Danmarks Geologiske Undersøgelse
II. Række. Nr. 66

Landnam i Danmarks Stenalder

En pollenanalytisk Undersøgelse over det første Landbrugs Indvirkning paa Vegetationsudviklingen

Af

Johs. Iversen

Land Occupation in Denmark's Stone Age

A Pollen-Analytical Study of the Influence of Farmer Culture on the Vegetational Development

I Kommission hos

C. A. Reitzels Forlag
Axel Sandal

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Forord.

Denne Undersøgelse blev allerede i Efteraaret 1939 forelagt i Dansk Geologisk Forening og refereret i Naturhistorisk Tidende (1940). Siden har jeg udvidet Undersøgelsen paa forskellige Punkter; Tydningen af de fundne Forhold er i det væsentlige uændret. Med velberaad Hu undgaas dog i denne Afhandling Ordet »Svedjebrug« om Skovrydningsbrandene, da det let fører til Misforstaaelser. Landnamet har rimeligvis været kombineret med Svedjebrug i Ordets mere specielle Betydning, men Landnamsbranden kan ikke sidestilles med en Svedjebrand af den karelske Art.

Emnet spænder over Felter, hvor jeg ikke er Fagmand. Det har derfor været mig til stor Nytte at diskutere forskellige Problemer, der knytter sig til Emnet, med Arkæologer og Forstbotanikere, som jeg derved er megen Tak skyldig. En særlig Tak vil jeg gerne rette til Dr. phil. Knut Fægri, Bergen, hvis inciterende Venskab ogsaa er kommet dette Arbejde til Gode, og til stud. mag. J. Troels-Smith, som venligst har stillet et kun delvist publiceret Diagram til min Raadighed. Malerinden Frøken Ingeborg Frederiksen har udført Tegnearbejdet med sædvanlig Omhu, og Lektor W. E. Calvert har foretaget Oversættelsen.

Den almindelige Del af nærværende Arbejde er paa dansk og engelsk, hvorimod den specielle Del kun foreligger paa engelsk. Notehenvisningerne refererer til den specielleDel (S. 32 ff.).

Indhold. — Contents.

Landnam i Danmarks Stenalder.

Efter den sidste Istid har Vegetationen til at begynde med udviklet sig efter de samme Love som tidligere i Mellemistiderne; alle Vekslinger var blot Udtryk for Ændringer i Klima og andre naturlige Faktorer. Den ældre Stenalders primitive Kulturer har kun i forsvindende ringe Grad kunnet indvirke paa Skovbilledet. Jægerne har haft deres Stier som Dyrene deres Veksler, og ligesom Vegetationen omkring Maagekolonier præges af al den tilførte Fuglegødning, saaledes har ogsaa Plantevæksten i umiddelbar Nærhed af den ældre Stenalders Bopladser haft sit karakteristiske Præg af Møddingplanter[10]). Menneskets Indvirkning paa Vegetationen naaede ikke langt ud, faa Skridt udenfor Bopladsen lukkede Urskoven sig, og her var Naturen ene om at bestemme, hvad der voksede frem.

Dette Forhold ændrede sig radikalt med Landbrugets Indførelse. Nu — og først nu — begyndte Mennesket at gribe ind i Skovbilledet, og der er ingen Tvivl om, at de Ændringer, der er indtraadt som Følge heraf, har været ligesaa dybtgaaende og ligesaa interessante som de tidligere, der stod i Forbindelse med klimatiske og andre rent naturlige Aarsager. Man maatte derfor paa Forhaand vente, at de ogsaa vilde kunne spores tydeligt i Pollendiagrammerne.

Yngre Stenalders Begyndelse ligger i Pollendiagrammerne et Sted omkring Zonegrænsen VII—VIII efter Knud Jessens Zoneinddeling[4]). Her omtrent maa altsaa Agerbrugskulturen sætte ind, og det var en meget tillokkende Opgave at finde dens Spor i disse Lags pollenfloristiske Udvikling. I dette Øjemed har jeg foretaget en indgaaende Undersøgelse paa Materiale fra særlig egnede Lokaliteter i forskellige Egne af Landet. For at faa nye Momenter frem, har jeg ogsaa udført systematiske Tællinger over sjeldnere Pollentyper (Pollen af Korn, Ukrudt, Vedbend, Mistelten m. fl.), der ofte giver ligesaa værdifulde Oplysninger som Træernes Pollen. Dette har medført, at der maatte tælles langt større Pollenmængder end ellers, et tidsrøvende Arbejde, der dog ogsaa

[10]) Notetallene i Teksten henviser til Numrene i den specielle Del S. 32 ff.

er kommet de andre Pollenkurver til Gode, idet den statistiske Usikkerhed derved er blevet reduceret til et Minimum[2]).

I det følgende skal vi nu paa Grundlag af nogle udvalgte Pollendiagrammer fra Sjælland, Fyn, Øst- og Midtjylland gennemgaa de enkelte Faser i det omtalte kritiske Omraade af Vegetationsudviklingen omkring Zonegrænsen VII—VIII én for én og samtidig søge at naa til en Forstaaelse af deres Natur.

Vi befinder os midt i Egetiden. I et Par Aartusinder har Eg, Elm og Lind i Forening dannet Højskoven, lidt Fyr fandtes paa daarlig Bund, El voksede især paa vaade Steder sammen med lidt Birk. Misteltenen (*Viscum album*)[5]) var en almindelig Snylteplante paa de Træer, den kan vokse paa, og blomstrende Vedbend (*Hedera helix*)[6]) klatrede overalt, hvor den kunde finde Støtte, og udviste en Frodighed, som nu kun ses i det sydlige og vestlige Europa.

Saa indtræder der nogle lidet iøjnefaldende, men vigtige Ændringer i Skovbilledet. Asken (*Fraxinus excelsior*)[7]), som tidligere kun havde spillet en meget ringe Rolle, tager til i Hyppighed paa Bekostning af Elmen, hvis Kurve falder stærkt. Kurven for Vedbend viser nøjagtig samme Forløb som Elme-Kurven: den falder brat, og Vedbend danner ovenfor dette Niveau selv i Promille-Diagrammer[2]) ikke mere nogen sammenhængende Kurve. Egens Kurve viser oftest en svag Stigning. Disse smaa pollenfloristiske Forskydninger kan næppe staa i Forbindelse med menneskelige Indgreb, thi selvom man til Nød kunde forklare Elmens Tilbagegang som betinget af Husdyrs Efterstræbelser[8]), saa kan Vedbend's samtidige Tilbagegang ligesaalidt forklares paa denne Maade som Askens Fremgang. Da den samme Udviklingsgang kan paavises over hele Landet baade i frugtbare og i ufrugtbare Egne (sml. især Tavlerne II—VII), maa man formode, at der ligger en klimatisk Aarsag til Grund. Kun den stærke Tilbagegang for blomstrende Vedbend giver Fingerpeg, der viser i hvilken Retning Klimaet maa have ændret sig. Vedbend er en udpræget atlantisk Plante, som ynder varme Somre og milde Vintre[6]), det vil sige et Klima, som man fra gammel Tid har tillagt den »atlantiske Periode« af Postglacialtiden. Da denne netop omtrent skulde spænde over det Tidsomraade, i hvilken blomstrende Vedbend er saa almindelig i Danmark, og skulde efterfølges af den mere kontinentalt prægede »subboreale Periode«, hvis kolde Vintre maa have været skadelige for Vedbend's Trivsel, er det nærliggende at sætte Faldet i Vedbend-Kurven i Forbindelse med Overgangen fra det »atlantiske« til det »subboreale« Klima. Jeg har derfor i vore Pollendiagrammer lagt Grænsen mellem disse to Klimaperioder ved Elme-Kurvens Fald, der jo er samtidig med Tilbagegangen for Vedbend. Naar ogsaa Zonegrænsen VII—VIII lægges paa dette Sted, saa kommer Zone VII til at svare til den atlantiske, Zone VIII til den subboreale Periode, og dermed er der opnaaet den smukkeste Overensstemmelse mellem det klassiske Skema over Klimaperioderne efter Istiden (BLYTT, SERNANDER, HARTZ) og den pollenfloristiske Inddeling efter KNUD JESSEN (sml. Skema Tavle VIII). I norske Diagrammer (fra Jæren) har FÆGRI (1940) fornylig paa lignende Maade fastlagt Grænsen mellem den atlantiske og den subborale Klimaperiode, og skønt en Sammenstilling mellem de norske og danske Diagrammer vanskeliggøres af de afvigende Naturforhold i disse to Omraader, synes FÆGRI's Grænsedragning at være i fuld Overensstemmelse med den her gennemførte[9]).

Lige ovenfor Zonegrænsen VII—VIII, saaledes som den er sat her, altsaa i Begyndelsen af den subboreale Periode, faar Kurverne i de fleste danske Pollendiagrammer et meget ejendommeligt Forløb, der vidner om en mærkværdig pludselig Ændring i Skovenes Sammensætning og Tilstandsform. Højskovens Elementer: Egen, Linden, Asken og Elmen gaar midlertidigt stærkt tilbage, medens Birken viser en forbigaaende Stigning, Ellen en mere varig Stigning i Pollenhyppighed, og samtidig naar Hasselkurven et meget udpræget Maksimum. Hvad betyder dette paafaldende Minimum i Egeblandingsskovens Kurve? Er det maaske Udtryk for en forbigaaende Temperaturnedgang?

Forskellige Forhold umuliggør en saadan Tolkning. Man maa gøre sig det klart, at denne klimatiske Nedgang maatte have en pludselig og rent ud katastrofal Karakter, for at den skulde kunne trykke Egeskovens Kurver saa brat og voldsomt ned, og dette er uforeneligt med Hasselens stærke Fremvækst. Misteltenen viser heller ingen Tilbagegang, skønt dens Varmekrav er større end Egs og Linds. Uforklarligt vilde det ogsaa være, at det netop blev Birk og El — men slet ikke Fyrren — der profiterede af de ændrede Forhold. Fyrrens Pollen gaar tværtimod som Regel tilbage i Hyppighed i denne Zone. Helt svigter Hypothesen, naar det gælder at forklare det vigtige Faktum, at Fasen indledes med en pludselig Stigning af de urteagtige Planters Pollen.

I Stedet for en almindelig Klimanedgang kunde man, for at komme udenom disse Vanskeligheder, postulere en Klimaændring af anden Karakter. En Sænkning af Grundvandstanden som Følge af et meget tørt Klima kunde faa Birk og El til at rykke ud over sumpede Omraader, der tidligere kun var bevoksede med Kærplanter. Dette vilde forklare Fremgangen for Birke- og Ellepollen og det relative Fald for de andre Træers Pollen. Ogsaa her kommer imidlertid Stigningen i Urternes Pollenhyppighed i Vejen, og Forklaringen maa afvises.

Tilbage bliver saa Kulturens Indflydelse. Det ligger nær at sætte Minimet i Egeblandingsskovens Kurve i Forbindelse med Skovrydning.

Oprindelig tænkte jeg mig Forholdet saaledes: Skovrydningen har hovedsagelig kun ramt den høje Bunds Egeskov, Sumpskovene med deres El og Birk er sluppet fri. Disse sidste Træer maa derfor udvise en relativ Stigning i Diagrammerne. Utvivlsomt har dette Fænomen gjort sig gældende, men det kan ikke være hele Forklaringen. I Diagrammer fra salte Fjordaflejringer findes det omtalte Kurveforløb meget smukt udviklet, skønt der ikke findes Sumpskove ved Randen af salte Fjorde.

En naturlig og tilfredsstillende Forklaring af de forskellige Pollenkurvers Forløb faar man derimod, naar man antager, at de pollenfloristiske Forskydninger er Udtryk for Vegetationsudviklingen i et Omraade, hvor et agerbrugsdyrkende Folk har foretaget Landnam og med Økse og Ild har ryddet op i den tætte Urskov. Da denne Forklaring kræver, at man tillige i større Maalestok har taget Ilden til Hjælp, maatte man vente, at der kunde paavises Spor deraf. Jeg kom i Tanke om et mistænkeligt, skarpt begrænset Lag af Trækul i Ordrup Mose lige under den problematiske Zone, og jeg gav mig til at foretage en minutiøs Gennemanalysering af den indsamlede Prøveserie. Resultatet syntes at bestyrke min Formodning om, at der var en Sammenhæng mellem dette Trækullag og Minimet i Egeblandingsskovens Kurve, og jeg skal nu gennemgaa Diagrammet ud fra denne Betragtning.

Ordrup Mose har under Litorinatransgressionen været en Øresundsfjord[36]); det omtalte Brandlag laa nær Overkanten af et tykt Lag Saltvandsgytje. Paa Tavle I findes yderst til venstre (D) et Trappediagram, der angiver Hyppigheden af Trækulstumper i Præparater fra Laget lige under Kullaget, fra selve Kullaget (Analyse Nr. 12) og fra Lagene over Kullaget. Man ser, at ogsaa Laget under Brandlaget indeholder noget Trækul; det er ganske naturligt, da Profilet ligger i umiddelbar Nærhed af den kendte store Bloksbjerg-Boplads fra ældre Stenalder[34]), hvis primitive Beboere endnu synes at have levet der, da det nye agerbrugsdyrkende Folk tog Egnen i Besiddelse og fortrængte dem. Til venstre (E) findes desuden Silhuetter, der angiver Forskydningerne i forskellige Træers Pollental pr. cm^2 af Præparat; i Modsætning til Pollendiagrammet (A), der kun viser de relative Forskydninger i Pollenhyppighed, faar vi herigennem noget at vide om den absolute Pollentæthed i de forskellige Gytjelag. Endelig findes til højre for Pollendiagrammet Hyppighedskurver for urteagtige Planter beregnet i Forhold til den samlede Mængde Træ-Pollen (B).

Hvorledes reagerer nu Vegetationen paa denne »Svedjebrand«? Kurverne for Pollentæthed viser umiddelbart over Brandlagets Underkant en pludselig og enestaaende voldsom Tilbagegang for alle Træarters Pollen[36b]). Denne paafaldende Fattigdom paa Pollen i dette næppe 10 cm tykke Lag kan ikke være nogen Tilfældighed, thi samtlige Prøver fra den over 4 m tykke marine Lagserie under Brandlaget havde en betydelig og tilsyneladende ganske ensartet Pollentæthed. »Svedjebranden« har aabenbart ramt hele Skoven i Omegnen af Bloksbjerg, og det er gaaet ligeligt ud over alle Træarter. Pollendiagrammet viser derfor ikke nogen større Ændring, det relative Hyppighedsforhold mellem Træernes Pollen er nogenlunde det samme.

Efter alt at dømme er Brandlaget aflejret i Løbet af nogle faa Aar. Det bestaar hovedsagelig af Kul og dets Tykkelse er ikke meget mere end en Hundrededel af hele den marine Lagserie. Vi har derfor Mulighed for i Pollenkurverne at følge Vegetationsudviklingen efter Skovbranden.

I selve Brandlaget indtræder en stærk Stigning af Urternes Pollenhyppighed sammenlignet med Træernes. Denne Forskydning gaar parallel med den omtalte Tilbagegang for Træernes Pollen og er aabenbart blot et nyt Udtryk for Skovens Ødelæggelse: Urtevegetationen langs Stranden af Ordrup Fjord og paa den gamle Bloksbjerg Boplads formaar nu at gøre sig stærkere gældende overfor Træerne i den samlede Pollenregn.

Regenerationen af det brændte Omraade sker i et noget langsommere Tempo. Hurtigst i Vendingen er Birken og Ellen, og disse Træer viser derfor en betydelig relativ Fremgang i Pollendiagrammet, og det er i første Linie dette Forhold, der bevirker det bratte Fald i Egeblandingsskovens Kurve.

Forklaringen herpaa er ganske ligetil. Birk og El har en meget større Spredningsevne end Egen. Deres Frø dannes regelmæssigt hvert Aar i stor Mængde, de er smaa og lette og føres langt med Vinden, medens Egens tunge Frugter kun spredes langsomt. Birk og El vil derfor i Modsætning til Egen straks kunne vokse frem overalt, hvor Spiringsbetingelser er til Stede. Dertil kommer saa, at Birken og Ellen allerede blomstrer og sætter Frugt, naar de er 10—15 Aar gamle, Egen derimod først i en Alder paa 30—40 Aar[20b]). Birken og Ellen kan altsaa allerede have produceret nogle Generationer, inden Egen overhovedet har naaet Kønsmodenhed. Betydningen heraf er indlysende. Hasselen har ligesom Egen en daarlig Spredningsevne, til Gengæld naar den Kønsmodenhed endnu tidligere end Birk og El. Maaske forklarer disse to Faktorer dens ejendommelige Kurveforløb[21]).

Den, der har profiteret mest af Svedjebranden, er Birken. Kort efter Landnammet naar den en større Hyppighed end nogen Sinde tidligere siden Birke-Fyrreperioden. Dette er meget interessant, thi ogsaa i Nutiden er det først og fremmest Birken, der indfinder sig efter en Skovbrand[20a]). Birkens store Spredningsevne og tidlige Kønsmodenhed er ikke den eneste Forklaring herpaa; ved almindelige Skovrydninger i frugtbare Egne plejer Birk ikke at indfinde sig. Sagen er den, at Birkens Frø kun spirer frem, naar Jorden har en egnet Tilstandsform, men netop paa Askebund er Spiringsbetingelserne særlig gunstige.

Den øverste Analyse i Diagrammet viser en Tilbagegang i Birkens Kurve. Dette er ikke nogen Tilfældighed; alle Diagrammer med et udpræget Minimum af Egeblandingsskovens Kurve viser, at Birkens Opblomstringstid kun er af kort Varighed. Birken er vort mest lyselskende Træ[20c]), den taaler ingen Skygge, og kun naar der ryddes op i Skoven har den en Chance. Birken er Pioneren blandt vore Træer, og det kortvarige Birkemaksimum ovenfor Trækullaget er derfor overmaade betegnende.

I det foregaaende har der hele Tiden været Tale om en »Svedjebrand«, men kan den Vegetationsudvikling, om hvilken Pollenfloraen vidner, ikke ligesaa godt være indtraadt som Følge af en naturlig Skovbrand?

Hertil er for det første at bemærke, at naturlige Skovbrande hovedsagelig kun optræder i Naaleskov. Man maa nuomstunder endog gøre sig Umage for at faa Løvskov til at brænde. En Urskov antændes lettere, alligevel er Skovbrande sikkert heller ikke almindelige i helt oprindelige Løvskove. Dette er kun et negativt Argument, men der findes ogsaa forskellige positive Vidnesbyrd om, at Agerbrugskulturen er blevet indført til Egnen, netop paa det Tidspunkt, da Branden indtræder. Som vi har set, faar de urteagtige Planters relative Pollenhyppighed en Stigning umiddelbart efter Branden. Et Specialdiagram (NTP-Diagram*), Tavle I C), der er opstillet paa Pollen fra ikke-træagtige Planter (Urter, Lyngplanter)[3]), viser, at det stort set drejer sig om de samme Planter som fandtes tidligere, først og fremmest Salturter (*Chenopodiaceer*) og Græsser (*Gramineer*). Men dernæst optræder for første Gang nogle Pollenkorn af Vejbred (*Plantago*) og vel at mærke ikke af Strandplanten *Plantago maritima*, men af Ukrudtplanterne *Pl. major* og *Pl. lanceolata*[12]). Disse to Planters Pollen findes i alle vore Diagrammer[13]), saa snart man kommer til »Landnamsfasen«, først her, men saa med sammenhængende Kurve op til Nutiden. Vejbred er aabenbart fulgt til Danmark sammen med de første Bønder, paa samme Maade som den siden har fulgt Europæeren overalt i Verden, hvor han har slaaet sig ned. »De Hvides Fodspor« er Vejbred blevet kaldt af Amerika's Indianere; de neolitiske Erobreres Fodspor er Vejbred-Pollen i vore Diagrammer. Forløbet af Vejbred-Kurven er i Ordrup Mose den typiske: den starter, hvor Egeblandingsskovens Kurve begynder at falde, og naar Maksimum, hvor hin er i Minimum. Ved Siden af Vejbred har Bynke (*Artemisia cf. vulgaris*) været et almindeligt Ukrudt. Dens Pollen fandtes i stor Mængde, og den har ogsaa i historisk Tid været et meget frygtet Mark ukrudt, som først ved Nutidens dybe Pløjning er blevet slaaet ud[14]).

