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## Some west baltic pollen diagrams

*By Knud Jessen, Copenhagen*

In a paper from 1935 (1) I gave a short view over the 9 zones in which danish pollen diagrams covering the late- and the post-glacial periods may be divided on the basis hitherto procured. A very valuable stimulation to an attempt at a more detailed division is given by Tage Nilsson (2) in his interesting paper on pollen diagrams from Scania, and from a danish point of view so much the more as one of his diagrams is from a bog in northern Sealand. Completely to transfer Tage Nilsson's 12 zones to danish diagrams does not seem possible, but partly on the basis of new pollen diagrams from this country it is possible to subdivide some of my original zones and to fix my zone border V/VI sharper than done in the paper cited, and in this way to procure a somewhat better accordance between the scanian and the danish diagrams. Thus the rational border of *Alnus* practically may be used to separate my zones V and VI which very nearly agree with the

zones VIII and VII of Tage Nilsson, and further my zones VII and IX can be divided in two subzones a and b, and the same perhaps will be possible also for some of the other zones. The prove of this however will be given in an other paper, but some subzones will be marked on the pollen diagrams published here. The more the pollen diagrams can be divided, the more there will be need of archæological datings of them.

In the following a couple of such datings shall be treated which seem to be of significance within Denmark, and as the localities in question are situated in the southern part of the country the investigations perhaps will have some interest for botanists and geologists in northern Germany too. Besides, for comparison is taken a pollen diagram from a bog lying near south of the danish-german border, viz Hornholz bog at Flensburg.

#### GAMMELLUNG BOG ON THE ISLE OF LANGELAND

In 1935 J. Winther (3) published an interesting paper on his investigations of the remarkable house-sites from the younger danish stone age at Troldebjerg on the isle of Langeland. The author refers this culture layer to the older passage-grave period (p. 31 and 44), and in accordance with this Dr. Therkel Mathiassen kindly has told me that in his opinion it dates from about 2500 to 2200 BC. The culture layer was lying along the foot of a steep hill side facing toward the west and directly bordering on the Gammellung bog out in which it could be followed in form of scattered lying bones of domestic animals, pieces of flint more or less roughly hewn, throw-stones, a scraper and worked pieces of wood, which all together were placed in the upper part of the peat and mud layers, as shown in fig. 1. Also various implements have been found elsewhere in the border party of the bog just in the same horizon which must be contemporaneous with the settlement from the older passage-grave period along the border of the bog. The thick layer of earth seen at the eastern end of the section is slipped down material from an old wall and contained much refuse from the culture layer. The surface of the bog now was covered with a rather dry meadow vegetation growing on peat-mould.

At the western end of the section shown in fig. 1 the following layers were found.

- A. 0—0,18 m. Peat-mould.
- B. 0,18—0,5 m. Sedge-fen-peat, the lowermost part of the layer containing drifted mud (Gyttja) material, i. a. fruits of water plants.

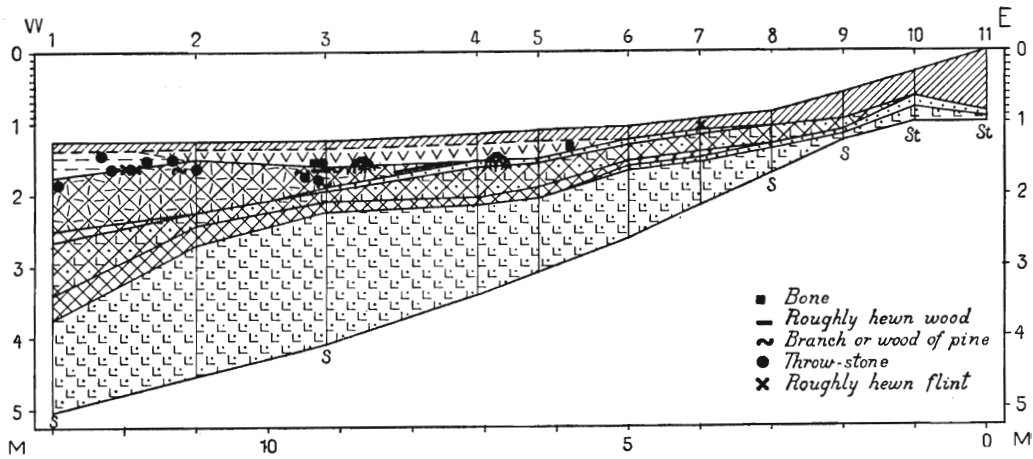


Fig. 1. Gammellung bog. Section of the eastern border-zone with refuse from the dwelling-place

