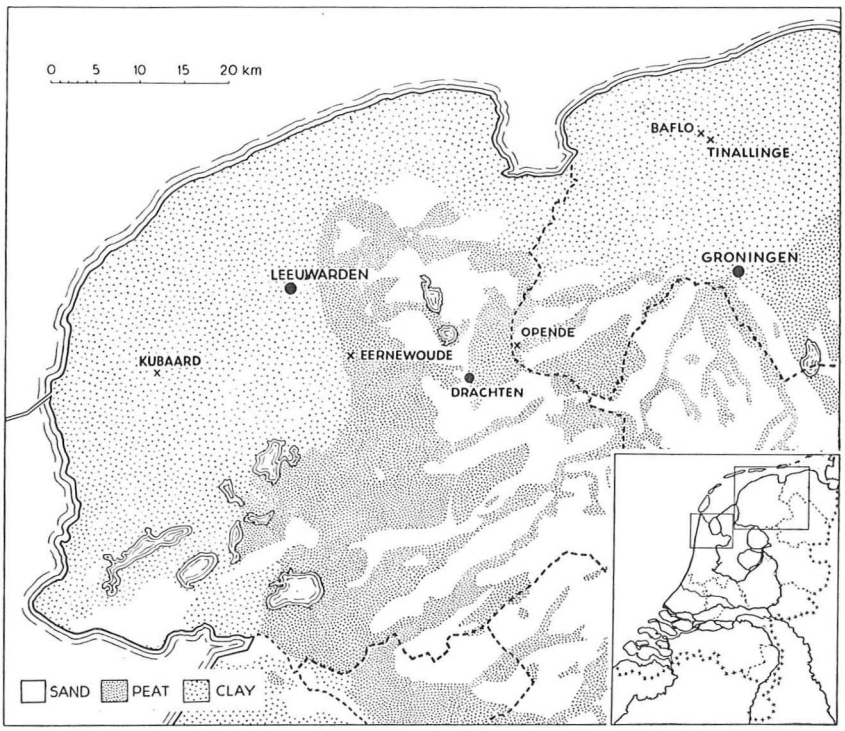


Fig. 57. Map of a part of the Northern Netherlands. The localities from where a pollen diagram was prepared are indicated by a crosslet.

holocene genesis of the western part of the province of Friesland and of West-friesland (province of North-Holland) the reader can be referred to the papers of Wensink (1958) and Pons & Wiggers (1959, 1960).

With the exception of the Opende diagram the depths are given with respect to N.A.P. (Nieuw Amsterdams Peil – Amsterdam Ordnance Datum). It must thereby be taken into consideration that the absolute heights are not exactly known. However, the deviation would not be more than 0.1–0.2 m.

Miss S. Jelgersma, geologist at the ,,Geologische Dienst'' (Geological Survey) in Haarlem, sampled the Oostwoud profile. The samples from Kubaard and Baflo I were collected by Dr. U. Tuinstra of Warffum. The ,,Dienst Landaanwinningswerken'' (Service for Land Recovery Works) at Baflo assisted in the sampling of the Baflo II and the Tinallinge profile. The provincial society for the protection of nature in Friesland, ,,It Fryske Gea'', kindly gave permission for the boring in the Saiterpetten near Eernewoude and lent assistance in the field work. The late Professor Dr. Hl. de Vries (Physics Laboratory of the State University, Groningen) made a radio-carbon measurement of a sample from the Eernewoude profile. The drawings in this paper were made by Mr. B. Kuitert and Mr. H. Roelink. Dr. J. J. Butler improved the English text.

## A. *The diagrams from Eernewoude, ●pende and Kubaard* (Pls. XX–XXII)

The Eernewoude profile was sampled in the Saiterpetten, 3 km west of the town of Eernewoude. At that spot, wich lies at about 0.3 m below N.A.P., the peat is covered by a clay layer of c. 30 cm. The diagram, Pl. XX, shows the result of

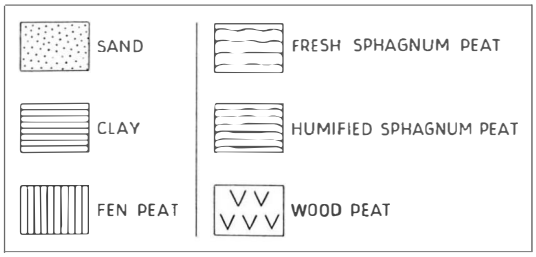


Fig. 58. Key to the symbols employed in the pollen diagrams.

the palynological investigation of this profile. As usual, the pollen frequencies of both the trees and the herbs are shown as percentages of the tree pollen sum in which *Corylus* is included. In the Eernewoude diagram *Myrica* has not been included in the Σ AP, because otherwise the high percentages for this shrub in the

upper samples would too much influence the course of the curves for the other pollen types. Some pollen diagrams from this area have already been published (Van Zeist 1949/50). The new diagram gives, however, some further information especially for the herbaceous plants.