Det er velkendt, at der i Yngre Stenalder fandt en ret udstrakt Kornavl

*) N. T. P = Non-tree-pollen.

Sted, og man maatte vente, at ogsaa Kornpollen lod sig paavise i Brandlaget. FIRBAS har vist, at de dyrkede Kornsorters Pollen er større end »Vildgræssernes«, — kun Marehalm har lige saa store Pollenkorn[11]). Naar man desuagtet næsten intet Kornpollen finder i Lag fra Sten- og Broncealder, hvor *Plantago*-Pollen ofte findes i store Mængder, saa hænger det sammen med, at Hvede og Byg, der blev dyrket i Sten- og Broncealder, er Selvbestøvere, som praktisk talt ikke frigør noget Pollen. Til Trods for denne ugunstige Omstændighed fandtes noget Kornpollen i Lagene over Brandhorisonten, ikke meget, men dog nok til at godtgøre Korndyrkning; Marehalm kan der nemlig ikke godt være Tale om, eftersom de fleste af disse Pollenkorn fandtes i Søkalken.

Et yderligere Bevis for Bondekulturens Ankomst giver Fundet af en Knogle, som af Dr. M. Degerbøl bestemtes til et Skinneben af en Tamko. Ved Hjælp af lidt Gytje, pillet ud af Knoglens Hulheder lod den sig tidsfæste med stor Nøjagtighed. Den hører til i den nedre Del af Søkalken, altsaa netop i Minimet for Egeblandingsskovens Kurve[36c]). Hermed er Beviskæden sluttet.

Der kendes flere Eksempler paa, at Minimet i Egeblandingsskovens Kurve optræder som en saa pludselig og kortvarig »Episode« i Pollendiagrammet, at det ligesom i Ordrup Mose kan opfattes som Udtryk for Successionen efter et lokalt Landnam med paafølgende kortvarig Bebyggelse. Det er især i mindre Moser, hvor den pollenfloristiske Udvikling har et forholdsvis lokalt Præg, at vi finder saadanne Forhold, som da kan tages som Bevis paa en neolitisk Boplads i umiddelbar Nærhed af Mosen[31]). I Aflejringer fra større Søer eller Fjorde har Kurverne et jævnere Forløb, og Faldet i Egeblandingsskovens Kurve er ikke betinget af en enkelt Landnamsbrand, men snarere Udtryk for den gradvise Ændring i den videre Omegns Skovbillede som Følge af en hel Serie af Skovrydninger, foretaget efterhaanden som det agerbrugsdyrkende Folk tog nye Omraader i Besiddelse. Ogsaa her findes dog gerne et eller andet Sted paa det udjævnede langstrakte Minimum et pludseligt voldsomt, men forbigaaende Kurvefald, der vidner om, at nu fandt et Landnam Sted i den nærmeste Omegn. Et smukt Eksempel paa et Kurveforløb af denne Art viser Diagrammer fra den nu udtørrede Korup Sø, der i Stenalderen hørte til Kolind Sunds store Fjordsystem[39]).

Korup Sø udvalgtes specielt til denne Undersøgelse, fordi den byder paa en Række til Formaalet gunstige Vilkaar. Den ligger i Djursland, hvor den tidlige neolitiske Kultur har haft stor Udbredelse og derfor i særlig Grad maa have kunnet indvirke paa Skovbilledet. I Dyssetid har der endog ligget en lille Bygd (»Barkær«)[33]) umiddelbart ned til den dybe Fjord, hvis hastige Gytjeaflejring har ydet de bedste Betingelser for at registrere de enkelte Faser i den til Bygden knyttede Vegetationsudvikling. Fjorden har været stor nok til at Boringsprofilet kunde lægges saa langt fra den tidligere Fjordbred, at tilfældige lokale Forhold ikke har kunnet gribe forstyrrende ind i den pollenfloristiske Udvikling, saaledes at de lovmæssige Forskydninger i den nærmere og fjernere Omegns Vegetation desto klarere træder frem.

Tavle II er et Oversigtsdiagram[39]) fra Korup Sø. Et grundigt undersøgt Udsnit af Diagrammet i lidt forandret Maalestok (Tavle III) omfatter den Tidsperiode, inden for hvilken Minimet i Egeblandingsskoven falder. Som det vil ses, er Zonegrænsen VII—VIII smukt udviklet, Elmens og Vedbendens Pollenkurve falder voldsomt, medens Askens og Egens stiger. Med Analyse Nr. 7 begynder Faldet i Egeblandingsskovens Kurve, og baade Eg og Ask — snart ogsaa Lind — gaar tilbage. Det er aabenbart Skovrydninger i nogen Afstand fra Fjorden, der gør sig gældende, thi Urtepollenkurverne viser ingen Reaktion, udover den ganske vist meget oplysende Forekomst af nogle faa Pollenkorn af Vejbred (*Plantago major*), den neolitiske Bondes »Fodspor« i Pollendiagrammet.

Analyse Nr. 11 bringer en pludselig og voldsom Stigning i Urtepollenets Hyppighed og dermed tager den fra Ordrup Mose kendte Udvikling sin Begyndelse med nøjagtig de samme Faser i samme karakteristiske Rækkefølge. Vi maa antage, at Bondefolket nu har slaaet sig ned i Korup Sø's umiddelbare Nærhed og grundlagt den allerede omtalte Bygd fra Dyssetiden, »Barkær«. Selve Landnamet — svarende til Brandlaget i Ordrup Mose — kommer til Udtryk i Analyse Nr. 11. De urteagtige Planters Pollen, som gennem hele den marine Lagfølge har ligget meget jævnt omkring 4%, stiger nu pludselig til det to-tredobbelte. Denne relative Stigning kommer ligesom i Ordrup Mose til at begynde med ret ligeligt alle Urtegrupperne til gode, og vi maa heraf slutte, at den i højere Grad er betinget af en Tilbagegang i Træernes Pollenproduktion, end af en Fremgang i Urternes[19]). Skoven er i udstrakt Grad blevet ødelagt, — men den Vegetation, der er skaanet, har stadig det samme Præg som før. Hverken Træpollendiagrammet (Tavle III A) eller det specielle Diagram for ikke-træagtige Planter (NTP-Diagram, III C) viser nogen væsentlig Forandring.

Først i den følgende Analyse (Nr. 12) begynder den gennemgribende Ændring i Pollenfloraen, som er en Følge af Successionen efter Skovrydningen, at tage Fart. Blandt Træerne er det igen Birken, der først vinder frem, dens Kurve bøjer brat til højre og krydser Egeblandingsskovens Kurve, som — hvis Urskoven stadig havde været ubrudt i Djursland — burde have udvist 3—4 Gange højere Procenttal end Birkens. Ligesom ved Ordrup Mose efterfølges ogsaa her Birkemaksimet af et vældigt Hasselmaksimum.

Urtepollenfloraen afspejler paa en endnu smukkere Maade, end vi saa det i Ordrup Mose, de neolitiske Bønders Virksomhed. Særlig oplysende er NTP-Diagrammet, i hvilket de enkelte Urtepollentyper er beregnet i Forhold til den samlede Sum af Urte- og Lyngpollen. I selve Landnamslaget — Analyse 11 — har Urtevegetationen som sagt stort set endnu det oprindelige Præg, men allerede i næste Analyse har Vejbred-Kurven krydset samtlige andre Pollenkurver for urteagtige Planter. Vejbred (*Plantago lanceolata* og *Pl. major*) maa have været utrolig almindelig omkring Korup Fjord, siden den har kunnet levere mere Pollen end alle Græsser og Halvgræsser tilsammen. Ligesom i Ordrup Mose faar ogsaa Bynkens Pollenkurve et stort Opsving gennem den neolitiske Bebyggelse. Bynke-Pollen spiller ganske vist en vis Rolle ogsaa før Landnamet, det drejer sig dog her utvivlsomt om Strandbynke (*Artemisia maritima*), da man ikke finder noget tilsvarende i Indlandsdiagrammer. Derimod maa det være *Artemisia vulgaris* eller evt. *A. campestris*, der vinder frem under Bebyggelsen[14]), og man maa antage at den har været et almindeligt Ukrudt. Kornpollen optræder sparsomt og faar sin største Hyppighed samtidig med Vejbred i Analyse 13.

Menneskene og deres Husdyr har, som vi har set, grebet voldsomt ind i Skovbilledet omkring Korup Sø. Urskoven er forvandlet til en Kratskov (Lavskov), i hvilken Hassel, El og Birk er fremherskende. Efter at Skoven bliver overladt til sig selv regenerer Egeskoven. Pionertræet Birk forsvinder hurtigt. Derimod varer det længere inden El og Hassel, der taaler noget mere Skygge end Birken, trænges tilbage til deres normale Hyppighed[20c]).

I to Diagrammer, ét fra Sjælland og ét fra Jylland, har vi nu i Enkeltheder fulgt den pollenfloristiske Udvikling, der knytter sig til Minimet i Egeblandingsskovens Pollenkurve. Paa samme Maade kunde vi gennemgaa nogle andre Diagrammer, men da de i ét og alt stemmer overens med de forrige, skal jeg nøjes med at henvise til Tavle IV og VII og de dertilhørende Noter.

Overalt finder vi den samme slaaende Sammenhæng mellem Faldet i Egeblandingsskovens Kurve og Opblomstringen af en indtil da helt ukendt, kulturbundet Urteflora, og det er næppe muligt at komme udenom, at disse ellers uforklarlige, store Forandringer i Vegetationsbilledet staar i Forbindelse med Agerbrugerens Optræden paa Skuepladsen.

Adskilligt vanskeligere er det at faa Rede paa, hvorledes vi i Enkeltheder skal forestille os disse første danske Bønders Virksomhed. En Ting synes dog at staa fast: Kolonisationen paa et Sted er ikke begyndt »saa smaat« for efterhaanden at blive mere og mere omfattende. Forholdene baade ved Korup Sø og Ordrup Mose viser jo utvetydigt, at der er foregaaet et pludseligt og meget omfattende Landnam. Ved første Øjekast kan dette synes overraskende, men tænker man nærmere over det, forstaar man, at en enlig Nybyggerfamilie midt ude i Urskoven mellem mer eller mindre fjendtligsindede »indfødte« Jægere, vilde Dyr og alle Slags »Aander«, vilde være en mere urimelig Tanke.

Et større Antal Mennesker har altsaa slaaet sig ned i en Egn og grundlagt en Bygd paa et dertil egnet Sted. Endnu inden de har flyttet deres Husdyr til deres nye Hjemsted, har de i Fællesskab udført en vældig Skovrydning. Husdyrene skulde jo have Føde, men Urskoven har ikke kunnet yde den. Man maa ikke forestille sig den som en Nutids Egeskov; talløse døde, styrtede Træer har ligget paa Kryds og tværs og gjort Skoven ret ufremkommelig og fattig paa Græs og løvrige Buske[17]). Der maatte skaffes Lys og Plads, saa Urter og lave Buske kunde vokse frem. Til det Formaal har Ilden været et mindst ligesaa vigtigt Hjælpemiddel som Øksen. En Kulturskov af Løvtræer er ikke saa nem at faa i Brand, men i Urskoven lettes Foretagendet af de uhyre Mængder af dødt, tørt og mørnet Ved, som ligger overalt og er let antændelige[17]). Rimeligvis har Menneskene iøvrigt hjulpet til ved nogen Tid før Ildspaasættelsen at hugge Buske og mindre Træer om og slaa Kærver omkring de større Ege, for ikke at behøve at fælde dem[18]). Efter Branden har Landskabet haft et trist Udseende; i den forkullede Ørken har de store men ødelagte Ege raget op som Vidner om den tidligere mægtige Urskov.

Denne store Svedjebrand ved Kolonisationens Begyndelse kan ikke sidestilles med en enkelt Svedjebrand af den Art, som i Nutiden kendes fra det karelske Svedjebrug. I Karelen anvendes ifølge LINKOLA (1916) hele den brændte og mellem Stubbene nødtørftigt pløjede Skovflade til Korndyrkning; naar Jorden saa efter nogle faa Aars Forløb er udpint, overlades den til sig selv eller rettere sagt til Husdyrene. Hvis Svedjebranden og den paafølgende Succession ved Ordrup Mose og Korup Sø var af denne Art maatte de fleste Kornpollen fremkomme umiddelbart efter Skovrydningen, inden Skovens Regeneration endnu havde gjort sig gældende. I Virkeligheden synes Maksimet for Kornpollenkurven at falde et Stykke e f t e r Landnamet og samtidig med Maksimet for Vejbred-Pollen.

En ejendommelig Parallel til det neolitiske Landnam danner derimod Nordboernes Landnam paa Grønland. I »Vesterbygden«s Moser fandt jeg (IVERSEN 1934) et udpræget, tyndt Trækullag af lignende Art som i Ordrup Mose, og det kunde paavises, at det kendetegnede Kolonisationens Begyndelse og hidrørte fra, at Nordboerne straks ved deres Ankomst havde brændt de Heder og Krat, der oprindelig havde dækket Egnen. Efter Branden voksede en frodig Urtevegetation frem, der bedre egnede sig som Føde for de talrige medbragte Husdyr.

Ogsaa den store Svejdebrand ved det neolitiske Landnam i Danmark har sikkert haft til Hovedformaal at skaffe Føde til Husdyrene. I Urtepollenfloraen har vi et inddirekte Bevis paa, at Stenalderbønderne har holdt mange, forbavsende mange Husdyr. Ellers vilde det være utænkeligt, at Vejbred saa hurtigt kunde faa saa stor en Hyppighed. Størstedelen af Vejbred-Pollenet tilhører *Plantago lanceolata*, og denne Art vokser paa Græsjorder, hvor Husdyr (eller Høslet) holder Vegetationen lav, medens *Plantago major*, hvis Pollen forekommer meget sparsommere, mere hører til omkring Bebyggelse. Vi maa altsaa tænke os, at en mindre Del af det ved Landnamet askelagte Omraade er blevet tilsaaet, medens Størsteparten har været overladt til sig selv. Den sorte Flade er hurtig blevet grøn af de fremspirende eller fremskydende Urter, Buske og Træer, hvis friske Løv har været kærkommen Føde for Faar og Kvæg, der har gaaet frit om. Paa denne Maade er der opstaaet en forbidt lav Kratskov, i hvilken Hassel og El har spillet en fremtrædende Rolle. Efterhaanden som det er lykkedes Træerne at skyde op over Dyrenes Rækkevidde, er Skoven blevet mørkere, formodentlig har man saa bødet paa det med Øksen. En saadan lav Form for Skovbrug findes ifølge DENGLER[22]) den Dag i Dag i de mest uoplukkede Omraader af Sydeuropa, ved Bosættelser ved Yderranden af Urskoven f. Eks. i de rumænske Karpater, i Bosnien og andetsteds. De vældige subboreale Hasselmaksima i vore Diagrammer viser, at de kendte store, kulturbetingede Hasselkrat i de primitive Egne paa Balkan, har haft deres Parallel herhjemme i Stenalderen.

Ved Siden af Kvægavl har Korndyrkning været et vigtigt Led i de neolitiske Bønders Landbrug, men vi ved næsten intet om, af hvad Art deres Agerbrug har været. Utvivlsomt har de straks efter Landnamet afgrænset et Omraade til Agerjord og saaet Korn — Hvede og Byg — i Asken. Rimeligvis har de saa efter nogle Aars Forløb opgivet de efterhaanden udpinte Agre og svedjet et nyt Omraade, og saaledes anvendt et lignende Svedjebrug, som det finske[23]). Men dette bliver ikke let at bevise; man kan ogsaa tænke sig at de vedblivende har dyrket de samme Agre saa længe Bygden bestod og blot svedjet, naar Agerjorden skulde udvides. Den danske Jord er jo mere yderig end den finske, og længe har en Bygd næppe bestaaet[29]).

Naturligvis er Landnamsfasen ikke helt samtidig i de forskellige Diagrammer, men det er paafaldende, at den i alle Tilfælde, hvor en nærmere Datering har været mulig, hører til i Begyndelsen af den subboreale Zone, kun lidet ovenfor Zonegrænsen[25]).

I det foregaaende har jeg hele Tiden gaaet ud fra, at disse »Landnam«, om hvilke vore Diagrammer vidner, er foretaget af et nyt, udefra til Danmark indvandret Folk, der bragte Bondekulturen til Danmark. Man kunde spørge, om dette nu ogsaa er saa sikkert? Kunde det ikke ligesaa godt tænkes, at Bondekulturen har udviklet sig af den gamle Fangerkultur uden større Indvandring af fremmede? Dette centrale Spørgsmaal bliver alsidigt behandlet i JOHS. BRØNDSTEDS Bog om Stenalderen (1938), til hvilken der kan henvises. Arkæologerne er endnu ikke naaet til Enighed; det er dog tydeligt, at Indvandringsteorien mere og mere vinder Terræn. Sidst har THERKEL MATHIASSEN gennem en Sammenstilling af Bopladsfund, der stammer fra det første Afsnit af vor Yngre Stenalder, vist, at de arkæologiske Forhold i Danmark afgjort tyder paa, at der har fundet en Nyindvandring Sted; i samme Retning peger de nyere zoologiske Iagttagelser[26]) og det forekommer mig, at de botaniske Forhold ligefrem tvinger til denne Slutning.

Ræsonnementet er følgende. I Aartusinder har Danmark været beboet af en yderst spredt Befolkning af Jægere og Fiskere, der helt har tilpasset sig til de haarde Vilkaar, Naturen bød dem. En sammenhængende Urskov med farlige Sumpe som eneste Lysninger har dækket hele Landet[16]). Saa med ét ændres Billedet. Med en forbavsende Hurtighed foregaar et gigantisk Landnam i de fleste Egne af Landet, Urskoven ryddes i største Maalestok, en kulturpaavirket Kratskov vokser op, en helt ny Urtepollenflora indvandrer. Skulde det være den lille Stamme af »Indfødte«, som næppe har talt mange Hundrede Mennesker, der pludselig totalt har ændret sine aartusindgamle Vaner og præsteret en saadan Kraftudfoldelse? Denne Tanke synes ganske urimelig, ikke mindst fordi man stadig samtidig med Bondekulturen finder netop dette Fangerfolk, som fra Arilds Tid havde levet i Landet, fiskende og jagende som fordum, kun lidet paavirket af de nye Forhold[27]).