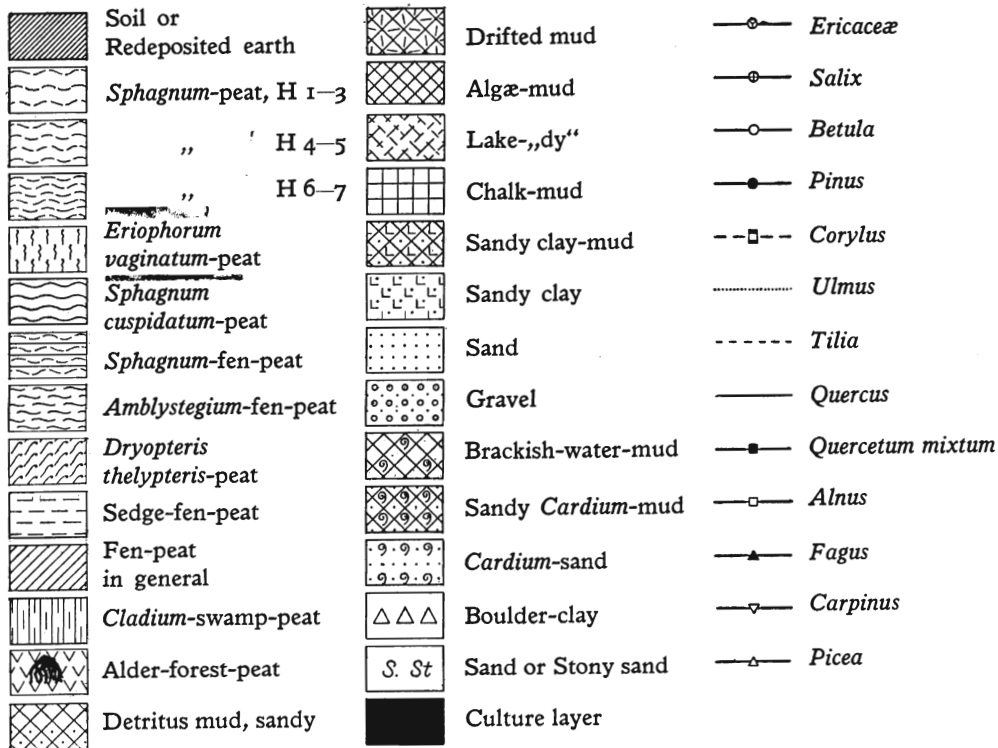


Fig. 2. Explanations of the symbols

- C. 0,5—1,25 m. Drifted mud. In the uppermost 25 cm of the layer macroscopical remains of the following plants were found: *Alnus glutinosa* (common), *Betula pubescens*, *Ceratophyllum demersum*, *Cladium mariscus* (common), *Corylus avellana*, *Fraxinus excelsior*, *Menyanthes trifoliata*, *Nymphaea alba*, *Najas marina* (common), *Pinus silvestris*<sup>1)</sup>, *Potamogeton natans*, *P. praelongus*, *Quercus* sp. *Ranunculus flammula*, *Rubus idæus*, *Scirpus lacuster*, *Tilia cordata* (common). — *Ceratophyllum demersum* and *Najas marina* were found also in the lowermost 5 cm of the layer.
- D. 1,25—1,4 m. Dark greyish brown sandy detritus mud. *Potamogeton natans*.
- E. 1,4—2,18 m. Grey or light grey fine sandy clay-mud.
- F. 2,18—2,45 m. Grey brown chalky detritus mud. At point 6,25 m of the section a catkin scale of *Betula pubescens* was found in this layer.
- G. 2,45—3,73 m. Light grey fine sandy clay.
- H. 3,73—3,8 m +. Hard sand without stones.

The section shows that Gammellung bog is a grown over lake at the border of which a drifted mud was accumulated. Nearest the shore the mud has been grown over by an alder-swamp

<sup>1)</sup> As macroscopical remains of *Pinus silvestris* younger than the zones V and VI are rare in Denmark, in this connection may be remembered on the find of charcoal of this tree in a dwelling-place from the bronze age at Öster Stigtehave in the northern part of Langeland (4). It is to assume that the pine for long times has survived the "pine-period" on this island as elsewhere in Denmark as a rather rare tree in the forests.