The Eernewoude diagram compares well with other diagrams from the northern Netherlands, particularly from southeastern Drenthe. On the ground of the absence of *Fagus* and the relatively high values for *Ulmus* it may be concluded that the lower part of the peat was deposited during the Atlantic. A striking feature in the diagrams from western and northwestern Europe is formed by the elm decline. This decline of *Ulmus*, which on the basis of a number of radio-carbon measurements is to be dated at about 3000 B.C., constitutes the transition from the Atlantic to the Subboreal. In the Eernewoude diagram the elm decline takes place between samples 9 and 11. A radio-carbon measurement of the level just above sample 9 gave an age of 2980 ± 70 B.C. (GRO 2237), which is thus in agreement with the other $^{14}C$ dates of this palynological horizon[1].

From the decrease of *Ulmus* on, *Fagus* is present in very low percentages. An initial rise of the beech curve up to about 1 % can be seen in sample 22. A further increase of this tree starts at sample 27. Now *Carpinus* also occurs regularly, whereas *Corylus* shows a decline. At this rise of the *Fagus* curve, which could be dated at about 750 B.C., the border between the Subboreal and the Subatlantic is to be placed (cf. Van Zeist, 1955*b*).

The Opende diagram (Pl. XXI) which agrees fairly well with the diagram from the same raised bog published by De Planque (1949/'50, Fig. 2), illustrates the vegetational history during the Subatlantic. The samples from which this diagram was prepared were collected in the remnant of the formerly extensive raised bog to the east of the town of Drachten. This remnant is situated 4 km southwest of Opende and 6 km northeast of Drachten.

In the upper part of the diagram, beech shows relatively high values and hornbeam is also fairly abundant. In the Subatlantic forest beech and hornbeam certainly played an important part. The fact that at present beech is for the most part lacking in the remnants of woods which have escaped reclamation is to be ascribed to human activity. From late mediaevel times onwards beech, which is less valuable as timber, would have been replaced by oak. Moreover, beech cannot be used as coppice.

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[1] It must be kept in mind that the Groningen radio-carbon dates are to be raised by about 200 years. As a consequence of this practically all the dates mentioned in this paper should have been corrected with this amount. In order to avoid confusion this correction has not yet been applied here.

The Eernewoude diagram forms a link between the diagrams from southeastern Drenthe and that from Kubaard (Pl. XXII). The samples from the Kubaard profile were collected at a point c. 500 m south of the village. At that spot, which lies c. 0.2 m above N.A.P., the peat is covered by a marine deposit of about 3 m.

In the Kubaard area the peat rests on a so-called cover sand plateau (Wensink 1958, Fig. 1). At the beginning of the Atlantic the sea invaded the lower grounds between the cover sand plateaux (Van Donselaar & Jonker 1952). The higher grounds themselves were not flooded until later. In the Kubaard area peat formation started in the Atlantic, when the lower grounds had thus already been invaded by the sea.

The Kubaard diagram shows a marked increase of *Quercus* between samples 26 and 27. A similar rise of the oak curve can also be observed in the Eernewoude diagram between samples 20 and 22. In both the diagrams this increase of *Quercus* is accompanied by a rise of *Fagus*. In the Eernewoude diagram the increase of beech at this time is up to about 1%. In the corresponding part of the Kubaard diagram *Fagus* does not reach more than 0.4%; whereas below sample 27 only two pollen grains of this tree were met with. This is in contrast to the Eernewoude diagram, in wich *Fagus* occurs fairly regularly above the *Ulmus* decline. That *Fagus* is practically absent in the Kubaard diagram between the elm decline and the rise of the oak curve would in a part be caused by the circumstance that this profile was – with the exception of the upper samples – rather poor in pollen. In consequence of this a relatively small number of tree pollen was counted in most samples. The fact, however, that in the upper part of this diagram the *Fagus* percentages are considerably lower than 1% indicates that in general the share of beech in the pollen content of the Kubaard profile is less than in that of Eernewoude. It is not unlikely that this phenomenon is to be ascribed to the circumstance that the distance between the Kubaard area and the higher soils with forest vegetation was rather great. In the pollen rain the share of the relatively heavy beech pollen would have decreased with increasing distance from the higher soils.

The upper part of the Kubaard diagram shows a conspicuous increase of various herbs, whereas *Sphagnum* and *Ericaceae* disappear practically entirely. The pollen of *Chenopodiaceae*, *Triglochin*, *Plantago maritima* and highly probably also of *Artemisia* would – at least for a considerable part – have been produced by salt marsh plants. From this it may be concluded that at that time the shore line would not have been far away from the site of the Kubaard profile. As the topmost part of this profile contains rather much clay, and the *Pediastrum* met with in samples 28, 29 and 30 must be of secondary origin, it is reasonable to suppose that occasionally the bog was even flooded by the sea.

However, in the upper samples a relatively large number of pollen grains were

counted of plants wich cannot endure a salt content of any importance, such as *Hydrocotyle*, *Lysimachia*, *Galium* and *Lythrum*. This would suggest that the periods of flooding with salt water must have been of short duration. The transition from a *Sphagnum-Calluna* vegetation to a somewhat less oligotrophic swamp vegetation suggests that the surface of the bog came under the influence of the ground water. It is not impossible that the absolute or relative rise of the sea level caused an impeded drainage of the coastal area in consequence of which the bog more or less drowned. From what was said on p. 130 it follows that the small increase of *Fagus* at sample 27 can be dated at about 1500 B.C. Consequently, the effect of a marine transgression became perceptible in the Kubaard area at that time.