Det typiske Minimum i Egeblandingsskovens Kurve forekommer som sagt i næsten alle danske subboreale Diagrammer; der findes kun faa Undtagelser, men de er til Gengæld interessante, idet de ligger i de magre Egne af Midtjylland[28]). Som Eksempel vælges et Promille-Diagram fra Bølling Sø, som ligger i Kanten af den store Karup Hedeslette. Kolonisationen begynder ved Analyse Nr. 6, her optræder Vejbred- og Kornpollen for første Gang og her viser Urtepollenkurven en tydelig Stigning. Noget udpræget Minimum for Egeblandingsskovens Kurve kan derimod ikke iagttages, ligesaalidt som Birken gaar synderligt frem. Intet tyder paa, at der her har fundet en lignende Landnams-Svedjebrand Sted som i de mere frugtbare Egne af Landet. Det er nærliggende at antage, at det har været unødvendigt at gaa saa radikalt til Værks. Urskoven har været mere aaben og lys end andetsteds, derom vidner den store Hyppighed, som Birken — vort mest lyselskende Træ — har haft. Skoven har i Forvejen i nogen Grad haft det Præg af Kratskov, som var nødvendig, for at Kvæget kunde finde sin Føde. I Analyse Nr. 8 stiger Urtepollenets Hyppighed atter stærkt, og vi maa antage, at en ny og stærkere Kolonisation har fundet Sted; maaske er det Enkeltgravsfolket, der er trængt frem til Egnen. Heller ikke denne Gang findes Tegn paa nogen større Svedjerydning.

Forholdene i de jydske Hedeegne giver Fingerpeg om, hvorledes man skal tyde det ejendommelige Faktum, at Svedje-Skovrydningen med dens karakteristiske Succesion kun optræder én Gang i de danske Diagrammer. VAUPEL giver i sin Bog om de danske Skove en malende Skildring af de ødelæggende Virkninger, som Kvæggræsning har paa Skovens Styrke og Tæthed. Det omstrejfende Kvæg kan da ogsaa i Stenalderen og Broncealderen have sørget for, at Skoven aldrig genvandt sin fordums Tæthed og Ufremkommelighed, som vilde have krævet en ny Afbrænding.

Kulturens Indvirkning paa den danske Vegetation synes dog gennem hele den subboreale Periode hovedsagelig kun at have bestaaet i en Omformning af Skoven; den er vistnok blevet forringet, men har stadig været en sammenhængende Storskov, der har dækket næsten hele Landet[29]). Saa indtræder i Begyndelsen af den subatlantiske Periode et nyt radikalt Omsving i den danske Vegetationsudvikling, Skovens Tilbagegang begynder at tage Fart og giver sig til Kende i de urteagtige Planters og evt. ogsaa Lyngens stærkt forøgede Pollenhyppighed. Der maa i den tidlige Jernalder være sket en gennemgribende Ændring i Landbruget; det forandrede Klima og Jernets Indførelse har medført en ny og højere udviklet Kulturform[30]). Først i denne Tid begynder det danske Landskab, som vi nu kender det, at blive til: det aabne Land med sine Marker, Enge, Heder og Skove.

Land Occupation in Denmark's Stone Age.

A. General.

Following upon the final glacial period the vegetation in Denmark at first developed according to the same laws as those governing events in the inter-glacial periods; all changes were merely an expression of alterations in climate and other natural factors. The primitive cultures of the Early Stone Age could have but little effect on the forest growth. The hunters had their paths as the animals their tracks; and just as the vegetation around bird colonies receives its character from the manure supplied to it, that in the immediate vicinity of Mesolithic settlements was characterized by midden plants[10]). Man's influence on the vegetation did not extend far; the virgin forest closed in a few paces outside the settlement, and there nature alone determined what was to grow.

All this went through a radical change with the introduction of farmer culture to the country. Then, and not before, the forest picture began to be altered by man, and there can be no doubt that the changes thus brought about were just as profound and just as interesting as those which earlier were associated with climatic and other purely natural causes. It would therefore be anticipated a priori that they would be clearly identifiable in the pollen diagrams.

In pollen diagrams the Danish Late Stone Age begins at a place close to zone border VII–VIII, after JESSEN's zonal divisions of the diagrams[4]). This must mean that farmer culture started at about this time, and it would be a very attractive task to find its traces in the pollen-floristic development of these strata. With this in view I have made a careful analysis of material from particularly suitable localities in various parts of the country. In order to bring new elements to light I have also made systematic counts of less common types of pollen (pollen of cereals, weeds, *Hedera*, *Viscum*, etc.), which provide information just as valuable as the pollen of the trees. This has entailed the

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[10]) The reference numbers relate to the numbers in the chapter on "Special Problems, etc." P. 32 ff.

counting of much greater quantities of pollen than otherwise, a time-consuming labour but one that has also been to the benefit of the other pollen curves, the statistical uncertainty having thus been reduced to a minimum[2]).

On the basis of some selected pollen diagrams from Zealand, Funen, East and Middle Jutland I shall now examine one by one the various phases in the aforesaid critical stage of the vegetation development round about zone border VII–VIII and at the same time endeavour to grasp their nature.

It is in the middle of the Oak Period. For about two thousand years *Quercus*, *Ulmus* and *Tilia* together have formed the high forest; there was a little *Pinus* in poor soil; *Alnus* grew especially in wet places with a little *Betula*. *Viscum album*[5]) was a common parasite on those trees that make suitable hosts, and flowering *Hedera helix*[6]) climbed wherever it could obtain a hold and was of a luxuriance seen nowadays only in southern and western Europe.

Then occurred some rather inconspicuous but important changes in the forest picture. *Fraxinus excelsior*[7]), which formerly had played only an unimportant role, increased in frequency at the expense of *Ulmus*, whose curve fell rapidly. The curve for *Hedera* describes exactly the same course as the *Ulmus* curve; it falls abruptly, and above this level *Hedera*, even in *per mille* diagrams[2]), no longer forms a continuous curve. In most cases the *Quercus* curve displays a slight rise. These small pollen-floristic changes can scarcely be connected with human interference; for even if one might at a pinch explain the decline of *Ulmus* as the result of the attentions of domestic animals[8]), the simultaneous decline of *Hedera* can no more be explained in this fashion than the increase of *Fraxinus*. As the same course of development can be shown to have taken place all over the country, in parts both fertile and unfertile, it is reasonable to assume a climatic cause. One factor alone, the marked decline of flowering *Hedera*, gives an indication as to the direction in which the climate must have changed. *Hedera* is distinctly an Atlantic plant, partial to warm summers and mild winters[6]), that is to say a climate which from early times has been connected with the "Atlantic Period" of the post-glacial age. As that very period must, according to the theory, have extended over the time during which *Hedera* was so common in Denmark, followed by the more continental "sub-Boreal Period", whose cold winters must have been inimical to *Hedera's* growth, it seems the obvious thing to do to connect the fall in the *Hedera* curve with the change from "Atlantic" to "sub-Boreal" climate. Consequently, in our pollen diagrams I have laid the border between these two climatic periods where the *Ulmus* curve falls, this being simultaneous with the decline of *Hedera*. If then we place the zone border VII–VIII at this point, we find that Zone VII corresponds to the Atlantic period and Zone VIII to the sub-Boreal, thus obtaining perfect concordance between the classical scheme of climatic periods after the Ice Age (BLYTT, SERNANDER, HARTZ) and the pollen-floristic division according to JESSEN[4]) (cf. Plate VIII). In Norwegian diagrams (from Jæren) the border between the Atlantic and the sub-Boreal climatic periods was similarly drawn recently by FÆGRI (1940); and although a comparison between Norwegian and Danish diagrams is rendered difficult by the natural differences between these two regions, FÆGRI's border seems to be in full conformity with the one described above[9]).

Just above the zone border VII–VIII as plotted here, i. e. in the beginning of the sub-Boreal Period, the curves in most Danish pollen diagrams describe a very peculiar course which bears witness of a remarkably sudden change in the composition and state of the forests. The elements of the high forest, *Quercus, Tilia, Fraxinus* and *Ulmus* undergo a distinct but temporary decline, while *Betula* reveals a transitory, *Alnus* a more lasting increase in pollen frequency, and at the same time the *Corylus* curve reaches a very pronounced maximum. What is the significance of this conspicuous minimum in the curve for the "Oak Mixed Forest" (*Quercus* + *Ulmus* + *Tilia* + *Fraxinus*)? Can it be the expression of a temporary lowering of the temperature?

There are various arguments against that interpretation. It must be realized that this climatic decline must have been of a sudden and actually a catastrophic character to depress the curves of the Oak Forest so abruptly and violently, and this would be incompatible with the rapid advance of the hazel. Nor is there any apparent decline in *Viscum*, though its thermal requirements are greater than those of *Quercus* and *Tilia*. It would also need some explaining why it was *Betula* and *Alnus*, but not the *Pinus*, that profited from the altered conditions. On the contrary, the pollen of *Pinus* as a whole declines in frequency in this zone. The hypothesis fails entirely when we have to explain the important fact that the phase is initiated with a sudden increase in the pollen of herbaceous plants.

In order to circumvent these difficulties, one might postulate a climatic change of another character than a general decline. A lowering of the ground-water level as a consequence of a very dry period would cause birch and alder to move out over marshy areas previously occupied solely by fen plants. This would explain the increase of *Betula* and *Alnus* pollen and the relative decrease in that of the other trees. Here again, however, the increase in the pollen frequency of the herbs forms an obstacle, and the explanation must be dropped.

There remains the influence of man. It seems reasonable to place the minimum in the curve of the Oak Mixed Forest in connection with forest clearance. Originally my idea was this: the clearance chiefly affected the Oak Forest of the high ground, whereas the marsh forests with their alder and birch escaped. Accordingly, the latter trees must display a relative increase in the diagrams. Doubtless this phenomenon did assert itself, but it cannot be the whole explanation. In the diagrams from salty fjord deposits this form of curve is handsomely developed, though there are no marsh forests at the borders of salt fjords.

On the other hand, we arrive at a natural and satisfactory explanation of the courses of the various pollen curves if we assume that the pollen-floristic changes express the vegetation developments in a region where land-tilling people have occupied the land and cleared this dense primeval forest with axe and fire. Now as this explanation requires that fire was largely made use of, it would be natural to expect that traces of it could be found. I recollected a suspicious, sharply delimited stratum of charcoal in Ordrup Mose just under the problematic zone, and subsequently embarked upon a precise and complete analysis of the sample series that had been collected. The result seemed to affirm my supposition that there was some connection between this charred layer and the minimum in the curve of the Oak Mixed Forest, and I shall now go through the diagram from that aspect.

During the Litorina transgression Ordrup Mose was a fjord in the Øresund[36]); the charred layer was near the upper edge of a thick deposit of saltwater gyttja (gyttja = organic mud). On the extreme left of Table I is a silhouette representing the frequency of charcoal fragments in slides from the deposit just under the charcoal layer, from that layer itself and from the deposits overlying it. It will be seen that the substratum to the fire-deposit also contains some charcoal; this is only natural, as the section lies in the immediate vicinity of the well-known large Mesolithic Bloksbjerg Settlement[34]), whose primitive inhabitants still seem to have been in occupation when the new farming people took the area into possession and forced them out. On the left of the pollen diagram there are also silhouettes to indicate the changes in the pollen numbers of various trees per square centimetre of slide; in contrast to what is the case with the pollen diagram, which exhibits only the relative changes in pollen frequency, we are here told something of the absolute pollen density in the various gyttja deposits. Finally, on the right of the pollen diagram there are frequency curves for herbaceous plants calculated in proportion to the total quantity of tree pollen.

How then did the vegetation react to the fire clearance? The curves for pollen density show that immediately over the fire deposit there was a sudden and unprecedented decline in the pollen of all kinds of trees[36 b]). This conspicuous poverty of pollen cannot be accidental, as every one of 34 samples from the marine series, 4 metres thick, under the fire deposit contained a considerable and apparently quite uniform pollen density. The clearance fire evidently encompassed the whole of the forest in the neighbourhood of Bloksbjerg, and it affected all trees alike. Consequently the pollen diagram exhibits no great change: the relative frequency ratio between the tree pollens is pretty much the same.

Judging by all appearances the fire deposit was laid down in the course of some few years. It consists mainly of charcoal, and its thickness is no more than a hundredth part of the whole marine series. Thus we have a chance of following the succession of plant growth after the clearance fire. In the fire deposit the pollen frequency of the herbaceous plants suddenly rises threefold. This relative increase correponds very well to the above mentioned simultaneous decline in the absolute tree-pollen frequency, and we must therefore assume that it is only a consequence of this decline. Already in the same analysis (No. 13) the forest regeneration begins. *Betula* and *Alnus* appear quickest, and therefore these trees record a considerable relative advance in the pollen diagram; it is principally this fact that causes the abrupt fall in the curves of the Oak Mixed Forest.

The explanation is quite simple. *Betula* and *Alnus* have a much greater power of dispersal than *Quercus*. Their seeds form regularly every year in large quantities, they are small and light and carry far on the wind, whereas the heavy fruits of the oak spread only slowly; therefore, in contrast to *Quercus*, *Betula* and *Alnus* are able to spring up immediately wherever suitable conditions for germination prevail. In addition, *Betula* and *Alnus* flower and fructify when they are only ten or twelve years old, whereas *Quercus* is 30—40 years old before it does so[20b]. This means that *Betula* and *Alnus* may produce some generations before the oak has even reached maturity. The significance of this is obvious. Like *Quercus*, *Corylus* has a poor power of dispersal, but on the other hand it reaches maturity before *Betula* and *Alnus*. These two circumstances may perhaps explain the curious features of its curve[21]).

The tree that profited most from the clearance fire was *Betula*; shortly after the land occupation it reached a higher frequency than ever since the Birch-Fir Period. This is very interesting, for nowadays too it is mainly *Betula* that makes its appearance after a forest fire[20a]). The great dispersal and early maturity of this tree is not the sole explanation, however; after ordinary forest clearances in fertile regions *Betula* does not usually appear. The fact is that its seed germinates only when the soil conditions are favourable. On ashy soil, however, these conditions are exceptionally favourable.

The uppermost analysis in the diagram reveals a decline in the *Betula* curve. This is not accidental; all diagrams with a marked minimum on the curve of the Oak Mixed Forest show that *Betula* flourishes only for a short time. The birch is the tree requiring most light[20c]), it cannot tolerate shade, and it only gets a chance when the forest is cleared of other trees. The birch is the pioneer among our trees, and the brief *Betula* maximum above the charcoal deposit is therefore very significant.

Throughout the foregoing the expression "clearance fire" has been employed. But the question arises of whether the vegetal development evidenced by the pollen flora might not just as well have occurred as the result of a natural forest conflagration?

In the first place one might answer that natural forest fires occur almost exclusively in conifer forests; indeed, it requires a good deal of effort to make a foliferous forest burn. This is a negative argument only, but fortunately we have much positive evidence to show that agriculture was brought to the region just at the time when the fire occurred.

As we have seen, the pollen frequency of herbaceous plants rises immediately after the fire. A "non-tree pollen diagram" (NTP diagram, Plate I, C), plotted on the pollen of herbaceous plants and heather, shows that in the main it is chiefly the same plants as those that were growing there earlier, first and foremost *Chenopodiaceae* and *Gramineae*. But next we find for the first time some pollen of plantain (*Plantago*), not, be it noted, of the salt-marsh plant *Plantago maritima*, but of the weeds *Pl. major* and *Pl. lanceolata*[12]). The pollen of these two plants is to be found in all our diagrams as soon as we come to the "land occupation phase"; this is its first appearance, but thereafter it has a continuous curve up to the present day. Apparently *Plantago* came to Denmark together with the first farmers in the same manner as it has since followed the European all over the world, wherever he has settled. *Plantago* has been called "the white man's trail" by the American Indians; the trail of the Neolithic conquerors is the *Plantago* pollen in our diagrams. In Ordrup Mose the course of the *Plantago* curve is typical; it starts where the Oak Mixed Forest begins to fall, and reaches its maximum where the other is at the minimum. Side by side with *Plantago* a common weed was *Artemisia cf. vulgaris*; its pollen was found in large quantities, and in historic times too it was a greatly detested field weed, one that became of minor importance only with the era of modern deep ploughing[14]).

It is a familiar fact that in the Late Stone Age a good deal of cereal cultivation took place, and therefore it was to be expected that cereal pollen would also be demonstrable in the fire deposit. FIRBAS showed that the pollen of cultivated cereals is larger than that of "the wild grasses", *Elymus arenarius* alone having pollen as large[11]). If nevertheless one finds hardly any cereal pollen in Stone and Bronze Age deposits, where *Plantago* pollen often occurs in large quantities, the reason must in part be that barley and wheat, the cereals that were cultivated in those ages, are self-fertilizing and give off scarcely any pollen[24]). Notwithstanding this unfavourable circumstance there was some cereal pollen in the strata directly overlying the fire horizon—not much, it is true, but sufficient to prove that cereals were cultivated.

Further evidence of the arrival of farmer people is provided by the finding of a bone which Dr. M. DEGERBØL identified as the tibia of a domestic cow. With the aid of a little gyttja picked out of the hollows in the bone it was possible to date it with fair accuracy. It belongs to the lower part of the lake marl, i. e. just in the Oak Mixed Forest minimum[36c]). This closes the chain of evidence.

We know of several examples of how the minimum in the curve of the Oak Mixed Forest occurs as an "episode" in the pollen diagram, one so sudden and brief that, as in Ordrup Mose, it may be regarded as a manifestation of the succession after a local occupation of land followed by a short-lived settlement. It is especially in bogs of small size, where the pollen-floristic development has a relatively local stamp, that we find such conditions, and these may then be taken as evidence of a Neolithic settlement in the immediate vicinity of the bog[31]). In deposits in large lakes or fjords the curves have a smoother course, and the fall in the curve of the Oak Mixed Forest is not the result of a single "clearance fire", but more likely an expression of the gradual change in the forest picture of the country round about as a consequence of a whole series of forest clearances, undertaken gradually as the soil-tilling people took possession of new areas. However, here too we often find somewhere on the flattened, lengthy minimum a sudden and violent, but transitory fall in the curve to show that just then an occupation had taken place in the vicinity. A handsome example of a curve taking this course is provided by diagrams from the now dried-up Korup Sø (Lake Korup), which in the Stone Age formed part of the great fjord system of Kolind Sund[39]).

Korup Sø was selected for this investigation especially because many of the circumstances connected with it are favourable to the purpose. It lies in the province of Djursland, where the early Neolithic culture was widespread and therefore was capable of exerting particular influence on the forest picture. In the Dolmen Period there was in fact a settlement ("Barkær")[33]) right on the deep fjord whose rapidly formed gyttja deposit has provided the best conditions for registering the various phases of the vegetal developments associated with the settlement. The fjord used to be so large that the boring section could be sited so far from the earlier bank that incidental local conditions were unable to interfere with the pollen-floristic development, so that the regular changes in the vegetation in the immediate and more distant surroundings stand out so much the more distinctly.

Plate II a is a survey diagram[39]) from Korup Sø. Plate III contains a carefully examined section of the diagram, given on a somewhat different scale and comprising the period in which the minimum on the Oak Mixed Forest curve falls. It will be seen that the zone border VII–VIII is well developed, the pollen curves of *Ulmus* and *Hedera* fall abruptly, whereas that of *Fraxinus* rises. Even at Analysis No. 7 the fall on the Oak Mixed Forest curve has already begun, and both *Quercus* and *Fraxinus*—quickly followed by *Tilia*—decline. This means that forest clearance at some distance from the fjord is becoming perceptible, for the herbaceous pollen curve records no reaction beyond the occurrence —a very instructive one by the way—of some few pollen grains of plantain (*Plantago major*), the "trail" of the Neolithic farmer in the pollen diagram.