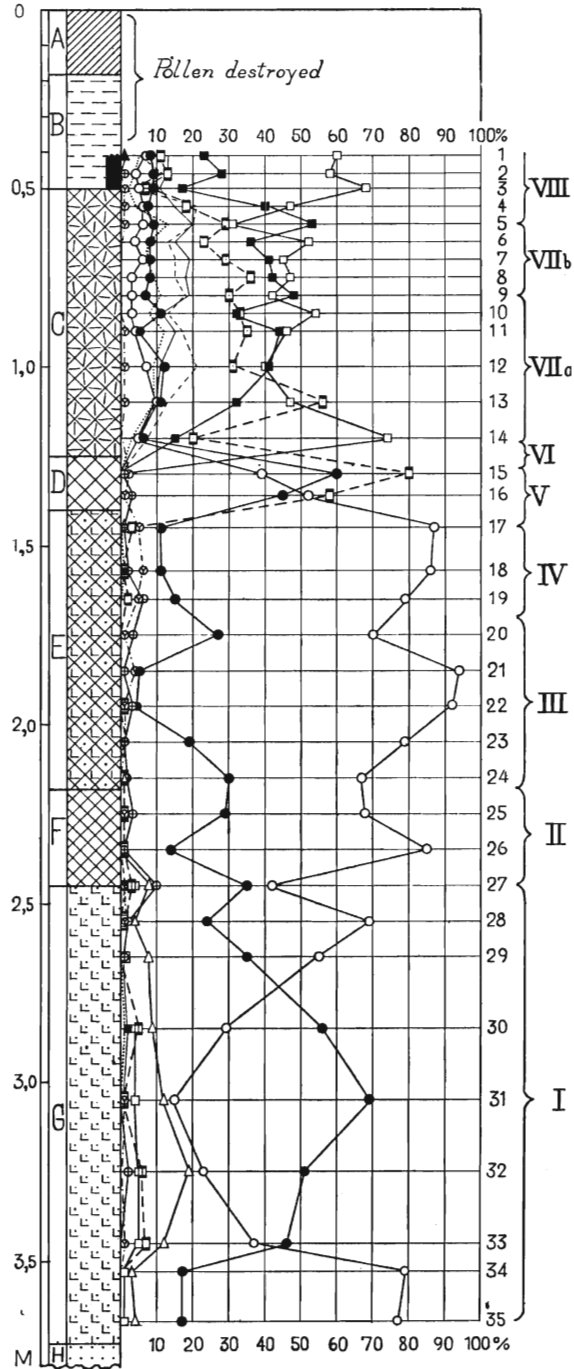


Fig. 3. Gammellung bog  
Pollen diagram from the western end of the section

which in some greater distance from the original shore turned over in a sedge-swamp. The position in the section of the culture refuse makes it most likely that these swamp vegetations penetrated out over the mud just in the older passage-grave period when the houses at Troldebjerg were in use.

The pollen diagram, fig. 3<sup>2)</sup> is worked out on samples taken at point 13 m of the section. Though no remains of arctic plants were found, the stratigraphy of the lowermost layers as well as the pollen diagram itself makes it evident that in Gammellung bog is represented as well the older *Dryas*-clay (zone I, layer G) with its rich representation of secondary pollen (5), as the Alleröd-mud (zone II, layer F), while, by help of the pollen diagram only, it is possible to distinguish between zone III, the upper *Dryas*-clay and zone IV or the pre-boreal zone, cfr. the pollen diagrams especially from Brøndum (1), Lundby (6), Fjerritslev (7) and Sækkedam (2). For the rest, the late glacial part of the Gammellung pollen diagram will not be discussed here.

The zone-border VII/VIII is very distinctly marked in this diagram as it is in the most of the danish pollen diagrams hitherto done, by the curves of *Ulmus* and *Tilia* falling strongly inward. At the same diagrammatical level Tage Nilsson in Scania places his zone border V/IV. In Gammellung bog this level is situated in the uppermost part of the drifted mud which at point 13 m evenly turned over in the layer B, by this making it unlikely that a lacuna in the stratification may exist here. The position of the culture refuse in the section allows to suggest that the lowermost part of zone VIII is contemporaneous with the culture layer along the shore of the former lake, and this is fully confirmed by the diagram fig. 4 based on samples taken in a trench 56 metres north of the section fig. 1 and 7 metres west of the border of the bog. The culture layer found here, by J. Winther has been followed right in to the wall, on the eastern side of which also here have been lying huts from the older passage-grave period. The section of the trench was as follows.

A. 0—0,25 m. Peat-mould.

B. 0,25—0,46 m. Dark brown sedge-fen-peat.

C. 0,46—1,7 m +. Brown drifted mud containing i. a. *Najas marina* and *Tilia cordata*.

The culture horizon, indicated by the occurrence of flint chips, a flint drill, some throw-stones, bones i. a. a netherjaw of a pig, and an ornamented sherd of pottery was found from 0,25 to 0,45 metres below the surface. The fragment of diagram from this site is pretty well conformable with the spec-

<sup>2)</sup> The pollen analyses published in this paper are carried out mainly by Mr. K. M. Eriksen.

tras 1–4 in the big diagram, and in accordance with what has been communicated here, thus the older passage-grave period on Langeland should be contemporaneous with the lowermost part of zone VIII. Unfortunately the pollen diagram could not be continued

higher up, the pollen content being destroyed in the upper part of the peat and the youngest layers of the bog being dug away long ago all over the bog.

A representation of the beech by 1% in the uppermost spectrum of the pollen diagram fig. 3 must be seen in relation to the fact that a piece of charcoal of this tree has been found in a culture layer from the younger passage-grave period at Lindö lying about 5 km west of Gammellung bog (8). Such an early — surely quite sporadic — occurrence of the beech is known, due to macroscopical remains in culture layers, also from a few other localities in Denmark, and consequently the trace of beech in spectrum 1 can not be taken as an indication that zone VIII is stopping at that level.

#### BUNDSÖ ON THE ISLE OF ALS

In the beginning of this century the german archæologists R. Virchow and C. Rothmann published their results of an excavation in the dwelling-place from the younger passage-grave period (about 2000 BC) lying in Bundsö on the isle of Als (9). Later, the site has been surveyed by the danish archæologist Helweg Mikkelsen and by Dr. Therkel Mathiassen for the danish National Museum. In 1929 in company with Helweg Mikkelsen as well as later I have had the opportunity of making some investigations at the locality which shall be mentioned here.