The upper part of the Eernewoude diagram shows no indications of an increased wetness as is the case with the Kubaard profile. On the other hand relatively much *Myrica* pollen was counted in samples 36, 37 and 38. The upper samples from the peat deposit near Jislum, likewise flooded by the sea, also contained much *Myrica* pollen (Van Zeist 1955*a*, Fig. 28). *Myrica* seems to have been a common shrub on bogs in the vicinity of the coast. From the *Carpinus* values of about 2% in the upper samples it could be concluded that as a consequence of the deposition of clay peat formation at the site of the Eernewoude profile stopped some centuries A.D.

In the Opende profile, pollen of *Plantago maritima* was regularly met with from sample 11 on. Between samples 14 and 15 an increase of *Chenopodiaceae* as well as *Plantago maritima* can be seen, suggesting that the sea invaded the area north of the Opende profile. From the course of the *Carpinus* curve it may be concluded that this invasion took place some centuries A.D. It is thus at about the same time that the immediate proximity of the sea becomes perceptable in the pollen content of the Eernewoude profile. More to the west, in the Lower Boorne area, the deposition of marine sediments started again at about 300 A.D. (Cnossen 1958).

In various diagrams from northwestern Germany and the northern Netherlands, the first pollen grains of *Plantago lanceolata* and Cereals appear at or just above the decline of *Ulmus*. This is to be ascribed to the activity of a sessile farmer population. To obtain arable land these farmers reclaimed a comparatively small part of the forest; their not very numerous cattle were kept in stalls or at least within an enclosure (cf. Troels–Smith 1953, 1955). When after a lapse of time, the soil became exhausted, another part of the forest was reclaimed; and on the abandoned fields the forest could regenerate. The first farmers in the northern Netherlands would have belonged to the Funnel Beaker Culture. This culture is best known though its megalithic tombs; but the possibility of the presence of the Funnel Beaker Culture in a pre-megalithic phase must be kept in mind.

Somewhat higher in the diagrams a marked increase of plantain can be observed. This has to be ascribed to the influence of the nomads of the Protruding Foot

Beaker Culture (cf. Waterbolk 1954; Van der Waals & Glasbergen 1955, 1959). These herdsmen destroyed large areas of forest with the help of axe and fire in order to obtain suitable grazing land for their cattle (cf. Iversen 1941, 1949).

The increase of *Fagus* up to about 1 % coincides approximately with the transition from the Neolithic to the Bronze Age. During the Bronze and Iron Age the economy would mainly have been based on farming. Now, there would have been no more nomadic herdsmen, but farmers who pratised both agriculture and cattle breeding.

In each of the samples 12 to 15 from the Eernewoude profile one pollen grain of *Plantago lanceolata* was met with. These very low percentages for lanceolate plantain could be explained in two ways. They could indicate a settlement of farmers on the sandy soils near Eernewoude. On the other hand these few pollen grains of plantain could have been caused by the activity of nomadic herdsmen roaming at a greater distance from the site of the Eernewoude profile. This last explanation is, however, highly unlikely. It has already been mentioned that the elm decline between samples 9 and 11 has to be dated at c. 3000 B.C. while the increase of *Fagus* up to about 1 % (between samples 21 and 22) took place at c. 1500 B.C. There are no indications for great changes in the rapidity of peat accumulation between the level of c. 3000 B.C. and that of c. 1500 B.C. in the Eernewoude profile. For that reason it is highly probable that in this diagram the first grains of *Plantago lanceolata* are to be dated between 2200 and 2600 B.C. This is too early to be ascribed to the activity of the nomads of the Protruding Foot Beaker Culture who did not reach our country before about 2200 B.C. Consequently, there is reason to suppose that early in Neolithic times a farmer population already lived on the sandy soils of central Friesland. However, up to now no traces of the Funnel Beaker Culture – which was present in the province of Drenthe at that time – are known from this area. Perhaps archaeological indications for early Neolithic habitation will be discovered in the future.

It is likely that the 0. 3 % *Plantago lanceolata* in sample 17 is to be ascribed to the activity of the herdsmen of the Protruding Foot Beaker Culture. In this connection it can be mentioned that near Egbertsgaasten, 4.5 km west-northwest of Drachten, the remains of a burial mound of this culture were excavated by Siebinga (1944). Moreover, from the same area a battle-axe of this culture is known (cf. Boeles 1951, p. 42).

From sample 23 on, *Plantago lanceolata* shows relatively high values, suggesting that during the Bronze and Iron Age the sandy soils of central Friesland were regularly occupied. For this habitation the archaeological evidence is still scanty. That much material can have been lost is demonstrated by the urnfield from Legauke, 3.5 km northwest of Drachten. Although much pottery came to light during the destruction of this urnfield, not a single sherd has been preserved.

In summary, it can be remarked that the palynological investigation points to an early Neolithic occupation of the sandy soils in the Eernewoude area. From the Early Bronze Age on up to at least the first centuries A.D. – where the peat formation of the Eernewoude profile breaks off – there was a continuous activity of prehistoric man in this area.

The diagrams from Jislum and Lichtaard published formerly (Van Zeist 1955*a*, Figs. 27 and 28) show that man was also present on the diluvial soils in the north-eastern part of the province of Friesland during the Bronze and Iron Age.