Analysis No. 11 reveals a sudden and violent increase in the frequency of herb pollen, and with this the development observed in Ordrup Mose begins, with exactly the same phases in the same characteristic succession. We must assume that the farmer people have now settled close to Korup Sø and founded the aforesaid Dolmen-Period settlement of "Barkær". The land occupation itself, corresponding to the fire stratum in Ordrup Mose, is manifested in Analysis No. 11. The pollen of the herbaceous plants, which throughout the marine series has remained steady at about 4 per cent, now rises suddenly to two or three times as much. This relative increase applies to all the herb groups equally, from which fact we may assume that it was governed more by a falling off in the pollen production of the trees than by an increase in that of the herbs[19]). Extensive destruction had taken place in the forest, but the vegetation that was spared retained its previous character. Neither the "classical" diagram (Plate III, A) nor the special diagram for non-tree pollen (the NTP diagram, C) reveal any marked change.

Only in the following analysis (No. 12) do we find the first signs of the radical change in the pollen flora due to the succession after the forest clearance. Among the trees it is again *Betula* that thrives first; its curve turns sharply to the right and crosses the Oak Mixed Forest curve which, if the virgin forest had still been untouched in Djursland, would have been three or four times higher than the *Betula* curve. As was the case in Ordrup Mose, the *Betula* maximum here is succeeded by a tremendous *Corylus* maximum.

Still better than what we saw in Ordrup Mose the herbaceous pollen flora reflects the activities of the Neolithic tillers. Particularly instructive is the herb pollen diagram, in which the various types of herbaceous pollen are calculated in percentages of total herbaceous pollen. In the land-occupation stratum, Analysis 11, the herbaceous vegetation still retains its original character on the whole; but in the very next analysis the *Plantago* curve crosses all other pollen curves for herbaceous plants. Plantain (*Plantago lanceolata and Pl. major*) must have been almost incredibly common round about Korup fjord, as it contributed more pollen than all *Gramineae* and *Cyperaceae* together. Side by side with *Plantago* and *Gramineae*, *Artemisia* reaches the highest frequencies as in Ordrup Mose; in all probability this is the field weed *Artemisia vulgaris,* but there is the possibility that *A. campestris* was also present, as the soil around Barkær is sandy. Cereal pollen is sparse and attains its highest frequency together with *Plantago* in Analysis 13.

As we have seen, man and his domestic animals interfered greatly with the forest picture around Korup Sø. The primeval forest was changed to copse-woods, in which hazel, alder and birch predominated. In time, however, the oak forest was regenerated. Birch, the pioneer tree, which will not endure shade, soon disappears, but it takes longer to force the alder and hazel back to their normal frequency[20b]).

In two diagrams, one from Zealand and one from Jutland, we have now followed the details of the pollen-floristic developments associated with the minimum in the pollen curve of the Oak Mixed Forest. Other diagrams might be examined in the same manner, but as they conform in every way with the above, I shall merely refer to Plate IV and VII and the notes to it.

Everywhere we find the same striking coincidence between the fall of the Oak Mixed Forest curve and the flourishing of a culture-conditioned herbaceous flora that had no precedent; and it is scarcely feasible to ignore the possibility that these great and otherwise inexplicable changes in the vegetation are connected with the arrival of the farmer people into the arena.

It is a much more difficult matter to visualize details in the activities of these first Danish farmers. Nevertheless, one thing seems certain: colonization in an area did not begin in a small way, to become more comprehensive as time went on. Conditions at Korup Sø and at Ordrup Mose show unmistakably that there was a sudden and extensive land occupation. At first glance this may seem surprising; but on thinking it over one realizes that a solitary settler family in the wild forest among more or less hostile "native" hunters, savage animals and various kinds of "spirits" would be still more unreasonable an idea.

Accordingly, a number of people settled in an area and built a settlement in a suitable spot. Before moving their domestic animals to the new home they all embarked on a wide clearance of the forest; the cattle had to have food, but the forest as it stood could not provide it. That forest was nothing like the oak forest of today; innumerable dead, fallen trees lay in every direction, making access to it difficult and hindering the growth of grass and leafy bushes[17]). Light and air had to be provided for herbs and low bushes to grow. For this purpose fire would be at least as important as the axe. A cultivated forest of foliferous trees is perhaps difficult to set alight, but in a primitive forest this is facilitated by the great quantities of inflammable dead, dry and mouldering wood lying about[17]). One imagines too that the people helped by cutting bushes and small trees and piling chips around the large oaks to save the labour of felling them[18]). After the fire the landscape would be a dreary sight, with the big, destroyed oaks jutting up out of the charred waste as witnesses of the mighty forest that once stood there.

This great clearance fire at the commencement of a settlement cannot be paralleled with an isolated clearance such as that of the Carelian "Svedjebrug" nowadays. According to LINKOLA (1916), the whole of the burnt-off forest area between the stubs is sown for grain after only the most essential ploughing; then when the soil is exhausted after a few years, it is left to itself, or rather to the cattle. If the clearance fire and the subsequent succession at Ordrup Mose and Korup Sø had been of this kind, most of the cereal pollen would have appeared immediately after the clearance, before the forest regeneration had been able to establish itself. In actual fact the maximum of the cereal pollen curve falls a little *after* the land occupation and simultaneously with the maximum of *Plantago* pollen.

On the other hand, there is a peculiar parallel to the Neolithic occupation in the Norsemen's occupation of Greenland. In the bogs of the ,,West Settlement" I found a distinct, thin deposit of charcoal of a character similar to that in Ordrup Mose, and it could be demonstrated that it signified the beginning of the colonization; immediately on their arrival in the country the Norsemen had burnt off the heath and scrub which originally covered the region. After the fire came a luxuriant herbaceous vegetation, much more suitable as fodder for the many domestic animals that accompanied the Norsemen from Iceland (IVERSEN 1934).

In Denmark, too, the large clearance fires at the time of the Neolithic occupations presumably were first of all intended for securing food for the animals. In the herbaceous pollen flora we have indirect evidence that the Late Stone Age man had many—surprisingly many animals. Otherwise it is incredible that *Plantago* could attain to such a high frequency. Most of the *Plantago* pollen belongs to *Pl. lanceolata*, a species that grows on grassland where domestic animals (or mowing for hay) keep the vegetation low, whereas *Pl. major*, of which the pollen is much less frequent, has its habitat more around the houses. Thus we may assume that a small part of the burnt-off area was sown, whereas the greater part was left to itself. The black surface quickly became green from the emerging herbs, bushes and trees, whose fresh leaves would be welcome fodder for the cattle, which were free to move about. In this manner there arose a nibbled scrub, in which besides herbs, hazel and alder were prominent. Gradually as the trees succeeded in growing up over the reach of the animals the forest became darker, and presumably this was remedied by means of the axe. According to DENGLER[22]) there is a similar, low form of forestry today in the least settled parts of South Europe on the extreme edge of the primeval forest, for example in the Roumanian Carpathians, in Bosnia and elsewhere. The tremendous sub-Boreal hazel maxima in our diagrams show that the well-known culture-conditioned large hazel shrubs in the primitive parts of the Balkans had their parallel in Denmark in the Stone Age.

Besides animal husbandry, grain growing was an important feature in the life of the Neolithic farmers, but we know only very little of the nature of their agriculture. As soon as they occupied the land they would doubtless lay off part of it for agriculture and sow cereals—wheat and barley—in the ash. Then after a few years they would probably leave the exhausted area and burn off a new area, thus employing a method similar to that of Carelia[23]). This however is not easy to prove; it may also be that they continued to cultivate the same field as long as the settlement existed, and merely cleared more forest when the agricultural area was to be extended. Danish soil has a greater yielding power than Finnish, and a settlement would scarcely exist very long[29]).

Naturally, the land-occupation phases are not quite simultaneous in the different diagrams; but it is a striking fact that in all cases where any approximate dating has been possible, the occupation comes under the beginning of the sub-Boreal zone, just slightly above the zone border[25]).

In the foregoing I have assumed as a matter of course that these "land occupations", as evidenced by our diagrams, were undertaken by a new people immigrating into Denmark and bringing agriculture and cattle with them. Now the question may be raised of whether this is really so certain. Is it not equally likely that agriculture developed out of the old hunter culture, without any considerable immigration by strangers? This central question is discussed from many aspects in recent years. Though the archaeologists have not yet arrived at unanimity, it is clear that the immigration theory is gaining more and more ground. The latest contribution is by MATHIASSEN who, by means of a comparison of settlement finds dating from the first era of Denmark's Late Stone Age, shows that archaeological conditions in this country indicate very decidedly that there was an immigration[26]). Recent zoological observations[26]) point in the same direction, and it seems to me that the botanical evidence actually necessitates this conclusion.

The argument is as follows. For thousands of years Denmark was inhabited by a very scattered population of hunters and fishers who had adapted themselves to the severe conditions forced upon them by nature. A continuous forest, with dangerous swamps as the only openings, covered the entire country[16]). Then suddenly the picture changed. With astonishing rapidity land is occupied in most parts of the country, the forest is cleared on a very large scale, copsewoods grow up under the influence of culture, an entirely new herbaceous flora intrudes. Could it have been the small tribe of "natives", scarcely more than a few hundreds all told, that so suddenly made such a complete change in their ancient habits and put up such a display of new energy? That would seem to be beyond all reason, particularly because together with farmer culture we still find this same hunter people, who had lived in the country from time immemorial, fishing and hunting as before, only little affected by the new conditions[27]).

As I have said, the typical minimum on the Oak Mixed Forest curve occurs in almost all Danish sub-Boreal diagrams; there are only few exceptions, but they are interesting, as they lie in the sandy, unfertile parts of Middle Jutland[28]). The example chosen is a *per mille* diagram from the now dried-up Bølling Sø on the edge of the large Karup heath-plain. The colonization begins with Analysis No. 6; here *Plantago* and cereal pollen appear for the first time, and here the herbaceous pollen curve takes a distinct rise. On the other hand we can see no marked minimum for the curve of the Oak Mixed Forest, or that the birch makes any distinct progress. There is nothing to indicate that there was a clearance fire similar to those in the more fertile parts of the country. The immediate assumption is that it was unnecessary to institute any operation so radical. The forest must have been more open and light than elsewhere; this is evidenced by the great frequency of the birch, our most light-loving tree. To some extent the character of the forest was already light enough to enable the cattle to find their food. In Analysis No. 8 the frequency of the herbaceous pollen again rises rapidly, and we must assume that a new and more numerous colonization took place; it may have been the Single Grave people who then came into the area. Here again there is no sign of any extensive clearance fires.

Conditions in the heath areas of Jutland give a hint as to how we are to interpret the peculiar fact that forest clearance by fire with its characteristic succession occurs only once in the Danish diagrams. In his book on the Danish forests VAUPEL paints an eloquent picture of the destructive effects of cattle-browsing on the strength and density of the forest. Thus in the Stone Age too roaming cattle perhaps prevented the forest from regaining its former strength and inaccessibility, which would require another clearance.

However, the effects of culture on the Danish vegetation throughout the sub-Boreal period seem mainly to have consisted in a reshaping of the forest; it perhaps deteriorated, but was still a continuous forest covering most of the whole country[29]). Then at the beginning of the sub-Atlantic period came a new radical oscillation in vegetal developments in Denmark; the decline of the forest gathers speed and is manifested in the greatly increased pollen frequency of the herbaceous plants. At the beginning of the Iron Age there must have been a far-reaching change in husbandry; the altered climate and the introduction of iron involved a new and higher form of culture[30]). Then for the first time the Danish landscape begins to take the form in which we now know it: open country with its fields, meadows, heaths and forests.

B. Special Problems and Discussion.

I. Methodological Remarks.

1) Analyses of Pollen Samples.

In ordinary pollen analyses the usual boiling of the sample with KOH —combined with a hydrofluoric acid treatment when the sediment is clayey (ASSARSON and GRANLUND 1924)—is quite sufficient. But when large quantities of pollen are to be counted for each analysis, as in the present work, it is of advantage to employ other means of concentrating the pollen in the slides. In general I have therefore employed ERDTMAN's (1936) acetic anhydride method, which for clayey sediments may be combined with a previous treatment with hydrofluoric acid. Unfortunately, both the latter treatment and the acetolyzation affects the size of the pollen grain: with the former it becomes smaller, with the latter it becomes larger and coarser in structure. For this reason I have in certain cases used concentrated H_2SO_4 instead of acetic anhydride, followed by boiling with KOH; this treatment does not change the size and structure of the pollen grain and therefore it is useful when sizes are to be measured.

2) Statistical Uncertainty in Pollen Diagrams. Per Mille Diagrams.

Ording (1934 p. 177 ff.) points out that in pollen-analytical literature it does not seem to be realized in every case how much the accuracy of the calculated percentages depends on how many pollen have been counted. If the number of pollen counted is not particularly large, there is no point in discussing small oscillations in the curves, as they may be the result of purely statistical factors. This is not saying that one ought always to make large counts; but, to use Fægri's words, one ought to count so many pollen "dass die in jedem Fall gezogenen Schlüsse statistisch sichergestellt sind". Everything depends on the accuracy required by the purpose of the analysis. In the present work I have had to plot curves for pollen types with a frequency of under 1 per cent, and therefore I naturally had to count a very large number of pollen, usually I have counted more than 1000 tree pollen in every analysis. These diagrams may therefore be called "per mille diagrams", and it may be taken for granted that even small oscillations are statistically correct. In the diagrams the number of pollen counted is given for each analysis. The total number of tree-pollen counted as a basis for this work amounts to 140,000.

Schrøder (1930) described another method with his "Lupendiagramme". Instead of increasing the number of pollen counted he increased the number of analyses. This system too is employable, provided it is borne in mind that the small curve oscillations in such cases are of no consequence, as they are not statistically certain; on the other hand the reliability of the curve picture in its entirety is ensured by the large number of analyses. In homogeneous gyttja series, where no sedimentary alternations or local pollen intrusions disturb the regularity of the curves, the *per mille* diagram is preferable; but in critical places, where an important change in the floristic development occurs, it may be necessary even with *per mille* diagrams to employ many samples taken close together.

3) NTP (Non-Tree Pollen) Diagrams.

In many cases it proves of advantage to set up a special diagram for non-tree pollen, in which the sum of herbaceous plants and heather is the basis of calculation (see Fægri 1935 p. 7 and 1941 p. 31;

GAMS 1937). This is particularly so when the effects of culture influence are to be traced, for these of course are much more perceptible in herbaceous than in tree vegetation. In the present work the pollen sum comprises: *Ericales*, *Gramineae*, *Cyperaceae*, *Centrospermae*, *Compositae*, *Plantago* and *Rumex*. The pollen curve for *Gramineae* also includes cereals, which by the way are also shown separately in silhouette form.

The symbols in the NTP diagram are the same as in FÆGRI (1941); the latest standardization proposal by GAMS (1938) unfortunately has not been accessible to me. For *Rumex* and *Plantago* I have had to devise new symbols, as they have not previously been included in the pollen-analytical literature. According to the rule laid down by VON POST (1929) the first group of immigrants ought to have a round symbol, the elements of the warmth period a four-sided one, and the last immigrants a triangular. Accordingly the symbol for *Plantago (Pl. lanceolata + Pl. major)* should be angular; the other herbaceous pollen types should be round; I have also made the *Artemisia* symbol round, as the species of this genus cannot be distinguished by pollen analysis, and in Denmark *Artemisia* pollen is common in late-Glacial deposits.

4) Zoning in Pollen Diagrams.

JESSEN (1935, 1938, 1939) divided the Danish diagrams into nine zones. This small number compared with those used by some foreign authors is actually an advantage, for it promotes clarity; correlation of the diagrams is easier, and there is a better chance of acquiring a real understanding of the significance of the zone borders as reflecting climatic changes or changes due to immigration. If greater detail is required, the principal zones can always be split up. On the other hand a warning must be uttered against exaggerated division, for it is liable to lead to erroneous correlations (cf. FÆGRI 1941 p. 32). Only when one has decided what a certain pollen-floristic change means can one form any opinion as to whether it is of regional importance or not and whether or not it can be of chronological importance. For the most part JESSEN's nine zones are evidently climatic and thus are of regional significance.

In the present work I have endeavoured to show that the zone border VII–VIII should be laid there where the *Ulmus* curve falls and the *Fraxinus* curve rises, as this border seems to be climatically conditioned. The much more conspicuous fall in the curve of the Oak Mixed Forest shortly afterwards is unsuitable as a zone border, as it appears to be the result of Neolithic land occupation and thus cannot be regarded as a synchronous level. After this slight change JESSEN's zone division may be compared in the following manner with the classical climate periods of BLYTT, SERNANDER and HARTZ: I. Early Dryas Period, II. the

Allerød Oscillation, III. Late Dryas Period, IV. Pre-Boreal, V.–VI. Boreal, VII. Atlantic, VIII. Sub-Boreal, IX. Sub-Atlantic.

II. Pollen Types as Climate Indicators.

5) *Viscum album.*

Viscum pollen (Plate IX: 4) is very similar to *Ilex* pollen, but can be recognized without difficulty by the fact that the spines are more slender and less numerous. Nowadays the mistletoe as a spontaneous plant in Denmark is to be found only in a few specimens in the warmest part of the country (South Zealand, Lolland; cf. LANGE 1930). In late-Boreal, in Atlantic and in the greater part of the sub-Boreal period it was common all over the country, to judge from the pollen finds; towards the close of the sub-Boreal period it decreases in frequency. Today the greater part of Denmark seems to lie outside the climatic range of *Viscum*, and therefore the presence of *Viscum* pollen in Danish diagrams, like the well-known finds of *Trapa natans*, bears witness of a climatic decrease since the sub-Boreal period.

6) *Hedera helix.*

Hedera pollen (Plate IX: 1—3) can be distinguished from similar pollen (for example the pollen of *Lysimachia vulgaris* and *Euonymus europaeus*) when once the characteristic differences are realized: the angular form, the sculpture, the characteristic pore-structure etc.

As is often pointed out (cf. e. g. FRØMAN 1932, HOLMBOE 1918), *Hedera* is an Atlantic plant, with a liking for mild winters and warm summers. It thrives best in South and West Europe, where large, flowering specimens are very common. Northwards and eastwards *Hedera* decreases in frequency and luxuriance; in Denmark it is common as a sterile plant, but apart from the warmest coastal areas on the south flowering ivy is rare. At the eastern boundary—in the Baltic—it occurs only as a sterile plant creeping along the ground (KUPFFER 1905). The great frequency of flowering *Hedera* in the Atlantic period, like the frequency of *Viscum*, is evidence of the favourable climatic conditions at that time. The abrupt decline for flowering *Hedera* at the transition to the sub-Boreal period may just as well be due to a decline in summer as in winter temperatures; but a priori we must assume that it was the winter season that became colder in sub-Boreal times. This harmonizes with the fact that *Viscum*—whose northern boundary is determined more by the summer temperature—shows no decrease.