Bundsö is lying in the northern part of Als, about 5 km south of Nordborg. Previously it was the inner end of a 5 km long fiord entering from the fiord of Als, but since long ago it has been reclaimed, and its surface, now a meadow, is lying unto about 2 metres below the Ordinance Survey's Datum (mean sea level). Fig. 5 shows a somewhat schematic section of the fiord deposits at the southern side of the inner part of Bundsö close east of a high wall crossing right over the former fiord bottom. The section between the points 4 and 5 is surveyed in a trench sunk by Helweg Mikkelsen. The culture layer found here, containing numerous implements of flint and sherds of pottery, is marked on the figure. About 30 metres west

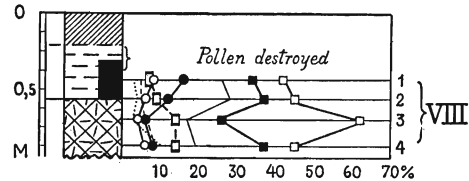


Fig. 4. Gammellung bog. Pollen diagram.  
See text

of these points and directly west of the before mentioned wall, the so called Flintholm is lying, which according to the archæologists has been the centre for the habitation in Bundsö in the younger passage-grave period.

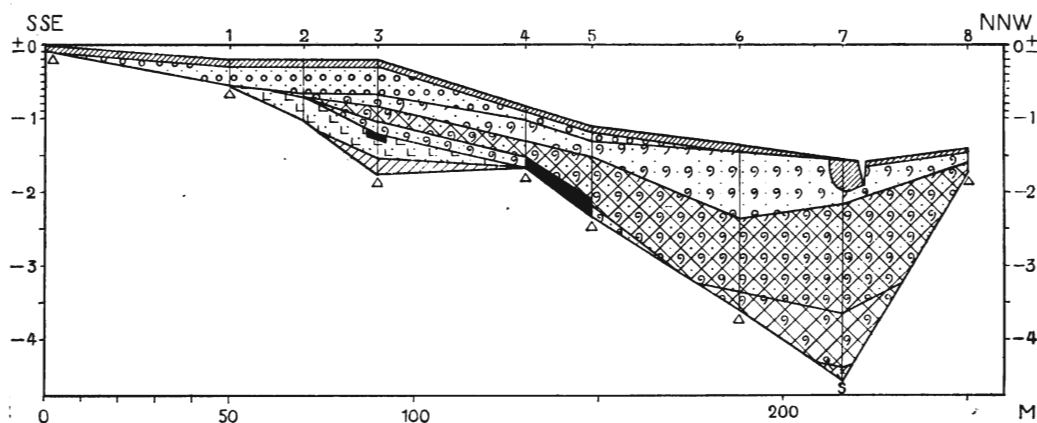


Fig. 5. Bundsö. Section of the south eastern part

The stratification at the points 3, 5 and 7 deserves a special description:

#### POINT 3

- A. 0—0,08 m. Gras-grown soil.
- B. 0,08—0,46 m. Topmost grey or reddish sand with few stones, downward changing over in gravel.
- C. 0,46—0,63 m. Grey sand with few stones.
- D. 0,63—0,83 m. Grey brown sandy *Cardium*-mud with numerous shells of *Cardium edule*.
- E. 0,83—1,0 m. Sand with few shells of *Cardium edule*. Refuse of flint.
- F. 1,0—1,35 m. Grey sandy clay containing small stones. On the surface of the layer rested several big stones, their diametre being up to 35 cm, and in the uppermost part of the layer numerous big shells of *Mytilus edulis*, much charcoal especial of *Fraxinus excelsior* and of *Quercus* sp. and *Betula* sp. were found; besides, flint-chips and sherds of pottery, some charred grains of barley (*Hordeum* sp.) and wheat (*Triticum* sp.), numerous non-charred fruit-stones of *Rubus idæus*; fragments of bones. — In the lower part of the layer no shells nor culture remains were found, only small splints of charcoal.
- G. 1,35—1,55 m. Brown, sandy fen-peat with much decayed wood.
- K. Boulder-clay.

It is to suggest that the sandy clay of layer F partly is a washed down material and that the culture layer here was lying in primary position forming a mere continuation of the culture layer on Flintholm.

#### POINT 5

- A. 0—0,09 m. Soil.
- B. 0,09—0,2 m. Reddish grey coarse sand or gravel. Flint-implements in secondary position; compare p. 134.

- C. 0,2—0,4 m. Grey sand containing numerous shells of *Cardium edule* and *Hydrobia ulvæ*.
- D. 0,4—1,08 m. Topmost grey, downward more brownish sandy *Cardium*-mud with numerous shells as in layer C and besides of *Mytilus edulis* and *Littorina* sp.
- E. 1,08—1,23 m. Muddy *Cardium*-sand containing shells as Layer D and besides a good deal of big shells of *Ostrea edulis*<sup>3)</sup>. Macroscopical remains of the following plants were found: *Alnus glutinosa*, *Betula* sp. *Chenopodiaceæ* (many seeds), barley (*Hordeum* sp., some charred grains), *Ranunculus repens*, *Raphanus raphanistrum*<sup>4)</sup>, *Ruppia maritima* (numerous fruits), *Rubus idæus*, wheat (*Triticum* sp., some charred grains). — Through the layer and in the lowermost 10 cm of layer D numerous flint-implements, sherds of pottery and bones of domestic animals occurred as it was the case too with the bottom layer through the whole trench from point 5 to point 4. The culture remains surely were lying in a secondary position representing an outwash from the culture layer in primary position at a higher level.
- K. Boulder-clay.