The Opende diagram shows continuous human activity from the beginning of the Iron Age on. Unfortunately, the upper layers of this peat deposit have vanished in consequence of the interference of man.

B. *The diagrams from Baflo and Tinallinge* (Pl. XXIII)

In the Baflo area a thin peat layer is found between the diluvial sand and the marine clay. At three sites this peat layer was sampled. The Baflo I series was taken in the town of Baflo which has been built on a dwelling mound. The Baflo II profile is situated 0.8 km and the Tinallinge profile 3.5 km east-southeast of the site of Baflo I. As appears from these three profiles, the depth of the diluvial subsoil increases from Baflo towards the east.

In this area peat formation did not reach the stage of raised bog. The increase of *Chenopodiaceae* – especially in the upper samples of the Baflo I diagram – can be considered as an indication of the approach of the sea. A more or less accurate palynological dating of the flooding of the peat in these three profiles is not possible. The fact that not a single pollen grain of *Fagus* was met with – although a relatively large number of pollen was counted in each sample – would suggest that here peat formation started and ended in Atlantic time. To this points likewise the circumstance that *Plantago lanceolata* seems to be lacking. However, for the same reason as in the Kubaard profile it must be taken into consideration that in the Baflo area the share of *Fagus* in the pollen rain would have been much lower than in the cover sand district. Consequently, on palynological grounds it cannot be excluded that the peat formation might have taken place partly or wholly in early Subboreal time. Unfortunately, the *Ulmus* curve does not provide any information in this respect. It will be needless to remark that the flooding of the peat in the three different profiles cannot be synchronous. So at the spot of the Baflo I profile peat formation was still taking place when more to the east the deposition of marine clay was already in full swing.

C. *The Oostwoud diagram* (Pl. XXIV)

The Oostwoud profile is situated 350 m north of the eastern end of the elongated village of Oostwoud, at a short distance from the two Bronze Age tumuli excavated by Van Giffen (not yet published). The height of the surface is about 1.80 m ÷ N.A.P. From this profile not only the peat but also the clay was analysed. Concerning the reliability of the clay samples with respect to rebedded pollen the following can be remarked. A comparison between the spectra from both the peat layers and those from the clay shows that in general the *Pinus* percentages in the

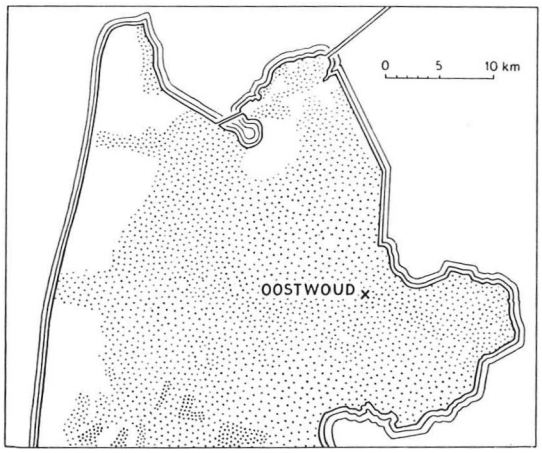


Fig. 59. Map of Westfriesland, showing the position of the Oostwoud profile (cf. the map of the Netherlands in fig. 57).

clay samples are somewhat higher than in the peat samples. Moreover, in the peat the *Quercus* values are higher and the *Corylus* values lower than in the rest of the profile. These differences, however, are fairly low so that it may be supposed that the spectra from the clay samples also give a reliable survey of the vegetational history of this area.

With regard to the character of the contamination it is likely that Late-glacial as well as older material was reworked. The presence of *Ephedra* and *Selaginella* points to contamination with Late-glacial pollen. Also *Pediastrum* is possibly of Late-glacial origin. On the other hand the regular occurrence of *Carpinus* below sample 35 points to interglacial pollen, probably from the Eemien. The relatively high percentages for *Picea* are an indication for secondary material of interstadial or interglacial age. Peat deposits in the northeastern Netherlands – wich lie at a shorter distance from the natural habitats of *Picea* than Westfriesland – show a

mean *Picea* value of 0.2% with a maximum of 0.4% during the Atlantic and the Subboreal. In a number of Oostwoud samples *Picea* reaches more than 1%.

In the Oostwoud diagram the tree pollen curves do not show conspicuous alterations. An elm decline can be observed between samples 9 and 10. It is likely that this decline is synchronous with the elm fall of c. 3000 B.C. According to a radiocarbon measurement the basis of the lower peat layer in the profile from Hauwert–Zwaagdijk, 2.5–3 km south of the Oostwoud profile, is to be dated at 2730 ± 140 B.C. (Pons 1957). It is reasonable to suppose that this peat layer can be correlated with the peat deposit between 615 and 580 cm in the Oostwoud profile. In consequence of this the layer between 615 and 605 cm would be dated at c. 2750 B.C. It is clear that in that case an age of c. 3000 B.C. for the decline of *Ulmus* between 665 and 645 cm is very likely.

At 575 cm *Ulmus* again reaches the same values as befor the decline. A similar new increase of *Ulmus* can also be observed in other diagrams, but than this rise is followed by a second, and final fall. This is not so in the Oostwoud diagram; the values for *Ulmus* remain relatively high. Also *Tilia* – which in many other diagrams decreases considerably in the course of the Subboreal – has about the same values through the whole Oostwoud diagram.