7) *Fraxinus excelsior.*

Fraxinus pollen is very delicate and is liable to shrink to unrecognizability in deposits where pollen on the whole is badly preserved. On the other hand it is easy to identify in strata having good conditions for preserving pollen, and it cannot be mistaken for *Salix* when once the distinguishing signs have been learnt (cf. NILSSON 1935 p. 502, illustrated in ERDTMAN 1935). *Fraxinus* occurs only sparsely in postglacial deposits, but all the same its curve is of importance owing to the marked rise on the border between the Atlantic and the sub-Boreal periods while at the same time the *Ulmus* curve recedes (cf. Note No. 8). Hitherto *Fraxinus* pollen has rarely been given much attention in the pollen-analytical literature (NILSSON 1935, IVERSEN 1937, TROELS-SMITH 1937, FAEGRI 1940). The pollen-analytical demonstration that *Ulmus* is replaced by *Fraxinus* in the sub-Boreal period is affirmed by finds of charcoal at settlements. JESSEN (1919) made an analysis of charcoal from Bronze Age settlements, and it turned out that the largest number of charred woods (58) belonged to *Fraxinus*, whereas there was only a single piece of *Ulmus* charcoal. For purposes of comparison JESSEN cites charcoal from Stone Age settlements, determined by E. ROSTRUP. In the shell heaps of the Early Stone Age *Ulmus* was the most frequent tree next after *Quercus* and *Betula*, whereas it was quite absent from the settlements of the Late Stone Age, where on the other hand there was *Fraxinus*, which could not be demonstrated in the earliest settlements.

8) *Ulmus* in Atlantic and Sub-Boreal.

The *Ulmus* decline at the transition between the Atlantic and the sub-Boreal periods is something of a riddle. The nearest available explanation is that many of the elms in Atlantic times were not of the *U. montana* species, but the more warmth-loving *U. campestris*, whose northern limit as a spontaneous plant now lies south of Denmark. This would also provide a natural explanation of why *Ulmus* has such a high frequency in the Atlantic period. In contradistinction to *U. montana*, which in Germany as a rule occurs only sporadically in the forest, *U. campestris* not uncommonly grows socially in "Auenwaldungen", where it propagates rapidly by means of suckers (DENGLER 1935 p. 310 and p. 306). Thus we also understand why *Fraxinus* replaces *Ulmus*, as *Fraxinus* has the same predilection for moist, fertile soil as *Ulmus campestris*, but ranges much farther to the northeast than it does. According to this the *Ulmus* decrease was due to climate. The explanation is supported by the simultaneous fall of the *Hedera* curve, due as far as can be judged to a decrease in the winter temperature. It is possible that the problem can be solved by means of a careful analysis of the *Ulmus* pollen, but I have had no opportunity for this as yet. Still, it is remarkable that the Atlantic *Ulmus* pollens are angular in shape and vigorous in sculpture, whereas sub-Boreal—sub-Atlantic are chiefly less angular and fainter in contour. This suggests that a thorough morphological examination might lead to a result. The difficulty is mostly one of obtaining recent material for comparison; in Denmark there will hardly be any "pure" *U. campestris*; all planted *Ulmus* seem to be of a more or less hybrid nature (verbal information from Dr. SYRACH LARSEN).

In S. W. Norway (Jæren) in the beginning of the sub-Boreal period FÆGRI (1940) found a similar fall in the *Ulmus* curve; if that fall had the same cause as that in the Danish diagrams, the above explanation will not do, for we cannot imagine *Ulmus campestris* as having grown in Jæren in Atlantic times. The probability is, however, that the *Ulmus* falls in Denmark and Norway are not synchronous, as *Ulmus*'s decline in Jæren only begins some way up in the sub-Boreal zone — provided that FÆGRI's correlation with the Danish diagrams is correct (cf. Note 9). There is good reason for assuming with NORDHAGEN and FÆGRI (FÆGRI l. c. pp. 122–23) that in Norway the sub-Boreal *Ulmus* curve was affected by Neolithic culture, as cattle are very partial to *Ulmus* leaves and, according to Nordhagen, these were formerly much used for fodder. In Denmark this explanation would not apply, as *Ulmus*'s decline occurs prior to the arrival of the Dolmen people into the country. Nor is it credible that a deterioration of the soil owing to the lime and other nutritives being washed out can be made responsible for the *Ulmus* fall, as if *Ulmus* requires good soil, *Fraxinus* does so no less, and in the diagrams *Fraxinus* replaces *Ulmus* to some extent (and cf. FÆGRI l. c., p. 58). In East Prussia, too, the *Ulmus* curve has a course like that in the Danish diagrams (GROSS 1935).

9) The Sub-Boreal Period in Pollen Diagram.

According to FÆGRI, the beginning of the sub-Boreal zone in Jæren is signified by a marked rise in the Oak Mixed Forest curve, though it is conditioned exclusively by the rise in the pollen frequency of *Quercus*. As I have said, in Danish diagrams there is also a clear rise of the *Quercus* curve at the border between the Atlantic and the sub-Boreal periods, but as a rule this increase is concealed by the immediately succeeding much heavier decline, due to the interference of the Neolithic farmers in the development of the forest. This makes it hard to draw any exact comparisons, especially as it is uncertain whether or not the Jæren diagrams are affected by cultural influences (but see the observations on the *Ulmus* curve in Note No. 8). It is a very interesting circumstance that in Jæren *Hedera* is most frequent in the sub-Boreal period, not in the

Atlantic as in Denmark. In a region so oceanic as West Norway it is more the summer temperature than the winter temperature that is the limiting factor, and therefore a continentalizing of the climate on account of the increase of the summer temperature associated with it is more likely to be an advantage to *Hedera*; whereas in less oceanic regions the simultaneously commencing decrease in the winter temperature will give the death-blow to *Hedera*. For the same reason it is clear that the sub-Boreal period must signify a climate optimum in oceanic Norway, whereas in Denmark it does so only for the more continental plants.

However, Fægri was unable to demonstrate any sign of a sub-Boreal dessication (see Fægri l. c., p. 59). This is important; in the oceanic Jæren the climate apparently was never so dry that the formation of peat in the bogs ceased. Something of the same sort applies to northwest Germany[1]). German investigators (e. g. Overbeck u. Schmitz 1931, Gross 1935—36) have therefore expressed doubt as to the correctness of the traditional theory of a dry continental sub-Boreal period. Indeed, it is also advanced that the plants *Fagus* and *Abies*, both Atlantic in character, attained to their first mass distribution in the sub-Boreal period, and that the *Calluna* heath at the same time covered large areas. In Denmark, however, these arguments against a more continental sub-Boreal period will hardly hold good. Peat formation actually ceased in many bogs after the Atlantic period, to begin again in the sub-Atlantic, so that Zone VIII is almost non-existent in many diagrams. It is also significant that *Fagus*, immigrating into Denmark at the juncture between Atlantic and sub-Boreal, continues to be a rarity through the whole of the sub-Boreal period and then suddenly spreads at the beginning of sub-Atlantic. The same applies to the *Calluna* heath, which in the Atlantic period remains merely as a temporary transitional stage between cultivated soil and the continuously regenerating forest. It is not until the beginning of the sub-Atlantic period that the heath spreads in Middle Jutland (cf. Note No. 29a, 30). All this means that the question of the climatic conditions in the Atlantic and sub-Boreal periods has not yet been cleared up; evidently it is more complicated than was originally assumed; on the other hand, the classical theory is supported by the new evidence produced in the present work and by Fægri's investigations in Jæren. Von Post (1920, 1925) points out that in Sweden it was actually possible to divide the post-glacial warmth period into a maritime *Cladium* phase and a continental *Trapa* phase. In Denmark the *Cladium* phase is represented by the *Hedera* phase.

The warmth maximum in Denmark occurred clearly enough in the

[1]) On the other hand Godwin (1940, p. 283 and Fig. 30) found signs in East England of a dessication in early Neolithic times; there are good reasons for connecting it with the beginning of the "sub-Boreal" climate.

Atlantic period; on this point there is the closest concordance between the present investigation and the opinion now prevalent in Central Europe (cf. GAMS 1925).

III. Pollen Types as Culture Indicators.

10) *Chenopodiaceæ* Pollen as Indicators of Mesolithic Inland Settlements.

In gyttja deposits that are contemporaneous with the settlements of the Gudenaa Culture regular finds were made of the pollen of *Chenopodiaceae*. These annuals require a very nitrogenous, open soil and cannot tolerate shade, so that under natural conditions they would grow nowhere else than by the sea shore. From the shore they already made their way in the Danish Early Stone Age to the settlements, where the middens provided them with ideal conditions of growth. As *Chenopodiaceae* are wind-pollinators and have a large pollen production, it will be possible to demonstrate Mesolithic inland settlements in the diagrams by the finding of *Chenopodiaceae* pollen. This actually is a new method of proving—and simultaneously of dating—inland settlements (compare Snarup diagram, Note No. 38).

11) Cereal Pollen.

The careful investigations of FIRBAS (1937) made it possible to demonstrate cereal cultivation by means of pollen analysis. Apart from their size ($> 35\mu$), cereal pollen excels by being particularly thick walled, having a distinct structure and a large pore with a well-marked ring. Such are the pollens of oats, rye and most wheats, next of the shore-grass *Elymus arenarius*. On the other hand the pollen of barley and of a solitary wheat (*Triticum monococcum*) are less distinctly of the "cereal type", so that they may be mistaken for pollen of wild grasses, whereas some wild grasses (e. g. *Agropyrum repens*) sometimes produce pollen approaching that of cereals in size. For this reason FIRBAS points out "dass ein ganz vereinzeltes Vorkommen eines dem Getreidetyp zurechnenden Pollens keinerlei brauchbare Auswertung gestattet." In my counts I have included only pronounced cases in the column "Cereal Type".

12) *Plantaginaceae* Pollen.

The pollen of Danish *Plantaginaceae* can be distinguished from one another by the following characteristics (cf. Plate IX).

A. Pollen large, more than 30 μ. Pores without projecting ring. Number of pores large .... *Litorella.*
B. Pollen less than 30 μ .... *Plantago.*
  I. With distinct projecting ring.
    a. Number of pores large (10–14)......... *Pl. lanceolata.*
    b. Number of pores small (5–7), ring very pronounced .... *Pl. coronopus.*
  II. Pores without pronounced ring.
    a. Sculpture faint. Number of pores small.. *Pl. maritima.*
    b. Sculpture vigorous .... *Pl. major, Pl. media.*

Plantago lanceolata is easily recognizable by the large number of pores in conjunction with the distinct ring. In *Pl. major* and *Pl. media* the pores are so little distinct that it is difficult to count them. For this reason I would not venture to say what is the exact number; it is less than in *Pl. lanceolata,* and seems to be greatest in *Pl. media,* though the latter is easy to distinguish from *Pl. lanceolata* by the indistinct ring.

13) Immigration of *Plantago lanceolata* and *Plantago major* into Denmark.

There has never been any doubt that the distribution of these two *Plantago* species was greatly increased through human agency, but opinions are divided on the subject of whether the species may be regarded as spontaneous in the flora of the various countries (see JESSEN and LIND 1922–23). These different opinions need not be discussed here, but it may be mentioned that LINKOLA (1916, 1921), whose classical works on the influence of culture on the vegetation in South Finland is almost unparalleled in the modern literature on the subject, considers both species to be anthropochorous in the region examined, i. e. that they were carried in by man. During the past few years I have collected observations at every available opportunity on the present distribution of *Plantago* in Denmark and have come to the same conclusion as far as this country is concerned. *Plantago major* is so closely associated with places with direct cultural influences that it would doubtless disappear from our flora if the culture ceased. True, it is encountered now and then by the shore; but, in all the cases I have been able to observe, it would no doubt disappear together with the cultural interferences in nature (grazing, mowing etc.) which keep the vegetation low or open. As regards *Pl. lanceolata* the position is less clear, as this plant can also grow in well-lighted oak forests (cf. JESSEN and LIND). Here again, however, we find that it is dependent on culture. The only occasion on which I have seen *Plantago* occurring in abundance in a wood was in an open oak scrub at Frøslev in South Jutland, but the scrub was browsed by cattle. Untouched oak forest is no place for *Plantago lanceolata,* as appears clearly e. g. from OLSEN's (1938) comprehensive statistical investigations into the ground flora in Danish oak forests and oak scrubs. OLSEN's paper contains 107 vegetation analyses from all parts of the country except Sleswig. *Pl. lanceolata* does not appear in any of them. The same applies to my vegetation analyses from oak forest and scrub in North Sleswig (1936 Tables 32–33). In virgin forest conditions for *Plantago* must have been still more unfavourable. What is more, *Plantago* nowadays has the best of conditions for spreading to the forests, as it is so common on culture and semi-culture soil. Before the introduction of agriculture into the country matters were quite different; from where were the seeds to come, even if there were patches here and there suitable for its growth?

The fossil finds are also in good conformity with the view that *Plantago lanceolata* came to the country with agriculture. The earliest finds of seeds abroad date from the Late Stone Age, and in Denmark from the Bronze Age (see JESSEN and LIND pp. 366–67); in all cases it seems to have been a matter of weeds.

The most reliable evidence, however, seems to be supplied by pollen analyses. In all Danish diagrams in which *Pl. lanceolata* and *Pl. major* have been counted, their curves start in the beginning of the sub-Boreal period, simultaneously with the entry of Neolithic culture into the country. *Plantago* produces large quantities of pollen, but not a single pollen grain of these species has been found below the zone border VII–VIII, though I have counted tens of thousands of pollen grains in Atlantic and Boreal deposits and have kept an eye open for them. On the other hand, the pollen of the shore plant *Pl. maritima* was found in marine gyttjas throughout the whole of the Littorina period, though very few in number in every case.

The beginning of the pollen curve for *Plantago lanceolata* (and *Pl. major*) is, as will be understood, a good guide to the establishment of the beginning of Neolithicum in our pollen diagrams. It is to be hoped that research on the occurrence of *Plantago* pollen in our neighbour countries will make some contribution to our understanding of the migrations of the Neolithic people.

14) *Artemisia* Pollen.

Like *Plantago* and *Rumex*, *Artemisia* is a wind-pollinator, for which reason its pollen is often found in large numbers in different deposits. *Artemisia* pollen is easy to identify from pollen of other *Tubuliflorae* in that the spines are vestigial or entirely absent (cf. WODEHOUSE p. 501 and Plate XIII). Unfortunately the pollens of the various species are scarcely distinguishable from one another, and it is only by indirect means that we can form an opinion as to what species are represented in the different zones of the pollen diagrams. In post-glacial sediments there can be only three species: *A. maritima, A. campestris* and *A. vulgaris*. In Littorina deposits *Artemisia* pollen is a constant find in relatively high frequencies (cf. the Korup diagram); this most probably is *A. maritima*. In inland bogs *Artemisia* pollen occurs at any rate only very sparsely in Boreal and Atlantic strata (Zone IV—VII); and as when plotting my few inland diagrams I did not distinguish *Artemisia* pollen from pollen of certain *Rosaceae*, which it resembles somewhat, I am unable to decide whether *Artemisia* grew in the interior at all at that time. In the land-occupation phase *Artemisia* pollen plays a great role in freshwater sediments too (cf. Ordrup Mose), and it is characteristic that its curve reaches its maximum a little earlier than the *Plantago* curve (see the NTP diagrams from Korup Sø and Ordrup Mose). In the NTP diagram too there is a marked rise of *Artemisia* pollen at this place, which demonstrates very clearly that *Artemisia* must have been fairly widespread as a weed around the first Neolithic settlement. Unfortunately it is impossible to decide by pollen analysis whether it was *A. vulgaris* or *A. campestris*; but as *A. vulgaris* in the earlier, more primitive form of agriculture was a very troublesome weed in the grain fields (see JESSEN and LIND, l. c., p. 183), it is natural to assume it was that species. This is also indicated by the circumstance that *Artemisia* pollen also attains to considerable frequencies in Ordrup bog, which lies in an area of boulder clay which cannot offer very good soil for *A. campestris*, a plant that predilectively grows in sandy soil. By the way the *Artemisia* curve is peculiar, for in the Korup diagram it has two maxima, one at the beginning and one at the close of the settlement period. At the time when *Plantago* and cereal pollen record their highest frequency, *Artemisia* has a minimum. I can find no natural explanation of this.

Nowadays *Artemisia vulgaris* is chiefly associated with localities under culture influence and is regarded by LINKOLA (1921) as anthropochorous in the Ladoga region. It is not improbable that, like *Plantago major* and *Pl. lanceolata*, it was brought into Denmark with the new agricultural people.

15) *Rumex* Pollen.

Rumex pollen is very delicate and disposed to shrink. In deposits where circumstances for preserving pollen are good, however, *Rumex* pollen is in good condition and easy to identify (illustration in WODEHOUSE 1935). It is found in Denmark through all late-glacial and post-glacial periods, but, apart from the late-glacial era (see also FÆGRI 1941 p. 77), occurs with noteworthy frequency only in association with agriculture on meagre sandy soil. Only in the two Middle-Jutland diagrams from Bølling Sø and Hostrup Sø respectively is there so much of it that it could pay to plot a curve for it. Here the species undoubtedly is *Rumex acetosella*, which is a characteristic and immensely widespread weed on washed-out, acid, sandy fields. Thus it is a very interesting fact that the *Rumex* curve rises quickly in the sub-Atlantic period, when the washing out of the sandy soils accelerates, whereas the rather more exacting *Plantago lanceolata* becomes rarer. Like *Plantago*, *Rumex acetosella* is one of man's constant companions. LINKOLA (1921), however, regards it as apophyte on the shore of Lake Ladoga, but anthropochorous in the interior. In Denmark, too, it must be spontaneous (cf. JESSEN and LIND p. 390), but in the Early Stone Age it grew only around the settlements, apart from the shore. Its seeds have not yet been met with in Danish Stone Age finds, whereas it is one of the commonest plants in sods etc. from Bronze Age graves (Jessen in JESSEN and LIND l. c., p. 18, IVERSEN 1939) and in Iron Age finds (see JESSEN and LIND l. c., p. 21).

From a section in North Hanover D. SCHRØDER (1939) mentions a pollen type with a curve parallel to the cereal-pollen curve but occurring in enormous numbers (up to 513 per cent. of the tree-pollen total). SCHRØDER considers it must be a field weed, and from both description and drawing it appears to be *Rumex* pollen. The heavy rise in the *Rumex* curve takes place immediately above the border horizon, i. e. in the Early Iron Age.

IV. The Land Occupation.

16) Vegetation in Danmark when the Farmer People Arrived.

The surprisingly low percentages of grass and herb pollen in Atlantic times (see plates) show that before the Neolithic forest clearances the country was covered by a continuous primeval forest, with no openings other than swamps and moors. Except for a few salt fens, pastures are entirely dependent on cultural measures such as grazing and mowing. Originally, in the form of alder thicket, the forest everywhere verged directly on swamp vegetation along lakes and streams. Apart from the forest in the least fertile parts of Middle and West Jutland the forest would not be particularly light either. The "Steppenheidetheorie" advanced in Germany by GRADMANN (1933), according to which the sub-Boreal climate created a more or less open steppe forest which had been particularly attractive to the first settlers, has no foundation in reality (cf. GROSS 1935–36). GROSS (l. c., p. 212) is undoubtedly right in saying: "Für die Gewinnung von Siedlungsland kam es nicht darauf an, ob die Waldbäume spärlich waren oder einen geschlossenen Bestand bildeten; das Feuer wurde mit ihnen in jedem Falle fertig."

17) Character of the Virgin Forest.

DENGLER (1935, p. 78) points out the "riesigen Mengen von Lagerholz" as the most characteristic feature of primitive forest in our latitudes. On the other hand the current idea of an impenetrable shrub-layer is wrong, "wo sie auftritt, da besteht sie meist nur in dem vielen, oft kreuz und quer liegenden Lager- und Moderholz, zusammengebrochener alter Baumleichen". It is obvious that under such conditions the forest must have been much more easy to burn than the seminatural foliferous forests of the present day. HESS and BECK (1916) indeed say expressly that the risk of fire in "virgin forest" is increased by the abundance of dead and dry wood.