## POINTS 7. The section surveyed by drilling

- A. 0—0,45 m. Redeposited earth and modern peat.
- C. 0,45—0,6 m. Sand with *Cardium edule*.
- D. 0,6—ca. 2,1 m. Brackish-water-mud containing numerous shells of *Cardium edule* and *Hydrobia ulvæ*. Uppermost the layer was greyish and rich in sand, downward turning brown, and being nearly free of sand near the basis; here much decayed wood and fruits of *Ruppia maritima*. Many brackish-water diatoms.
- H. ca. 2,1—ca. 2,8 m. Brown brackish-water-mud containing few shells of *Cardium edule*, the most of them being found in the lowermost 20 cm of the layer; here also *Hydrobia ulvæ*. Much decayed wood. In the lowermost samples few diatoms only occurred, viz *Campylo-discus clypeus* Ehr. and *Synedra crystallina* Lyngb.; at a little higher level (sample 36) however the diatom-flora was richer, containing i. a. *Achnanthes brevipes* Ag., *Campylo-discus clypeus* Ehr., *Diploneis didyma* (Ehr.) Cleve, *Nitzschia* cfr. *vitrea* Norman, *Rhopalodia musculus* Kütz., *Synedra affinis* Kütz. var. *fasciculata* (Kütz.) Grun, *S. crystallina* Lyngb., which all are common species of the fiord. Again in the upper part of the layer the diatoms were seldom.
- J. ca. 2,8—3,0 m. Greyish brown lake-, „dy“ with much decayed wood, fruits of *Batrachium* sp., *Carex* sp., *Potamogeton pectinatus*, *Scirpus lacuster*, seeds of *Menyanthes trifoliata*, Leaves of *Hypnum* sp., spores of *Dryopteris* cfr. *thelypteris*, pollen of *Cyperaceæ* and *Umbelliferæ*.
- K. Stony sand.

The two layers H and J were very much like each other, and it does not seem probably that there should be any lacuna between them.

## POLLEN ANALYSES

The lower part of the pollen diagram from point 7 (fig. 6) is not quite typical, i. a. the *Corylus*-maximum is uncommonly low, the zone-border VI/

<sup>3)</sup> On *Ostrea edulis* in the Baltic, see V. Nordmann (10). Also Rothmann noticed that the oyster occurred in this layer only and suggested that it has been fished at the mouth of the fiord.

<sup>4)</sup> Two pod-joints; in Denmark earlier such have been found in a culture layer from the bronze age and in culture layers from the middle ages (11).



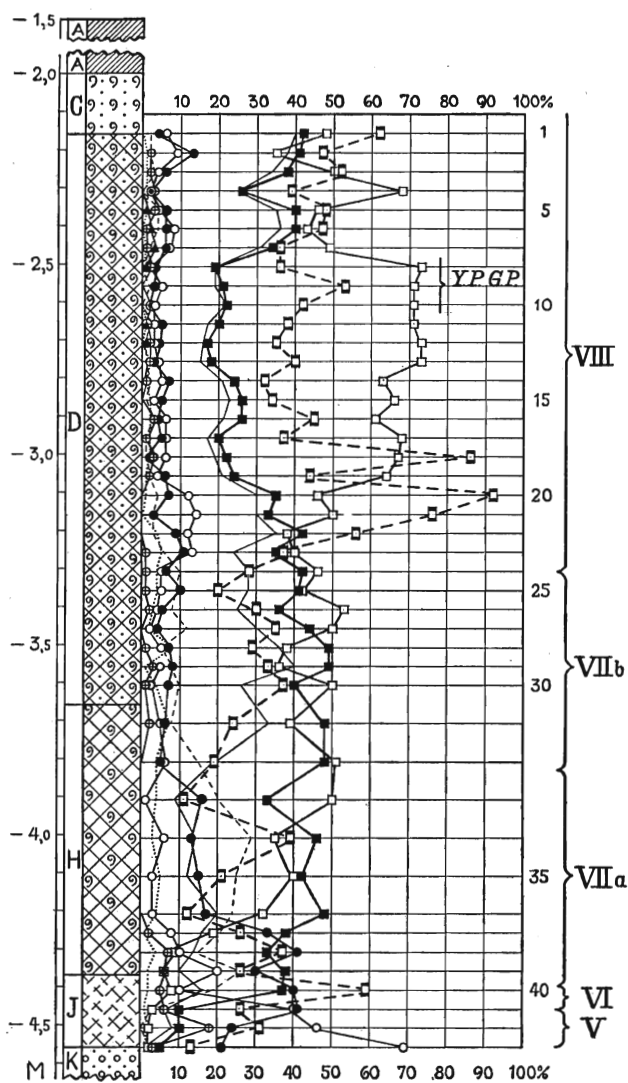


Fig. 6. Bundsö  
Pollen diagram from point 7 in the section  
YPGP, the approximate horizon of the younger  
passage-grave periode

diagrams, is characterized by a considerable *Corylus*-maximum, a rising of *Alnus* and an oscillation outward of the curves of *Quercus* and *Betula*. Comparing this diagram with the diagram from point 5 (fig. 7) the basal part of which covers the culture layer, it is evident that the *Cardium*-mud at point 5 can not be contemporaneous with any part of the mud layer at point 7

VII however, surely must be placed close over sample 40, the proportion *Quercus*:*Pinus* here reaching the value of 1 at a little higher level than the rational border of *Tilia* (compare (1) p. 187). By this the *Tilia*-maximum entirely falls within the subzone VIIa what ordinarily is the case, even if it is unusual that the frequency of *Pinus* reaches up to about 40% in the lower part of this subzone. With the placing of the zone-border as mentioned, the level of transgression of the sea at point 7 falls in the lower part of zone VIIa which may be somewhat later than the end of the Mullerup-(Maglemose-)period as this is fixed in the bogs on Sealand (6) and in central Jutland (12).