The *Fagus* curve comes wholly up to expectations. According to the Oostwoud diagram, beech arrived in Westfriesland some hundreds of years later than in the eastern Netherlands. There can be no doubt that the small rise of the beech curve up to about 1% between samples 43 and 45 is synchronous with a similar increase of *Fagus* observed in diagrams from the eastern Netherlands and dated at c. 1500 B.C. The radio-carbon dating of 1790 ± 120 B.C. for the upper peat layer in the profile from Hauwert–Zwaagdijk mentioned above supports this supposition. It is namely very likely that the peat between 380 and 355 cm in the Oostwoud profile is synchronous with the upper peat layer in the Hauwert–Zwaagdijk profile. In consequence of this the layer between 365 and 355 cm in the Oostwoud profile could be dated at about 1800 B.C., so that an age of c. 1500 B.C. for the level of 325 cm is quite reasonable.

As in the upper part of the diagram the *Corylus* curve does not yet show a considerable decline it may be concluded that the deposition of clay at that spot did not continue after c. 1150 B.C. (cf. Van Zeist, 1955*b*). In other parts of Westfriesland the deposition of clay must also have been finished at the same time, as Bronze Age burial mounds were built on top of the clay (Van Giffen 1944, 1953; Wiese 1956).

It should be noted that the result of the palynological investigation of the Oostwoud profile is not entirely in accordance with the conclusions arrived at by Pons & Wiggers (1960, Fig. 24). According to these authors in the Oostwoud area no more clay would have been deposited after c. 1900 B.C. However, the pollen diagram

of Pl. XXIV indicates that in this area at least in the lower parts the deposition of clay also took place after that date.

On account of the course of the *Fagus* curve the deposition of clay on top of the upper peat layer must have started some time before 1500 B.C. In the peat deposit near Kubaard the effect of the rise of the sea became perceptable at about 1500 B.C. (cf. p. 131). In both these cases the so-called Cardium transgression would be concerned here (cf. Muller & Van Raadshoven 1947; Wiggers 1955). For Westfriesland Pons (1957) already arrived at the same conclusion.

As for the harbaceous pollen, the high percentages for *Umbelliferae*, *Galium*, *Typha latifolia*, *Cyperaceae* and *Gramineae* are conspicuous. The presence of some silt in the peat suggests that the bog vegetation was occasionally flooded.

Concerning the palynological indications for the activity of prehistoric man the following can be remarked. Already at a depth of 770 cm a pollen grain of *Plantago lanceolata* was counted. This is surprising because in Post-glacial peat deposits in western Europe lanceolate plantain is never met with before the elm decline. For that reason it is likely that this pollen grain of *Plantago lanceolata* is of Late-glacial origin. In the same sample a pollen grain of *Ephedra* – undoubtedly a Late-glacial contamination – was also met with. It is true that pollen of *Plantago lanceolata* is scarce in Late-glacial deposits but this is also the case with *Ephedra*. It is of course quite possible that more pollen grains of *Plantago lanceolata* in the Oostwoud diagram are of secondary origin. It may, however, be assumed that at least a part of the pollen of lanceolate plantain in this diagram is due to human activity. It is certainly justifiable to conclude that there is palynological evidence for the presence of man in this area during the Late Neolithic, that is to say between c. 2200 and 1500 B.C. Pottery both of the Protruding Foot Beaker Culture and the Bell Beaker Culture is known from Westfriesland (cf. Van der Waals & Glasbergen 1959, Figs. 7 and 19). Naturally it cannot be determined whether the few pollen grains of *Plantago lanceolata* are to be ascribed to the activity of nomadic herdsmen at a fairly great distance from the Oostwoud profile or to that of farmers of the Bell Beaker Culture at a shorter distance. In this connection it can be remarked that below the Bronze Age tumuli mentioned on p. 132 sherds of Bell Beaker pottery were discovered. The regular occurrence of plantain in the upper part of this profile suggests that during the Early and Middle Bronze Age prehistoric man was likewise present in Westfriesland.