18) Forest Clearance.

The Carelian clearance fire is described by LINKOLA (1916, p. 74) as follows: "Um auf der gewählten Fläche keine grossen Bäume fällen zu müssen, wurde namentlich bei Kiefern, die sonst leicht beim Feuer verschont blieben, mit der Axt in Brusthöhe eine Kerbe ringsum den ganzen Stamm gehauen. Die Bäume verdorrten nun, verbrannten aber nur teilweise, als die Fläche 2–3 Jahre später durch Niederbrennen der gefällten kleinen und mittelgrossen Bäume urbar gemacht wurde".

Presumably a similar process was employed in the Stone Age. It is true that in Finland the forest consists of conifers, not foliferous trees, but the new forest growing up after the first clearance fire is foliferous (birch, alder), so that the succeeding clearance fires in Carelia are in foliferous forest too. We know also that other kinds of foliferous forest, e. g. linden forest, can be cleared by fire without difficulty (see MAGER 1934).

19) Relative Increase of the Pollen Frequency for Herbs immediately after the Forest Clearance.

The great relative increase of the pollen frequency for herbs immediately after the land occupation may a priori have been due just as much to a decline in the tree-pollen frequency as to an increase in the production of herbaceous pollen. If the latter were the case we would expect to find a change in the mutual pollen frequencies in the individual herb groups, as it would be improbable that the pollen flora of the new, herb-covered areas should be of the same composition as that of the old areas (reed swamps, strand vegetation etc.). There is no such change, however (cf. the diagrams Plates I, III); in fact, all types of herbaceous pollen have an equal share in the increase of frequency. It is noteworthy that, e. g. the *Cyperaceae* have the same increase as the grasses, though one should not imagine that *Cyperaceae* formed part of the pioneer vegetation after a clearance fire. The conclusion to draw then is that the increased frequency of herbaceous pollen (in proportion to that of the trees) is due more to the decline in tree pollen production as a consequence of the destruction of the forest than to the appearance of new herb-covered areas.

20) Regeneration after Clearance Fire.

The factors of importance to our understanding of the regeneration of the forest which can be read from the pollen-floristic development in the occupation phase are a) the productiveness of the trees and their ability to disperse the seeds, b) the various ages at which the trees reach sexual maturity, c) the light requirements of the trees, and d) the ability of the trees to produce shoots from the stub or root.

a) Productivity and Dispersal.

Apart from *Populus* and *Salix*, the most favourably placed in this respect is *Betula*, of which the seeds "sich auf grossen kilometerlangen Brandflächen sehr bald reichlich einzufinden pflegt, obwohl oft weit und breit kein Samenbaum zu sehen ist" (DENGLER 1935, p. 214). *Alnus*, too, has a regular and large production of small and light seeds, whereas *Quercus* is handicapped, for it is fruitful only every third or fourth year and its heavy fruits disperse only slowly compared with those of *Betula* and *Alnus*.

b) Maturity Age.

The age at which trees bloom for the first time is given variously by different authors. DENGLER (1935, p. 204) for trees in free stand says: *Betula, Alnus, Pinus* 10–12 years, *Tilia* 10–30 years, *Quercus* 30–40 years. In close stand, however, the figures are much higher for all trees. No doubt O. G. Petersen's (1920, p. 203) figures are for close stand: *Corylus* 10 years, *Alnus* 15–20 years, *Betula* 15–25 years, *Pinus* 15–30 years, *Tilia* 25–30 years, *Fraxinus* 30 years, *Ulmus* 40 years and *Quercus* 50–60 years. It is easy to understand the great lead in forest regeneration gained by *Betula* and *Alnus*, but especially *Corylus*, over the elements of the Oak Mixed Forest.

c) Light Requirements.

Clarity regarding the light required by trees and the consequences of it was created by VAUPEL as long ago as in 1863 in his classical work (p. 87 ff.). He divides our trees into three classes according to their ability to tolerate shade. *Fagus* and *Tilia* are among the group growing in the weakest light; no undergrowth can thrive below them. *Ulmus montana, Corylus, Fraxinus, Alnus* and *Quercus* require more light, *Ulmus* most, *Alnus* and *Quercus* least. The third class comprises the light trees proper, neither tolerating nor giving much shade: *Betula* and *Pinus*.

In recent times Boysen Jensen (1929) confirmed, and also on a more exact foundation amplified Vaupel's investigations; he also studied the relation of young plants to light and set up the following order, commencing with trees capable of standing most shade. 1. *Ulmus* and *Fagus*. 2. *Fraxinus* and *Quercus*. 3. *Alnus glutinosa*. 4. *Betula*. Thus both as young and as full grown *Betula* is our most light-loving tree, one that under normal conditions cannot thrive in competition with the others. This being so, a *Betula* maximum in the pollen diagrams will certainly mean that the light conditions were favourable. *Alnus*, too, requires more light than *Quercus*, says Boysen Jensen. All this, side by side with the conditions referred to under a) and b), helps to explain why the birch and the alder of all others had their great chance in the forest regeneration after the clearance fire.

d. Shoot Production.

In contrast to conifers, foliferous trees all have a tendency more or less to produce shoots from the stub; this tendency is particularly strong in *Alnus* and *Corylus*, and equally slight in *Betula* (Dengler 1935 p. 212). Very likely this helped to sustain *Alnus* and *Corylus* so well in the period after the occupation (e. g. the diagrams from Søborg Sø and Korup Sø, and Jessen's diagrams from Bundsø and Troldebjerg).

21) The Hazel's Reaction to the Clearance Fire.

In the analysis just over the fire deposit in Ordrup Mose the hazel (*Corylus avellana*) shows a strong relative increase, though the absolute quantity of pollen is very small. The hazel was destroyed by the fire as was the other foliferous trees, and the relative increase may have something to do with the fact that the hazel can send out shoots from very low on the root-stock, which no doubt survived the fire, and that these shoots may flower even three or four years later (Büsgen l. c. p. 160). However, the hazel spreads only slowly, and therefore the advantage at the start is lost. *Betula* and *Alnus*, whose seeds are dispersed much more effectively, spread more quickly and thereby depress the hazel curve. Before very long, however, the hazel spreads over the whole area into a continuous hazel scrub. This retardation of the hazel increase compared with the rapid increase of *Betula* and *Alnus* is repeated in other diagrams, and it indicates that the regeneration of the forest proceeded by means of seeds. Otherwise it would be incomprehensible that the hazel did not retain its initial start and show a constant relative increase.

22) Present Parallels to Stone Age Low Forest for Browsing.

According to Dengler (1935, p. 79 ff.), the lowest developmental stage of forestry known today consists of foliferous low forest. It appears from the quotation from DENGLER below that this leads precisely to the decline of the high forest—the Oak Mixed Forest—that is so characteristic of the Neolithic encroachment in the forest. According to DENGLER, trees are first felled, whereafter regeneration proceeds. "Die ersten zarten Ausschläge boten neben den Bodenkräutern und Gräsern eine willkommene Weidegelegenheit für das Vieh. Es enstand der oft verbissene, struppige und buschige Weideniederwald, in dem sich die Weichholzarten Birke, Aspe, Salweide, Hasel stark vordrängen in dem aber schliesslich doch hier und da wieder einige Stangen emporwachsen, den lichtbedürftigeren Ausschlag der Weichhölzer dann unterdrücken, und zum Weidewechsel mit jüngern Schlägen zwingen." "Man kann diese niedrigste Entwicklungsstufe des Wirtschaftswaldes noch heute in unaufgeschlossenen Gebieten Südeuropas in den Siedlungen am Aussenrande des Urwaldes verfolgen, z. B. in den rumänischen Karpaten, in Bosnien und anderswo." "Eine Menge von geschichtlichen Nachrichten und Überlieferungen deuten darauf hin, dass der Laubholzniederwald mit Viehweide auch bei uns eine der ältesten Entwicklungsstufen gewesen ist. Daneben haben sich gegendweise oder doch wenig später Wechselbetriebe zwischen niederwaldartiger Waldnutzung und vorübergehender landwirtschaftlicher Zwischennutzung zwischen den ausschlagenden Stöcken und andere nahestehende Formen ausgebildet."

23) The Clearance-Fire Method (The "Svedje-Method").

The Finnish form of agriculture on cleared areas still practised in some remote parts of the country, proceeds in the following manner according to LINKOLA (1916, p. 74): "Der junge Wald, der meistens ausschliesslich oder hauptsächlich aus Laubholz besteht, wird im Alter von 20–30 Jahren gefällt; dieses findet im Juni statt. Nach einem Jahre werden im Juni bei günstiger Witterung die dürren, am Boden liegenden Bäume verbrannt. An dem einen Rande der Fläche beginnend lässt man das Feuer sich allmählich verbreiten und alle Bäume, die Bodenvegetation wie auch einen grossen Teil der Humusschicht in Asche legen. Nach solchen Flekken, wo der Boden aus Mangel an Holz unverkohlt bleibt, schleppt man von andern Stellen Stämme herbei. Anfang Juli wird die schwarze Brandfläche, die voll von Stubben und oft sehr steinig ist, mit einem besonderen Pfluge oberflächlich gepflügt. Ende Juli wird der Roggen gesät und mit einer Egge, die aus ästigen Fichtenstämmen gemacht wird, in der Erde untergebracht. Zugleich umzäunt man die Fläche zum Schutz gegen das Vieh. Die Roggenernte findet im folgenden Jahre gegen Ende des Sommers statt. Das zweite Getreide ist gewöhnlich der Hafer. Ist der Boden ergiebig, so kann noch eine zweite, in Ausnahmefällen eine dritte, vierte usw. Hafenernte folgen. Dann lässt man die Fläche sich begrasen und benutzt sie gewöhnlich sofort als Weideplatz oder (bei fruchtbarerem Boden) eine Zeit lang als Wiese. In kurzem entsteht dort, teils aus Wurzelschösslingen, teils aus Samenkeimlingen, meistens aus beiden zusammen, ein junger Wald." "Der junge Wald, — — —, wird so lange als Weide benutzt, bis man ihn wieder niederbrennt."

The idea that this clearance-fire method was employed in Denmark in antiquity was first advanced and motivated by G. HATT (l. c. 1928, 1937 p. 134). He drew attention to the fact that the clearance-fire method formed part of the earliest form of agriculture everywhere in the world, so that a priori it seemed extremely probable that it was also used in primitive Denmark. He supported his theory furthermore by the great changes occurring in the antique settlements in Zealand, as demonstrated by LA COUR (1927), and it is a matter of course that a primitive form of agriculture like the clearance-fire method would be associated with a lack of stability in the settlement. Two circumstances referred to in the present work are also arguments in favour of HATT's opinion. In the first place, the first clearance fire after the occupation showed that the Neolithic agriculturists understood the method of burning the forest. Next, the surprising rapidity with which the occupation spread over Denmark shows that the Neolithic agriculture must have been extraordinarily extensive. As a rule the settlements could not have existed long. On the other hand it is clear that the form of agriculture practised in Denmark must have been different to that for instance in Finland (cf. JESSEN 1938 p. 92); for example, it is presumable that the soil could be tilled longer before it was exhausted.

24) Grain Growing.

As long ago as in 1929 VON POST suggested that the cereal pollen frequencies could be utilized for registering the successive expansion of the tilled area. However, it was only after FIRBAS (1937) had shown that it was possible to distinguish cereal pollen from that of the wild grasses (see Note 11)—though not without a certain margin of error—that a solid basis was secured for testing the suggestion. Subsequently both FIRBAS (1937) and his pupils and also GROSS (1939), SCHRØDER (1939) and others did actually demonstrate cereal-growing by means of pollen analysis and drew a cereal-pollen curve. Nevertheless, VON POST's original hope has only partly been realized. Everywhere the pollen curve for grain lies surprisingly low, and there is scarcely any cereal pollen in the diagrams for the Neolithic period. No doubt the reason for this rather depressing result is that all our cereals except rye (*Secale*) are self-pollinators. This is particularly the case with barley (*Hordeum ssp.*); but even with wheat (*Triticum ssp.*) and oats (*Avena sativa*), whose flowers often open, one never sees the pollen carried by the wind in great quantities as with *Secale*. Accordingly, only *Secale* can really assert itself in the pollen diagrams. This of course does not mean that the pollen-analytical demonstration of cereal pollen loses its value; it simply means that the cereal-pollen curve is not a definite expression of the intensity of cereal-growing. To judge from the many finds (see HATT 1937, p. 20 ff., JESSEN 1939 b) the only cereals grown in Denmark in the Late Stone Age were wheat and barley, and neither of these liberate much pollen. In the Bronze Age two new cereals appear, one of them a self-pollinator too (*Avena sativa*), the other (millet, *Panicum miliaceum*) without pollen of the cereal type (see FIRBAS 1937 p. 452). It is not until the Iron Age that *Secale* appears (see HATT 1937, pp. 23 and 41), the only grain with pollen of the cereal type really producing large quantities of pollen. Thus it is not so strange that there is so little cereal pollen in sub-Boreal deposits, even if in the Late Stone Age and Bronze Age there were settlements in the immediate vicinity (see the diagrams Plates I a. III). Consequently the heavy rise in the cereal-pollen curve when we get some way up into sub-Atlantic strata (e. g. in the Bølling diagram Plate V, and cf. FIRBAS 1938, LOSERT 1940 p. 385, SCHRØDER 1938) need not necessarily mean that cereal cultivation has now extended so much; it may also be connected with the introduction of rye. The fluctuations in the agricultural intensity in antiquity are better reflected in the curves for weed pollen, as four of the most important weeds (*Plantago*, *Rumex*, *Artemisia* and *Chenopodiaceae*) are wind-pollinators. It is of course only in the interior that the pollen of the *Chenopodiaceae* can be used as a culture indicator (cf. Note 10), and in fact it is associated just as much with the Mesolithic hunter culture as with the farmer culture.

25) Chronological Position of the "Occupation Phase".

As already pointed out, the fall in the pollen curve of the Oak Mixed Forest cannot be regarded as synchronous, and it is for this reason that I consider that the zone border VII–VIII in the pollen diagrams should not be laid there. It was shown earlier (p. 21 a. 37) that the *Ulmus-Hedera* fall cannot have been caused by culture, but that in all probability it was connected with a climatic change and that it marks the transition between the Atlantic and the sub-Boreal period. This provides us with a pollen-analytical guide to a dating of the land occupation. In all known Danish diagrams with a well-developed sub-Boreal zone, we find the fall in the curve for the Oak Mixed Forest in the beginning of this zone. Below are the localities of these diagrams: Zealand: Tengslemark (JESSEN 1937). Søborg Sø and Ordrup Mose (Plates I and IV of the present work). Sækkedammen (NILSSON 1935). Funen: Snarup Mose (Plate IV of this work). Als: Bundsø (JESSEN 1938). North Jutland: Korup Sø (Plate III). Brabrand Sø (TROELS-SMITH 1937). Dyrholmen (TROELS-

SMITH 1942). South Jutland: Svanemose (JESSEN 1939). South Sleswig (Germany): Hornholz Bog near Flensburg (JESSEN 1938). In Middle Jutland, where the occupation phase is undeveloped (see p. 52), the *Plantago* curve begins at the bottom of the sub-Boreal zone: Bølling Sø and Hostrup Sø (see Plates V a. VI).

Another possibility for dating is provided by the marine transgressions. In a preliminary publication (1937) I distinguished between three transgressions in Denmark: the Early Atlantic, the High Atlantic and the Late Atlantic. At that time, however, the border between Atlantic and sub-Boreal was not defined on the diagrams. By the establishment of this border in the present work it lies between the two peaks of the Late Atlantic transgression to which I referred in 1937 and which seem to be of general significance. It would therefore be reasonable to divide the Late Atlantic transgression into two phases: the Late Atlantic (the 3rd fjord period of Søborg Sø) and the sub-Boreal (the 4th fjord period of Søborg Sø) transgression phases (cf. TROELS-SMITH 1942). In diagrams from localities in which these transgression phases are separable we find that the culture-conditioned decline in the Oak Mixed Forest curve always lies in the sub-Boreal transgression phase.

26) Archaeological and Zoological Arguments for Immigration in the Dolmen Period.

The question of whether the Dolmen Period culture developed out of the old hunter and fisher culture or it was brought to the country by a new people has been much debated in recent years. Most recently MATHIASSEN conducted a very careful comparative investigation on the two Dolmen-Period settlements of Havnelev and Strandegaard. The result supports the theory of a new immigration, set up by O. RYDBECK (1928) and others. MATHIASSEN considers that "between these two adjacent settlements there are great, fundamental differences in almost everything: the shape of the flint implements, the flint technique, the pottery, the animal bones, the situation." The difference between these two finds cannot be explained by any difference in time; on the contrary, Havnelev with its Late Stone Age character seems to be a little older than Strandegaard, which has the stamp of the Mesolithic period. "Then may it not be different occupations that cause the dissimilarity? Strandegaard may have been a hunter (whaler) settlement on the coast, Havnelev a farmer settlement lying inland. This might explain many things. More domestic animals at Havnelev, more wild animals at Strandegaard, the lamps at Strandegaard, sealing, impressions of grain and the grinding stones at Havnelev, none at Strandegaard. However, this alone cannot explain the fundamental difference between the artefact types in the two finds, especially in the flint work, in which the technique is not the same at all. The only possible explanation seems to be that these were two different peoples, a newly immigrated farmer people represented at Havnelev, and a native hunter people represented at Strandegaard. Only under this supposition can we understand the circumstance that the Strandegaard people master the entire ancient Ertebølle technique and still use the forms comprising that culture, and at the same time they have learnt something of the new arrivals," a new and better pottery. "The Strandegaard people must be descendants of the people of the Ertebølle Culture, the Kitchen Midden people. Opposite them we have the immigrants, the soil tillers, the farmers in Havnelev. They brought grain and domestic animals with them, as well as flint polishing and good pottery; but they were almost strangers to flint shaping, especially the technique of flaking; however, they saw the handy and quite effective flake axes of the natives and endeavoured to imitate them"—but without attaining to the elegant workmanship of the older population. MATHIASSEN concludes with the following words on the Dolmen Period Culture: "The whole complex, rich and representative, as we find it in Havnelev, seems to appear suddenly and with great force, as would be the case with the immigration of a vigorous, not too small body of people who rapidly occupied most of our country's fertile agricultural areas."

DEGERBØL's examination of the bones found in the settlements of the Late Stone Age also suggests a new immigration. He points out (1939 p. 88) how surprisingly small is the role played by hunting in the Megalithic settlements. As MATHIASSEN (1940) says, this would be incomprehensible if the Megalithic people were an ancient hunter folk.

27) Contemporaneity of the Old Hunter Culture with the New Neolithic Farmer Culture.