Zone VII with its two subzones is well developed, and the border VII/VIII is distinctly marked. The lower part of zone VIII, as in several other danish pollen

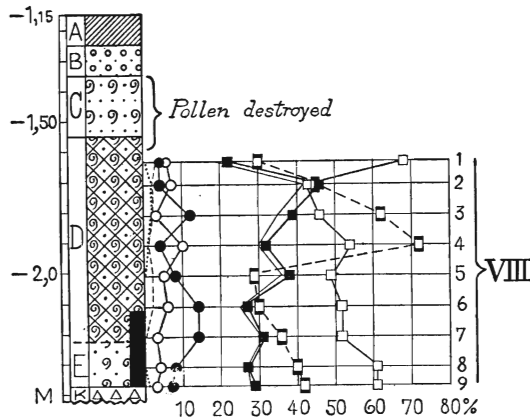


Fig. 7. Bundsö  
Pollen diagram from point 5 in the section

the spectras 14—17 of the diagram fig. 6, and the horizon of the culture layer in primary position must be somewhat younger than this level. If the archæologists are right in their suggestion that the dwelling-place has been build on pools in the fiord, however there should be no greater difference in age between the primary culture layer at point 3 and that in secondary position at point 5. Thus the horizon of the younger passage-grave period in the diagram fig. 7 can be suggested to fall about 0,75 metre above the zone-border VII/VIII, and consequently the horizon of the older passage-grave period somewhat below that. The subzones VIIa and VIIb in the diagrams from Gammellung and Bundsö agree very well with each other, but unfortunately the part of zone VIII represented at Gammellung, being untypical developed, does not permit a synchronizing with any part of zone VIII in the diagrams from Bundsö, why it is not possible to fix the diagrammatical level of the Gammellung culture layer more precisely than to the lower part of zone VIII.

In Scania Tage Nilsson places his zone-border V/IV at the same pollen diagrammatical level where I draw my zone-border VII/VIII. However, in Scania according to some archæological finds this level seem to be somewhat older in relation to the beginning of the younger stone age than in the western part of the baltic region, but I think it better to postpone the discussion of this disagreement until more material is procured.

below spectrum 17, and the diagram from point 5 seems to fit in rather good between the spectras 4 and 11 of the diagram from point 7, the culture layer itself covering the lower part of this cutting only. The little diagram (fig. 8) from the peat layer G at point 3 contributes to fix this level. Undoubtedly it belongs to zone VIII, however not to the lowermost part of this zone with its big *Corylus*-maximum, but it agrees quite well with the level between

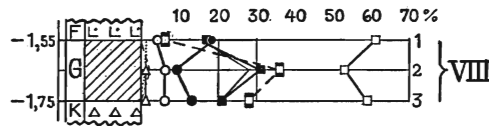


Fig. 8. Bundsö  
Pollen diagram from point 3 in the section

## DISCUSSION OF THE TRANSGRESSION

When the brackish-water in the beginning of period VII transgressed in over the lacustrine layer J which is a pronounced low-water-deposit, it may be assumed that the northern Als was lying about 4,4 metres higher than now. Some time before that event however, the sea must have penetrated into the Baltic, and it is probable that this occurred at all event not long time after the end of the Mullerup period; compare Tage Nilsson (2) p. 542. The Sound surely did not exist through the whole Mullerup period, and the first entrance of the sea into the Baltic must have taken place through the deep Great Belt.

Some holds for following the transgression of the salt water in Bundsö is given by the stratigraphy, a shore deposit or low-water deposit at the points 4—7 being overlain of a fiord-mud rich in shells, and by the synchronizing of the diagrams. When Dr. Therkel Mathiassen could make it probably, as he kindly has told me, that the fiord invaded the site on Flinholm still when this was habitated, it seems likely that the rising of the water level of the fiord nearly reached its historical level already in the stone age. In the period when the layers C and D (points 3—5) were accumulated no erosion in any culture layer seems to have taken place; at all event no antiquities or culture refuse are met in these layers. On the contrary however, numerous implements of flint and sherds of pottery from the younger passage-grave period are found in the sandy or gravelly layer B. Here, clearly they are lying in a secondary position, and their presence here must be due to a strong erosion of the shore in late times.

The results attained as to the transgression of the sea in the inner part of Bundsö fiord does not seem to agree quite well with E. Wasmund's dating of the transgression at Heiligenhafen on the southern shore of the Baltic, about 50 km east of Kiel (13). The transgression here, marked by marine mud (Schlick) overlying peat at 13—14 metres below the sea level, is referred to "the end of the first half part of the oak forest period" on the basis of pollen analyses (fig. 5) which show how the *Alnus* curve is rising to a great frequency, contemporaneously with a high *Tilia*-maximum, in a good distance below the contact between peat and marine mud. Thus, in spite of the level of transgression, being situated essentially lower at Heiligenhafen than it is at Bundsö, it seems to be a good deal younger.