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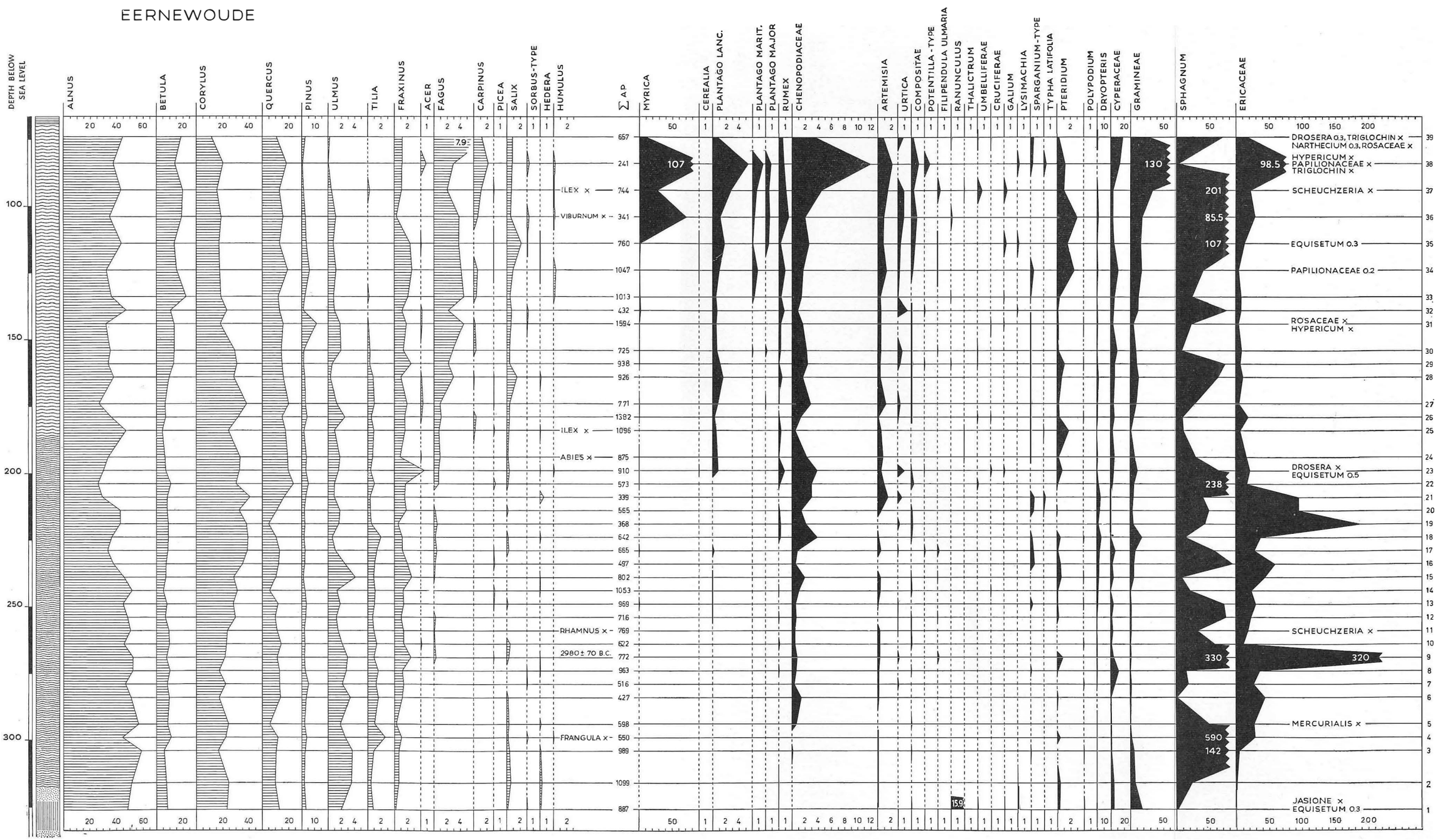


Pollen diagram at the Saiterpetten near Eernewoude.