RYDBECK (1928) was the first to make the suggestion that the Ertebølle Culture continued to exist well into the Late Stone Age, so that the old hunter culture and the newly-arrived farmer culture existed side by side. A geological proof of the correctness of this view was supplied by TROELS-SMITH by means of a pollen-analytical dating of the Brabrand settlement (1937). It turned out that this settlement was later than had been supposed, and that at any rate its later part was contemporaneous with the Late Stone Age. The pollen-analytical guide horizon employed was the fall in the curve of the Oak Mixed Forest, which, according to JESSEN's pollen-analytical Troldebjerg dating, was contemporaneous with the Early Passage Grave Period. It is true that in the present work I have shown that the course described by the curve need not be contemporary, as it was due to human agency. This, however, does not detract from TROELS-SMITH's evidence; indeed, it proves directly the contemporaneity of the later part of the Brabrand find with the agriculture of the Late

Stone Age. An archaeological proof of the contemporaneity of an Ertebølle settlement with the passage grave period was recently given by BEDKER (1939). As a matter of fact, DEGERBØL had previously pointed out that there were bones of domestic animals in a typical Ertebølle kitchen midden (DEGERBØL 1928). Furthermore, the Gudenaa culture—the Jutlandic "mesolithic" inland culture—lived on in the Late Stone Age, more or less unaffected by the Neolithic tiller culture (see MATHIASSEN 1937).

28) Vegetal Developments and the Land Occupation in Middle Jutland's Heath Areas.

The great heath plains of Middle Jutland were not always covered with a continuous heath. JONASSEN's pollen diagram (1936) from the lake Kragsø on the Karup plain has only about 10 per cent. of *Ericaceæ* pollen in the Atlantic period. My own analyses from Søby Sø on the great Arnborg heath plain confirm JONASSEN's results. The samples were taken by drilling from ice in the middle of the lake, so that trees on the shore cannot have affected the pollen flora very much. Nevertheless the *Calluna* pollen in the post-glacial warmth period reached less than 10 per cent. We find still less heather pollen in gyttja from heath lakes lying on the margin (see the Bølling diagram Plate V) or outside (see the Hostrup diagram Plate VI) of the heath plains themselves.

On the other hand, the pollen analyses do show that throughout the entire post-glacial period the vegetation in the Middle Jutland heath areas to some extent had a character of its own compared with that of the rest of the country. In Atlantic times the plains were wooded with oak forest containing many birches, with light enough for grasses and heather to thrive. Curiously enough it is not the heather but the grasses that lead in the NTP diagram from Bølling Sø (see Plate IV); it is not until sub-Atlantic times that the curves for *Gramineae* and *Ericaceae* cross; conditions are similar in lakes Søby and Hostrup. This too argues against the occurrence of extensive heaths in the post-glacial warmth period, and one gets the impression that herbaceous plants played the predominant part in the ground flora of the open birch-oak forest of that time. It is somewhat difficult to find any parallel to this type of forest in the present day. The oak-birch heath association (*Quercetum ericetosum*, TANSLEY l. c.) in England and the *Quercetum-Betuletum* (see TÜXEN 1937) in NW Germany, with which one might be tempted to compare it on account of the names, are actually rather different in character. On the other hand it must of course be borne in mind that the pollen flora provides information only about the relative frequency of the various plants, but actually we cannot know whether these plants, for example birch and hazel, grew together in the same association. In other words, it is possible that the vegetation in the heath areas belonged to quite different types The grassy oak forest with elm, linden, alder, hazel and herbaceous plants may have been associated with the river valleys, whereas the most unfertile areas may have been covered with an oak-birch heath association. See also FÆGRI's discussion on the sub-Boreal forests in Jæren (FÆGRI 1941, p. 53 ff.). The pollen diagrams from the Jutland heath areas occupy a sort of mid-way position between the normal Danish diagrams and those from Jæren.

In any case, the vegetation in the mid-Jutland areas was more open to the light, a fact which seems to have caused the land occupation there to follow another course than that in the rest of Denmark. In the present diagrams (Bølling Sø and Hostrup Sø) we can find no evidence of clearance fires, the birch has no distinct, transitory increase, and the fall in the curve of the Oak Mixed Forest is little pronounced. This does not mean that there was no settlement in the area; as usual, *Plantago* immigrates at the beginning of the sub-Boreal zone and, together with *Rumex*, attains to a relatively high frequency. Cereal pollen also appears together with the immigration of *Plantago*. Unless the characteristic land-occupation phase is undeveloped in the diagrams owing to slow sedimentation, we must assume that the relatively slight density of the forest and its wealth of grass made a clearance fire unnecessary.

V. Forest Decline in Sub-Boreal and Sub-Atlantic Times.

29) The Sub-Boreal Forest.

We have seen that man left his mark on the development of the Danish forest already in the Late Stone Age, the virgin forest in large parts of the country being changed into cultural forest. The reason why this transformation of the forest proceeded at such a surprising rate lies in the extensive character of the farmer culture and the motility of the settlement, as is evidenced by LA COUR's investigation (1927) on Zealand's earliest settlements, and pointed out by HATT (1928, 1937) as a characteristic feature of the Late Stone Age and the Bronze Age.

At the same time, however, this entails that the forest as a whole remained untouched throughout the sub-Boreal period. It would be quite erroneous to assume that the areas showing indications of Neolithic settlement were cleared of forest at the same time. As a matter of fact the pollen analyses make it quite clear that the woodless regions in the Stone and Bronze Ages cannot have been considerable at all. There were clearings around the settlements as long as the latter were inhabited, but the pollen analyses suggest that the arable land was of small extent; much the greater part of the utilized areas must have been covered with forest in which the cattle sought their food. In all probability animal husbandry meant at least as much as grain growing to the Neolithic farmer (cf. G. SCHWANTES 1939, p. 168).

Nor were the heaths of any great extent in the sub-Boreal period. As I have pointed out on another occasion (1939), SARAUW's (1898) much-quoted suggestion that many tumuli in Jutland were built of heath-turf is not supported by fossil analyses and is probably incorrect. The NTP diagram from Lake Bølling displays characteristic antagonism between *Calluna* and grasses, which indicates that *Calluna* temporarily dominated abandoned fields; but in the long run it seems that the forest was always able to regenerate.

30) Sub-Atlantic Forest Destruction.

In the introduction it was stated that the arrival of the farmer people in Denmark in the Dolmen Period signified a turning point in the development of Danish vegetation; the virgin forest was transformed into cultural forest. A new and equally radical crisis was inaugurated at the beginning of the sub-Atlantic period, and again the change seems to have taken place with astonishing rapidity. Actually, three things happened more or less simultaneously: Extensive bogging of low areas, a change in the composition of the forest from oak to beech, and finally a continually spreading forest demolition. Evidently the first two were the result of a climatic oscillation from a dry climate with warm summers to a moist one with cool summers. The destruction of the forest must be laid at man's door.

The shrinkage of the forest is recorded in the pollen diagrams by means of a marked advance for the pollen of herbaceous plants and—in heath plains—of *Calluna*. This change, which of course is best investigated in lake and fjord sediments, is actually a very good pollen-analytical horizon; but here, as with the land-occupation phase, it is a fact that we have no guarantee of the contemporaneity of this phase in the various diagrams. In fertile regions the decline of the forest is shown only by the curve for the herbaceous plant pollens; in the heath areas it is just as much the curves for *Calluna* and *Sphagnum* (see diagrams from Bølling Sø, Plate V, and Hostrup Sø, Plate VI). It is in this period, as already stated, that the first great heath areas are formed (JONASSEN 1935, JESSEN 1935).

It is difficult to obtain suitable diagrams for comparison from our neighbouring countries; either no attention has been given to the pollen of herbaceous plants, or the diagrams are not taken from homogeneous gyttja series, which is necessary if the pollen curves of the herbs are to be employed as a measure of the forest decline. One exception in this respect is Jæren, whence FÆGRI has a number of very instructive diagrams showing a still more abrupt rise in the curve for herbaceous plants or heather at the beginning of the sub-Atlantic zone than that found in Denmark. FÆGRI connects this sudden deforestation with the climatic change, though he considers that man's clearances precipitated the destruction of the forest and caused it to be so catastrophic in character. Thus according to FÆGRI the *Calluna*-heath in Jæren primarily is a type of vegetation that is governed by climate; this harmonizes with the fact that in Jæren the heath was already widespread in Late Glacial times, before the forest displaced it (FÆGRI 1935 S. 32). In Denmark there was no *Calluna* heath in the Late Glacial Period (IVERSEN 1934); and, if we disregard the heath on the most unfertile plains, we must take it that the great heath areas of historic times, like those in Northwest Germany (OVERBECK and SCHMITZ 1931, TÜXEN 1938, MAGER 1930-37), were the result of human agency; this is indicated i. a. by the fact that the pollen frequency, not only of heather but also of the herbaceous plants (not least the weeds), rises quickly in the early part of the sub-Atlantic period. On the other hand we must not underrate the concurrent importance of climate, even if its effects were chiefly indirect (cf. JESSEN 1935, p. 213).

Outside the Jutland heath plains the destruction of the forest seems to have been caused exclusively by clearing. But if this is so, how shall we explain the radical change that took place in the beginning of the Iron Age? Why do the great woodless areas appear now for the first time if the soil tillers of both Stone Age and Bronze Age organized forest clearances throughout the sub-Boreal period? I can find only one explanation: In the beginning of the Iron Age there must have been a complete change in the form of agriculture. The primitive, extensive method described in Note 22 was no longer used, new methods having been adopted.

In this connection it is of interest to recall HATT's demonstration (1937) of a change in the permanency of settlement in the Iron Age. Previously the people often moved about; now in the Iron Age, the permanent, regular settlement, the village culture, began. It is presumable that this development has something to do with the changed climatic conditions, but greater importance must doubtless be credited to the technical improvements in conjunction with the use of iron.

How did this new form of culture affect the vegetation? One might well imagine something in the direction of the "lövängkultur" described by M. SJÖBÆK (1932), a culture that played such a great role in South Sweden throughout the historic period and also is known in Denmark (cf. BÖCHER 1939). This "lövängen" ("leafy meadow") is a peculiar mixture of grass and coppice, the same area being covered sometimes with grass, at other times with bushes and low trees. In marked contrast to the aforesaid low forest for browsing this "löväng" was carefully preserved; the cattle were not allowed to come there; both foliage and grass were used for winter feed. This then was a form of agriculture of a rather high order, and there is no reason for believing that it was known in the Late Stone Age. It scarcely belongs to a sub-Boreal climate, but is much rather an adaptation to a cool and moist, sub-Atlantic climate. It presupposes a large measure of winter feeding, whereas in the Stone Age the cattle undoubtedly browsed outside throughout the year; they were not taken indoors and fed in the byre in winter time until the Iron Age (see G. HATT 1937, p. 135). It also agrees with SJØBÆK's conception of the "löväng culture" as being closely associated with the origin of village culture, which in fact is traceable back to the Iron Age. The finds of sickles and leaf-knives in Iron Age also agree very well with this theory (see STEENSBERG 1939).

If we assume that in the Iron Age the primitive low-forest form of husbandry was abandoned in favour of one like the "löväng-culture" we obtain a natural explanation of the sudden change in vegetation development, which is manifested especially in the greatly increased pollen frequency of the herbaceous plants.

VI. Sub-Boreal Settlements.

31) Pollen-Analytical Evidence of Neolithic Settlements.

In small bogs a Neolithic settlement near by will be reflected very distinctly in the pollen flora. All the characteristic changes consequent to forest clearance and the subsequent regeneration are locally intensified, whereas clearances not directly affecting the environs of the bog have only slightly affected the pollen-floristic development of the bog. Thus pollen diagrams from small deep bogs will reveal whether there was a Neolithic settlement near the banks of the former lake.

An excellent example of this is provided by Sækkedam in North Zealand, from which NILSSON (l. c. Plate 7, No. 8) has a fine diagram. Just over zone border VII–VIII (in NILSSON called V–VI) there is a very pronounced "land-occupation phase" of markedly episodic character. *Ulmus*, *Tilia* and *Fraxinus* disappear almost completely in some analyses, whilst *Betula* rises from 9 to almost 40 per cent., and *Corylus* from 30 to 130 per cent. This episode is in fact registered in the sedimentation, as just here we find a thin bed of clay gyttja (16 cm) right in the middle of the almost 4 metre deposit of homogeneous gyttja. These circumstances may be regarded as evidence that in the Dolmen Period there must have been a brief era of settlement on the banks of the lake. Thus it is very interesting that in this bog, during the excavation of a ditch running through Sækkedam, the workmen found a thin-butted axe of greenstone and a thin-butted polished flint axe, that is to say artefacts of the Dolmen Period. These finds induced the geologist N. Hartz and the conservator G. Rosenberg of the National Museum to make excavations along the margin of the lake; they did not succeed in finding a settlement, but came across i. a. a stone pavement that undoubtedly was laid by man (see JESSEN 1920, p. 36 f.). Possibly the settlement lies higher up, but it will scarcely be so easy to find it, as the area is timbered.

32) Troldebjerg.

The "village" discovered, excavated and published by J. WINTHER (1935, 1938) is dated to the Early Passage Grave Period. The botanic and geological features at Troldebjerg (Gammellung bog) were examined by JESSEN (1938), the result being that for the first time it was possible to establish the position of the Late Stone Age in the pollen diagram. It appeared that the culture deposit, and with it the Early Passage Grave Period, corresponded to the lower part of zone VIII; this means that the important zone border VII–VIII is practically contemporary with the beginning of the Late Stone Age.

In the diagram from Gammellung bog (see JESSEN l. c., fig. 3) the zone border VII–VIII is developed in typical fashion; the *Ulmus* curve falls abruptly. On the other hand the land-occupation phase is not quite characteristic, for both the *Betula* maximum and the *Corylus* maximum are missing. This is curious, inasmuch as one would have expected a particularly pronounced occupation phase just at this locality. As will be shown below, it was in fact registered in the pollen flora of Gammellung, but it never appeared in the published diagrams.

In his monograph WINTHER (1935, pp. 57—58) refers to some peculiar finds of bull heads with the marks of blows in the frontal bone. The heads were found out in Gammellung bog, which in the Troldebjerg era was a lake. According to Winther these heads must have been sailed out into the lake and sunk there as an offering to the gods. Thereafter they would lie in gyttja, so that they would be particularly suitable for pollen-analytical dating. Fortunately it happened that DEGERBOL had taken some gyttja samples from the cavities of two of these skulls and sent them in to the Geological Survey of Denmark with the request for a pollen-analysis. They were accompanied by a sample from a fourth skull, that of a bull, found later. The microscopical examination showed at once that the heads true enough had lain in lake gyttja. The analysis gave the following result:

	I		II		III	
Betula	14		8		7	
Pinus	7		8		4	
Alnus	60		69		74	
Ulmus	1	18	3	16	1	9
Tilia	1		1		1.5	
Quercus	15		11		6	
Fraxinus	1		1		0.5	
Fagus	0.3		—		—	
Corylus	46		62		76	
Plantago	0.3		0.7		—	
Rumex	2		0.7		—	
Armisia	0.6		—		—	
Chenopodiaceae	1.5		0.7		0.5	
Gramineae	1		2		2	
Cyperaceae	6		4		1	
Tree-pollen total	330		140		179	

Clearly these analyses are sub-Boreal; but if they are compared with JESSEN's diagrams (l. c., fig. 3) one finds no corresponding pollen spectrum. They have their place in the bottom of the curve minimum for the Oak Mixed Forest between Analyses Nos. 3 and 4, but are outstanding on account of their extraordinarily high *Corylus* percentage and a higher *Betula* percentage. Sample I seems to reveal a temporary *Betula* maximum, and all three a particularly well-developed *Corylus* maximum. By this it is proved that at Troldebjerg too there is a pronounced occupation phase; the fact that it is absent from JESSEN's diagram, plotted from the edge of Gammellung bog, is due presumably to the sedimentation boundary of the gyttja deposit here having been reached just at the time when the land occupation occurred. The deposits only began to grow again when the *Cyperaceae* occupied the former lake bottom, but by that time the occupation phase itself was already passed. JESSEN (l. c., p. 128) mentions the possibility of such a lacuna in the sedimentation profile in this locality. He also suggests that a lowering of the ground-water level due to climatic changes may have taken place, pointing out that the settlement at Troldebjerg took place in a period with a dry climate, the result being that the alder scrub advanced on to the gradually dessicated surface nearest the shore (see WINTHER 1935, p. 61).

33) Barkær, the Dolmen-Period Settlement near the Korup Sø Section.

The Barkær settlement was excavated by P. V. GLOB, but has not yet been published. The find is mentioned by BRØNDSTED (1938 pp. 145–146 and 341) and MATHIASSEN (1940 p. 38). It is a small village; it was possible to prove the existence of eight houses on the site, and presumably there were more. The artefacts are purely Neolithic, with no evidence of influence from the Ertebølle culture. According to MATHIASSEN (l. c.) it is apparently a little later than the Dolmen Period settlement of Havnelev in Zealand; this agrees well with the results of the pollen analyses. The first traces of Neolithic agricultural activities in the pollen diagram occur a little way below the local land-occupation phase in Korup Sø, which is assumed to correspond to the Barkær settlement. Accordingly, Barkær cannot represent the earliest period of the Dolmen Period.

It may perhaps seem rather hazardous simply to place the "land occupation phase" to the Dolmen Period. One might ask whether it might not have been connected with the Single Grave culture, which was brought to Denmark by a new people. I am unable to procure any definite counter-proof, but it seems little probable to me. A village like Barkær, lying on Lake Korup, must necessarily be traceable in an increase of the herbaceous pollen frequency. The first distinct increase occurs exactly in the land-occupation phase (cf. also the Dolmen-Period finds in the Sækkedam section, Note 28)[1]).

34) The Mesolithic Bloksbjerg Settlement in the Ordrup Mose Section.

This settlement was examined and described by WESTERBY (1927). About two years ago Dr. TH. MATHIASSEN together with the present author made an excavation at Bloksbjerg for the purpose of chronologically placing the settlement by pollen analysis and in relation to the transgressions. The laboratory work on the material is not yet completed, but it appears that the settlement extended over a very considerable period, its earliest part dating back to an early phase of the high-Atlantic transgression, whereas the latest part goes into the sub-Boreal period and, judging by all the signs, was still in existence when the new people made its occupation. The abnormally high percentage of *Chenopodiaceae* in the herbaceous pollen diagram, occurring right up to the clearance-fire deposit, seems to confirm this, even if one cannot rule out the possibility that the *Chenopodiaceae* pollen may have come from the natural shore vegetation.

In the upper deposits in the settlement WESTERBY (l. c., p. 41) found artefacts of the Late Stone Age, which apparently must be credited to the new people who made the occupation evidenced by the pollen curves.

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[1]) In a work now in hand regarding the geological associations of the Dyrholm find TROELS-SMITH (l. c., 1942) has succeeded in showing that the occupation phase in Djursland must be connected with the Dolmen Period. The evidence is provided by a pollen-analytical dating of a thin-butted polished flint axe and a Single Grave celt.

35) Bundsø.

This large rich settlement of the Late Stone Age was excavated and described by Mathiassen, Jessen and Degerbol (l. c.). The pollen diagram (Jessen 1938, fig. 6 and 1939 b, fig. 31) reveals a very marked minimum for the curve of the Oak Mixed Forest in the strata corresponding to the culture. As might have been expected, the forest was thus a copsewood under the distinct influence of culture; the alder predominates strongly. Mathiassen places the Bundsø find to about the middle or just after the middle of the Passage Grave Period. Accordingly, the occupation phase in the Dolmen Period, with its ephemeral birch and hazel maxima succeeded by a first minimum in the curve of the Oak Mixed Forest, lies a good way below in the diagram. It is significant that in this very diagram we find—simultaneously with the large Bundsø settlement—another minimum in the Oak Mixed Forest curve, this time without a birch maximum. Here we have further evidence that the curve oscillations for the Oak Mixed Forest in the sub-Boreal period were the results of cultural influences and therefore cannot be used for correlations. It is also worth noting that among the elements of the oak forest the chief effects are on the linden (and the elm), of which the soft, sappy leaves must have been more attractive to the domestic animals than those of the oak. The pollen of the linden disappears almost completely from the culture deposits (see Jessen 1939 b Fig. 32), though in diagrams with less cultural influence the linden is fairly high in the sub-Boreal period which, climatically, would be favourable to that tree.