In better conformity with the results of Wasmund seems to be the ex-

perience of E. Kolumbe (14) as to the transgression of the Baltic at the Schönberger Salzwiesen lying about 20 km north east of Kiel, in as far as the peat layer here, being covered by marine mud and reaching up to about 3,3 metres below the sea level, at all event does not seem to could be placed at a lower diagramatical level than one belonging to my zone VIII. Thus, the higher lying peat layer at the Schönberger Salzwiesen has been submitted to the transgression of the sea at a later time than the lower lying land surface at Heiligenhafen.

While in Kolumbe's diagram (fig. 4) from the Schönberger Salzwiesen there is no basis for assuming the existence of a lacuna of any significance between the peat and the overlying marine mud, the matter stands differently concerning the classical section of C. A. Weber from the fiord of Kiel of which Kolumbe in the paper cited has given an interesting analysis. When comparing his schematic diagram (fig. 6) of Weber's section IV with the diagram from Heiligenhafen, it seems most likely that the upper part of the submarine peat at Kiel, just where the pollen of oak and alder appears, nearly is synchronic with sample XVd at Heiligenhafen. Directly over this pollen diagramatical level at Kiel falls the contact between peat and marine mud, and in lesser than half a metre higher the beech pollen makes its entrance and is present regularly upward. This lower part of the marine mud at Kiel again most likely is contemporaneous with a level about sample IIIb at Heiligenhafen. The assumption based on these synchronizings, that the lacustrine-marine contact at Kiel represents a considerable lacuna, which already was assumed by Weber, further strongly is emphasized by drawing into consideration the pollen diagram of Wasmund from Beutinerhof at Eutin, lying about 40 km southeast of Kiel<sup>5</sup>). According to this view the surface of the pre-litorina peat at Kiel does not represent the real transgression level, and it seems better to leave out of consideration the section at Kiel when comparing the transgression of the Baltic at its south western coasts with the transgression at Bundsö. So far as I can see at our present state of knowledge there is a great discrepancy between the results from these two regions, when conceiving that the sinking of the land has been uniform: The Baltic transgressing a level at about - 4,4 metres at Bundsö much earlier (basis of zone VIIa) than it reached a level at - 13 or - 14 metres at Heiligenhafen, and reaching a

<sup>5</sup>) As to the conjectured position of the culture horizon in the sectio IV at Kiel, see Kolumbe p. 418.

level of about — 3,3 metres in the Schönberger Salzwiesen at a time most likely falling within zone VIII. If these datings hold good we seem here to face an outcome of inhomogenous movements of the earth crust (ungleichförmige Schollenbewegungen) in post-glacial time.

Another observation makes it likely that the latest movements of the post-glacial submersion of various parts within the west baltic region have had a heterogenous progress too. I refer to the interesting dating of the last phase of the transgression at the isle of Langeland given by Winther (8). In a submarine bog in the reclaimed frith of Henninge he found a flint dagger from the cist period (ca. 1800—1500 BC), which, as Dr. Therkel Mathiasen kindly informs me, typologically seems to belong to the first part of this period sooner than to the later, even if this can't be stated with any certainty. However, the conditions under which the dagger was found permit to suggest that the environ at the end of the stone age still was lying at least 2 metres higher than it does at present. The difference from what seems to have been the case at Bundsö is obvious when remembering that the transgression here probably stopped already in the younger passage-grave period or shortly afterward.

Further the attention should be drawn to some old land-surfaces, viz the submarine peat layer in the Fiord of Flensburg and the submarine Kitchen-midden at Eckernförde mainly dating from an older part of the younger stone age, both of them having yielded macroscopical remains of beech (15). Lying 7 to 8 metres below the sea level, they in relation to their age as it seems give evidence of an extraordinarily great subsidence in comparison with the deposits of Bundsö.

#### HJORTSPRING BOG ON THE ISLE OF ALS

In connection with the description given by G. Rosenberg (16) of the large boat from the early pre-roman (celtic) iron age which together with numerous other objects was unearthed in the little bog at Hjortspring on the isle of Als, 5 km south-east of Bundsö, I have given an account of the peculiar stratigraphy of the bog and of its pollen diagram. For comparison with this was added a pollen diagram from Hornholz bog at Jaruplundfeld near Flensburg, close south of the danish-german border, as the nearest locality from which I had a complete diagram. Referring to my report (16) however, I shall take leave here to resume some points of interest

especially for the archæological dating of the spreading of the beech in the south danish-west baltic region. Near the western border of the up to about 40 metres broad bog which is lying 42 metres above the sea level, the following section was surveyed.

- G. 0—0,1 m. Gras-grown soil.
- F. 0,1—0,52 m. Fresh *Amblystegium*-fen-peat.
- E. 0,52—0,64 m. Mud with *Potamogeton natans*.
- D. 0,64—1,16 m. *Dryopteris thelypteris*-fen-peat.
- B. 1,16—1,76 m. Sandy mud.
- A. Boulder-clay.