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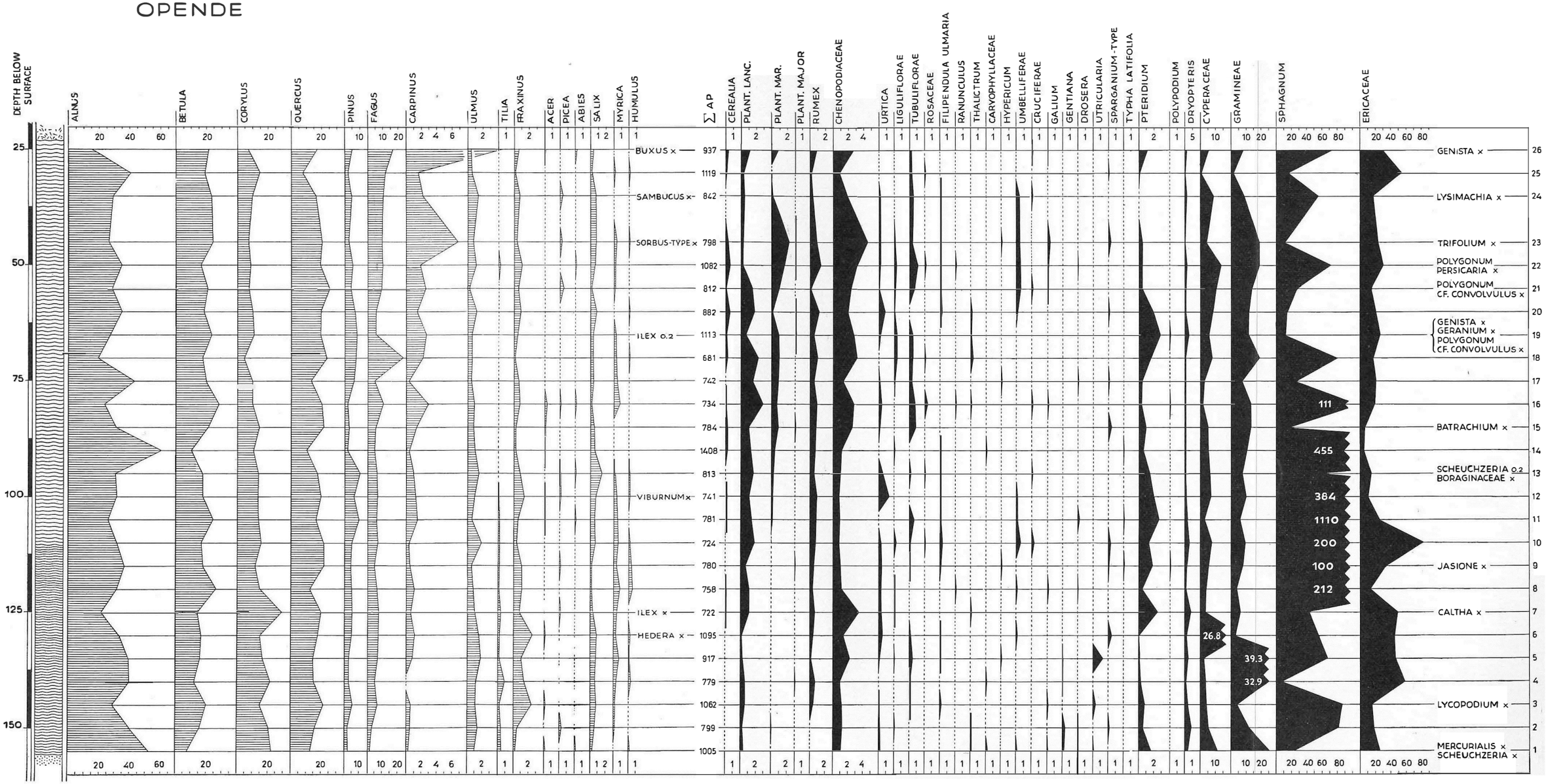
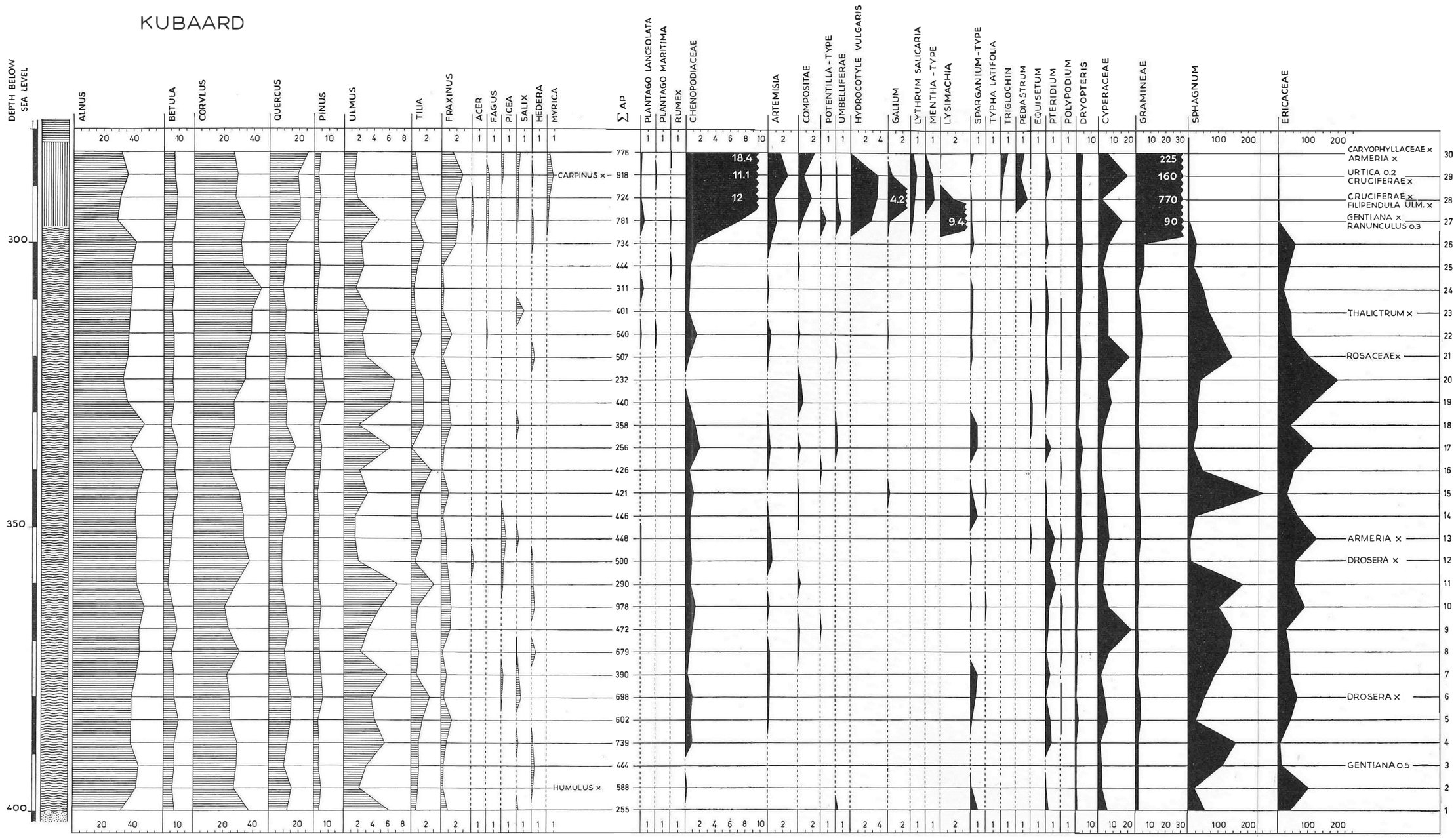
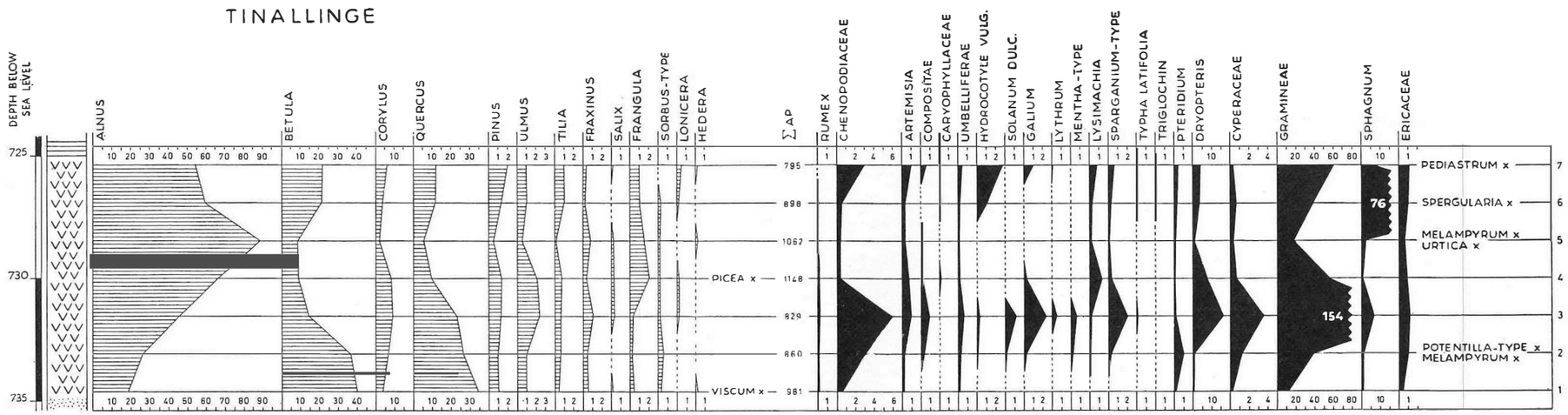
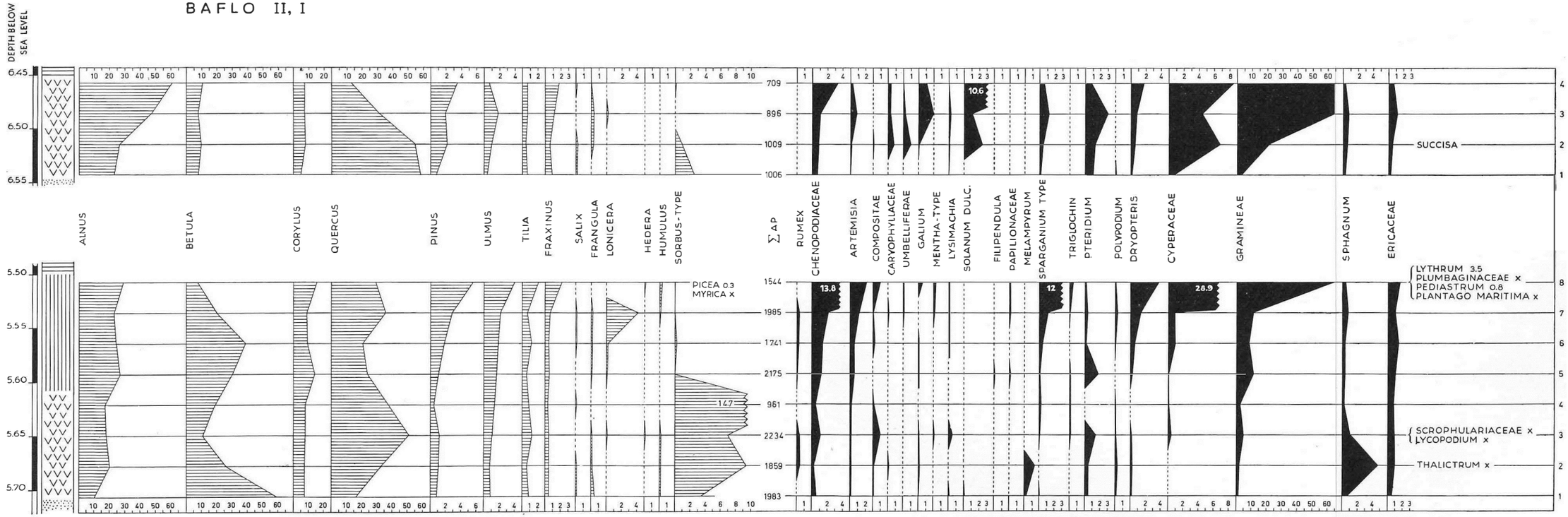



Pollen diagram from Opende.




Pollen diagram from Kubaard.




Pollen diagrams from Baflo and Tinallinge.

OOSTWOUD

Pollen diagram from Oostwoud.