The pollen diagram, fig. 9, just as the other pollen diagrams from the bog, shows that the layers D and B belong to zone IV and the layers E and F to zone IX, the layer-border E/D representing a lacuna answering to the zones V—VIII, compare fig. 10. It could be made credible that this lacuna is due to prehistoric cultural encroachments and that the surface of the bog has been rather dry when these took place. Soon afterward a little pool has come into existence on the decapitated surface of the bog, and the boat was laid down in this pool after the border-zone of it had been overgrown with peat. The remains of the boat and all the other objects mainly were found in the upper part of the mud bed E. As the coming up of the pool seems to have been independent of the encroachments, and as the changing from relative dry to wet conditions on the bog surface took place shortly before the sacrificing of the boat in early pre-roman time, it seems likely that the moist subatlantic climate has been sharing in this event.

The rational border of the beech-curve could be placed in the mud layer E why it is nearly contemporaneous with the boat. In Hornholz bog too a marked rising of the moisture has been registered, viz by muddy *Sphagnum cuspidatum*-peat covering a bed of highly decomposed *Sphagnum*-peat, at a level near the rational border of the beech-curve, just as is the case in other southern Jutland bogs (Svanemose south of Kolding, Ellum bog south of Lögumkloster). This induces the supposition that the start of the beech-curve in Hornholz bog as in Hjortspring bog is of early pre-roman age. Thus, through the investigations reported here it is made

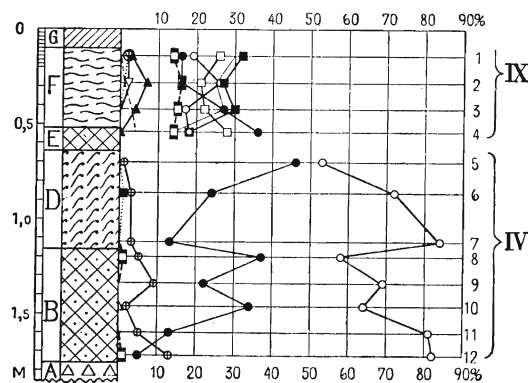


Fig. 9. Hjortspring bog. Pollen diagram

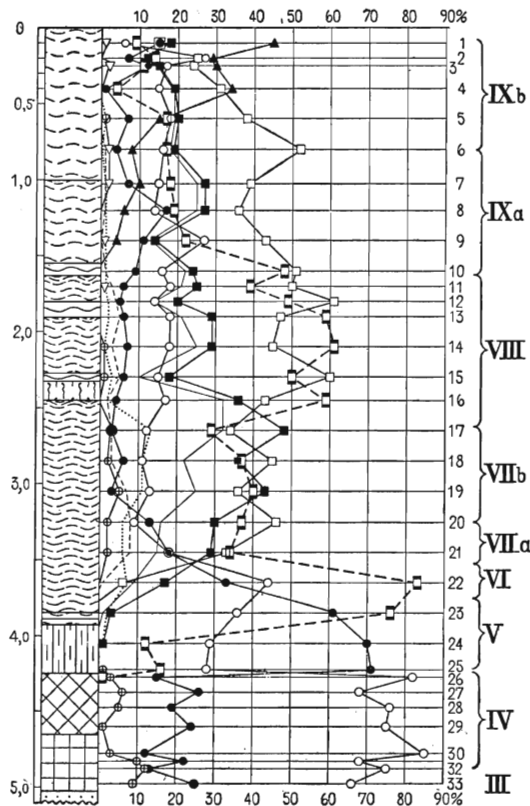


Fig. 10. Hornholz bog. Pollen diagram

credible that the rational beech-border in certain west baltic bogs nearly is contemporaneous with the subboreal-subatlantic changing of climate just as it could be proved in a number of north Jutland bogs on the basis of archæological bog-finds (1).

In the pollen diagram from Bundsö (fig. 6) traces of beech pollen were found especially at a level somewhat higher than that which is synchronized with the culture layer, it is, at a level undoubtedly older than the basis of zone IX. In this connection may be remembered the find of beech-bark in a bronze age tomb on the isle of Sylt and the find of beech-charcoal in the kitchen-midden at Eckernförde mainly from an older part of the younger stone age; (15) comp.

p. 136. A pollen diagrammatical expression perhaps, this last mentioned occurrence of the beech has got at the level about 100 cm in the "Lupen-Diagramm" from Ulsnis north of the Fiord of Schlei given by D. Schröder (17). In this diagram, I think the zone-border VII/VIII is seen at a level a little below 105 cm, and in an about 20 cm thick zone above this level beech pollen occurs with a frequency of up to 9%. Higher up this pollen species is very sporadically, and first from a level at 50 cm and upward is seen an unbroken beech-curve which from the level of 41 cm, probably the zoneborder VIII/IX, is rising quickly. In danish pollen diagrams also beech pollen is met somewhat below this border which, most distinctly in the sphagnum bogs, has been marked by a swamping of the bog surfaces at the beginning of the subatlantic period. However, a pronounced rising of the beech-curve, often to dominance, principally belongs to the subatlantic zone, showing that the beech first in subatlantic time did thrive so well that it could succeed in the struggle of competi-

tion with the other forest trees, especially the oak. Compare Bertil Lindquist (18).

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