VII. Description of Localities.

36) Ordrup Mose (Klampenborg Fjord) Plate I.

a. The Section.

On a previous occasion I published a description of the section (1937, pp. 226–227); at the bottom are late-glacial and boreal freshwater deposits, then 4½ m of marine gyttja overlain by 21 cm of lake marl and a thin stratum of mouldered peat. In the marine deposits it was possible by means of diatom-statistic analyses to distinguish between three marine transgressions: Early Atlantic, High Atlantic and Late Atlantic, though the latter partly overlaps the Atlantic-sub-Boreal border as defined here (cf. Note 25). The *per mille* diagram reproduced in this work comprises only the upper end of the series. The analyses are all entirely new. In accordance with the altered definition the zone border VII–VIII has been laid somewhat earlier than in the diagram published in 1937 (No. 5 instead of No. 10).

b. Curves of Absolute Pollen Frequency (per sq. cm of slide). See Pl. I, E.

The heavy decrease in the pollen frequency from the analysis below the fire deposit (No. 11) to that above the fire deposit (No. 13) is not due to any change in the sedimentation. On the other hand, the pollen frequency per sq. cm in the fire deposit itself will be distinctly reduced by the large quantity of charcoal. Consequently we cannot reckon with the analysis from the lower edge of the fire deposit (No. 12); indeed, the absolute pollen density there was extremely low; but if the charcoal could be removed from the mud the pollen count would be much higher than in the analysis immediately above the fire deposit. This is very natural, as the lower edge of the charcoal will contain a mixture of pollen from the mud underlying the charcoal and from the charcoal deposit itself. Unfortunately we have no sample from the middle of the thin fire deposit.—The absolute pollen frequency in the uppermost analyses (Nos. 15–18) are not suitable for unqualified comparison with the others, as the sediment changes between Nos. 14 and 15 from marine gyttja to lake marl, which had to be treated with hydrochloric acid. The main thing, however, is that the pollen density increases rapidly in the marine mud overlying the fire deposit, and that the increase seems to continue smoothly in the the lake marl.

c. Domestic Ox Bone from Ordrup Mose Settlement Deposit.

The bone was handed in to the institute by Mr. Svend Jørgensen and had been found during the excavation of a ditch near the Ordrup bog section, but nothing definite was known as to the depth at which it was found. Dating depended on the micro-flora in some mud from cavities in the bone. *Campylodiscus clypeus* was especially common; this brackish water diatom predominated in the lower part of the lake marl (analyses Nos. 14–16). The pollen flora gave the same result: *Salix* ½%, *Betula* 9%, *Pinus* 14%, *Alnus* 44%, *Ulmus* 3%, *Tilia* 2%, *Fraxinus* 2%, *Quercus* 25% (162 tree pollen), as well as *Corylus* 35%, *Gramineae* 3%, *Cyperaceae* 10%, *Chenopodiaceae* 2%, *Compositae* 3%, *Plantago* 2%. This spectrum lies closest to Analysis No. 14; we are above the fire deposit but below the minimum point of the Oak Mixed Forest curve.

A horse bone found on the same occasion, handed in by Mr. Jørgensen and determined by Dr. M. Degerbøl, could not be dated definitely by means of the micro-flora. All the same it belongs at any rate to somewhere above the fire deposit and is of sub-Boreal age. Possibly it came from the same settlement as the domestic ox bone, but is slightly later. In any case it lay in *Cyperaceae* peat, not in brackish water mud. In all the examined sections in Ordrup Mose the lake marl was only of slight thickness and was overlain by *Cyperaceae* peat.

37) Søborg Sø, Plate IV.

Søborg Sø was a large lake, now dried up, in northeastern Zealand, and in certain periods was connected with the Kattegat, partly through a narrow, winding watercourse running northwards with a well-protected threshold now 5 metres above sea level, partly through a narrow arm from the southeast end of the lake basin to Esrom Fjord. The latter connection seems to have been interrupted by a raised beach at an early period. In a previous publication (1937) I followed MILTHERS' (1935) example in referring only to the northern connection with the Kattegat; subsequently by means of excavations I demonstrated the narrow outlet to Esrom Fjord which RØRDAM stated much earlier (1892). On the other hand, like MILTHERS I have been unable to find any confirmation of RØRDAM's alleged extension of Søborg Sø southwest of Fjællenstrup. Four times in the post-glacial period Søborg Sø was a fjord, apparently corresponding to four transgressions which can also be proved in other parts of the country (see IVERSEN 1937, as well as TROELS-SMITH 1937 a and 1942). A renewed, thorough examination of the interesting fjord system at Søborg Sø would be desirable.

The section on which the diagram in Plate IV was plotted was described in an earlier paper (1937), where there is also a larger diagram. The new diagram comprises only the upper part of the section and is based on new and more comprehensive pollen counts. It should be observed, however, that the figures shown for tree pollen are only partly of importance to the tree-pollen diagram; the main object was to get the curves for herbaceous pollen, and therefore, when the latter required very extensive pollen counts, I desisted from separating the trees when the tree-pollen analysis seemed to be sufficiently assured.

38) Snarup Mose, Plate VII.

On an islet in the large Snarup Mose in South Funen there is a settlement of considerable size; it was examined by the National Museum in collaboration with Geological Survey of Denmark in the summer of 1936. The find has not been published yet, except for a communication by MATHIASSEN (1937 b).

The pollen diagram is from the bog round about the islet, but a good distance from the shore. The *Hedera* curve describes the normal course, falling simultaneously with the *Ulmus* curve and shortly after *Fraxinus* becomes common. The zone border VII–VIII is thus well developed. A little way up in Zone VIII there is a typical land-occupation phase; *Plantago* intrudes here. On the extreme right the occurrence of *Chenopodiaceae* pollen is indicated by a discontinuous silhouette, which shows that there was settlement in Snarup Mose no fewer than three times. The first (Analyses No. 4–6) coincide with the Mullerup Period; the second is much later (Analyses Nos. 18–19) and belongs to the close of the Atlantic period. The final settlement occurs in the Late Stone Age. This shows how cautious one should be with surface finds; they may have originated in any of these three settlements.

In the land-occupation phase there are the same stages as elsewhere. The birch curve has a marked but transitory rise, the hazel attains to a maximum shortly after the birch. *Plantago* appears at once with the occupation, but only becomes common in the course of time. The Oak Mixed Forest curve falls as usual and has its minimum while the *Plantago* curve reaches its maximum.

39) Korup Sø (Plates II and III).

In the Stone Age Korup Sø was connected with Kolind Sund by means of a narrow and winding, but deep stream (see A. Jessen 1920); the salt water made its way into the basin as early as the close of the Boreal period. The section was described in my 1937 publication, where there is also a diagram.

The special diagram (Plate III) is built on new and, as will be seen, very extensive counts. In the upper and lower parts of the survey-diagram (Plate II), comprising earlier and less comprehensive counts (about 300 tree pollen per analysis), I have coupled the analyses together in pairs, so that the number of pollen became large enough to permit of plotting regular curves for infrequent pollen types as well. This procedure is defensible in the case of a survey-diagram like the present. The more detailed course of the pollen curves in the lower part of the diagram will be found in my 1937 publication, p. 230. As regards Barkær, the Dolmen Period settlement on Korup Sø, see Note 33.

In the new diagram the zone border is laid in conformity with the new definition, and therefore it is moved from Analysis No. 7 to No. 4.

40) Bølling Sø (Plate V).

The dried-up Bølling Sø lies on the verge of the large Karup heath plain, surrounded on all sides by unfertile sandy soil. The greater part of its rather shallow basin is occupied by late-glacial deposits. The post-glacial gyttja is greatly compressed; at the deepest spot found the whole of the Atlantic, sub-Boreal and sub-Atlantic period measures less than one metre. This fact is connected with the very slow sedimentation in this oligotrophous region; on the other hand the samples are very rich in pollen. No lacuna is observable in the pollen diagram; the development of the forest stands out clearly in the diagrams. I have previously published a survey-diagram from Bølling Sø (1937 b). The new diagram was plotted on the basis of newly collected material (1939). Zone border VII–VIII is very distinct, the *Fraxinus* increase and the *Ulmus* decrease are typical, and *Hedera* is unusually sparse in this diagram. The land-occupation phase is indistinct (cf. Note 28). The sub-Atlantic climatic change is manifested in a rapidly rising percentage of *Sphagnum* spores. At the same time the destruction of the forest begins to gather speed. The disproportionately heavy rise in cereal pollen in Analysis No. 17 is probably due to the introduction of *Secale*, whereas the rise in *Rumex* may be explained by the washing out of the soil (*Rumex acetosella*).

41) Hostrup Sø (Plate VI).

Hostrup Sø lies in an unfertile diluvial-sand region not far from Tinglev heath plain in South Jutland. Boring was carried on from a boat in the south end of the lake. The *per mille* diagram includes only the upper part of the section. The zone border is well developed, with a fall for *Ulmus* and *Hedera*. The occupation phase is very indistinct, though there is a low maximum for the *Betula* curve and a faintly developed minimum in the curve of the Oak Mixed Forest. In the Atlantic period the entire region was forest-clad; in the sub-Boreal period there is a slow increase in the pollen frequency of herbs, *Calluna* and *Sphagnum*. In Analysis 12 there is a fairly rapid rise of the curve for *Calluna* and *Sphagnum*; presumably the large heath-bogs north of Hostrup Sø commence then. In the NTP diagram *Calluna* advances at the expence of the grasses. Possibly this level designates the transition to the sub-Atlantic period, although in the diagram it is marked by Analysis 16, where swamping again increases. Uppermost in the diagram the *Plantago* curve drops abruptly and *Rumex* (cf. *acetosella*) rises correspondingly (cf. the Bølling diagram).

42) Braband Sø (Plate VII).

Braband Sø, near Aarhus in Jutland, is known from the Mesolithic Braband settlement which was recently dated by pollen analysis by Troels-Smith (1937). In the present case the diagram is redrawn, for *Fraxinus* is included in the curve for *Quercetum mixtum*, which was not the case in Troels-Smith's published diagram. In addition, curves have been plotted for *Hedera* and *Plantago* after Troels-Smith's original analyses, though it should be observed that here the analyses are coupled together in twos or in threes (cf. Note 39).

The zone border VII—VIII is handsomely developed, with decreases for *Ulmus* and *Hedera* and increase for *Fraxinus*. The land-occupation phase follows almost immediately above the zone border. *Plantago* intrudes as usual in the beginning of the land-occupation phase and attains the maximum at the same time as the curve for the Oak Mixed Forest is at the minimum. For the rest see TROELS-SMITH's description of the section (1937).

Literature.

ASSARSON, G. o. GRANLUND, E. 1924: En metod för pollenanalys av minerogena jordarter. Geol. Fören. Stockh. Förh. *46*.

BECKER, C. J. 1929: En Stenalderboplads paa Ordrup Næs i Nordvestsjælland. Aarb. f. nordisk Oldkyndighed og Hist. 1939.

BRØNDSTED, JOHS. 1938: Danmarks Oldtid I. Stenalderen. København.

BÜSGEN, M.: *Cupuliferæ*. Lebensgesch. d. Blütenpfl. Mitteleuropas. Bd. II 1. Abt.

BÖCHER, T. W. 1933: Lyngheden i kulturhistorisk Belysning. Naturens Verden *23*, 1.

LA COUR, VILHELM. 1927: Sjællands ældste Bygder. København.

DEGERBØL, M. 1928: Pattedyrlevninger fra Langøfundet. Aarb. f. nord. Oldk. og Hist. III. R. *18*. København.

— 1939: see Mathiassen, Th., Jessen, K. og Degerbøl, M. 1939.

DENGLER, A. 1935: Waldbau auf ökologischer Grundlage. Berlin.

ERDTMAN, G. 1936: New Methods in Pollen analysis. Sv. bot. Tidskr. *30* p. 154.

FIRBAS, FR. 1937: Der pollenanalytische Nachweis des Getreidebaus. Zeitschrift f. Botanik Bd. 31.

— 1938: Über einige Ergebnisse der Pollenanalyse für die jüngere Waldgeschichte Deutschlands. Vortrag. C. L. Schrader. Hannover.

FRÖMAN, I. 1932: De nordligaste lokalerna i Sverige för vild murgröna (Hedera Helix L.) I. Svensk Botan. Tidskr.

FÆGRI, KNUT. 1935: Quartärgeologische Untersuchungen im westlichen Norwegen. I. Über zwei präboreale Klimaschwankungen im südwestlichsten Teil. Bergens Mus. Årb. Nat. r. Nr. 8.

— 1940: Quartärgeologische Untersuchungen im westlichen Norwegen II. Zur spätquartären Geschichte Jærens. Bergens Mus. Årb. 1939—40 Nat. r. Nr. 7.

GAMS, H. 1925: Die postglaziale Wärmezeit. Geogr. Zeitschr. 31.

— 1937: Vorschlag zur Vereinheitlichung der NBP- und Sporenzeichen. Innsbruck im Dez. 1937 (Issued as typewritten MS.).

— 1938: Vorschlag zur Vereinheitlichung der Zeichen für Mikrofossildiagramme .... Chronica Botan. 4. (This paper unfortunately has not been accesible to me).

GODWIN, H. 1940: Studies of the post-glacial history of the British vegetation III Fenland pollen diagrams. Philos. Transact. Royal Society London. Sér. B. Vol. 230.

GRADMANN, R. 1933: Die Steppenheidetheorie. Geogr. Zeitschr. *39*.

GROSS, H. 1935—36: Die Steppenheidetheorie und die vorgeschichtliche Besiedlung Ostpreussens. Altpreussen 1935—36.

— 1939: Moorgeologische Untersuchung der vorgeschichtlichen Dörfer im Zedmar-Bruch. »Prussia«. *33*. Königsberg.

HATT, G. 1928: Review of: Vilhelm la Cour: Sjællands ældste Bygder. Naturens Verden 12. København.

— 1937: Landbrug i Danmarks Oldtid. København.

HESS, R., und BECK, R. 1916: Der Forstschutz, ein Lehr- und Handbuch. Bd. 2: Schutz gegen Menschen, Gewächse und atmosphärische Einwirkungen. Leipzig u. Berlin.

HOLMBOE, JENS. 1921: Bergfletten i Norge som vild og plantet. Bergens Mus. Årb. 1918—19.

IVERSEN, JOHS. 1934: Moorgeologische Untersuchungen auf Grönland. Ein Beitrag zur Beleuchtung der Ursachen des Unterganges der mittelalterlichen Nordmännerkultur. Medd. Dansk Geol. Foren. Bd. 8. København.

— 1936: Biologische Pflanzentypen als Hilfsmittel in der Vegetationsforschung. Dissertation. København. (Medd. fra Skallinglaboratoriet).

— 1937: Undersøgelser over Litorinatransgressioner i Danmark. Medd. Dansk Geol. Foren. Bd. 9, H. 2. København.

— 1937 b: Pollenanalytiske Tidsbestemmelser af midtjyske mesolitiske Bopladser, see Mathiassen, Th. 1937.

— 1939: Planterester i tre Høje i Haderslev Amt. I H. C. Broholm og Margrethe Hald: Skrydstrupfundet. Nord. Fortidsminder. 3.

— 1940: Vegetations- og Klimaperioderne i Danmark efter Istiden, og Geologisk Vidnesbyrd om »Svedjebrug« i Danmarks yngre Stenalder. Naturhist. Tidende 4. København.

JENSEN, P. BOYSEN. 1929: Studier over Skovtræernes Forhold til Lyset. Dansk Skovf. Tids. 14.

JESSEN, AXEL. 1920: Stenalderhavets Udbredelse i det nordlige Jylland. Danm. Geol. Unders. II. Række, Nr. 35. København.

JESSEN, KNUD. 1919: Trækul fra Bronzealders Bopladser. Aarb. f. nordisk Oldk. og Hist. København.

— 1920: Moseundersøgelser i det nordøstlige Sjælland. Danm. Geol. Unders. II. Række, Nr. 34.

— 1935: Archaeological datings in the history of North Jutland's vegetation. Acta Archaeologica Vol. V. København.

— 1935 b: The composition of the forests in northern Europe in epipalæolithic time. With the assistance of H. Jonassen. Kgl. D. Vidensk. Selsk. Biol. Medd. 12.

— 1938: Some west Baltic pollen diagrams. Quartär Bd. I. Berlin.

— 1939: Naturforholdene og Mennesket i Danmarks Oldtid. Fortid og Nutid XIII.

— 1939 b: see Mathiassen, Th., Jessen K. og Degerbøl, M. 1939.

JONASSEN, H. 1935: Et Pollendiagram fra Karupfladen. Botanisk Tidsskr. Bd. 43.

KUPFFER, K. R. 1905: Bemerkenswerte Vegetationsgrenzen im Ost-Balticum. Verh. Bot. Ver. Prov. Brandenb. 1904. Berlin.

LANGE, AXEL. 1930: Misteltenen i Danmark. Bot. Tidsskr. Bd. 41. København.

LINKOLA, K. 1916: Studien über den Einfluss der Kultur auf die Flora in den Gegenden nördlich vom Ladogasee. I. Allgemeiner Teil. Acta Soc. Fauna et Flora Fennica 45: 1.

— 1921: II. Spezieller Teil. Ibid. 45: 2.

LOSERT, H. 1940: Beiträge zur spät- und nacheiszeitlichen Vegetationsgeschichte Innerböhmens. I. Der »Kommerner See«. Beih. z. Bot. Centralbl. Bd. LX. S. 346 ff.

MAGER, F. 1934: Die Rodungsfrage in Altpreussen. Jahresber. 1933/34 d. Königsberger Univ.-Bundes.

— 1930—37: Entwicklungsgeschichte der Kulturlandschaft des Herzogtums Schleswig in historischer Zeit. Veröff. d. Schleswig-Holst. Universitätsges. Nr. 25. I, II.

MATHIASSEN, TH. 1937: Gudenaa-Kulturen. En mesolitisk Indlandsbebyggelse i Jylland med Bidrag af Johs. Iversen. Aarb. f. nordisk Oldkyndighed og Hist.

— 1937 b: Klosterlund og Snarup Mose. Fra Nationalmuseets Arbejdsmark 1937.

— 1940: Havnelev-Strandegaard. Et Bidrag til Diskussionen om den yngre Stenalders Begyndelse i Danmark. Aarb. f. nordisk Oldk. og Hist.

MATHIASSEN, TH., JESSEN, K., og DEGERBØL, M. 1939: Bundsø, en yngre Stenalders Boplads paa Als.

I. Therkel Mathiassen: Bopladsen og Oldsagerne.

II. Knud Jessen: Bundsøkulturens pollendiagramatiske Stilling.

III. Knud Jessen: Kornfund.
IV. Magnus Degerbøl: Dyreknogler.
Aarb. f. nordisk Oldkynd. og Hist. København.

Mentz, A., og Ostenfeld, C. H. 1906: Planteverdenen i Menneskets Tjeneste. København.

Milthers, V. 1935. Nordsjællands Geologie. Danm. Geol. Unders. V. R. Nr. 3.

Nilsson, Tage. 1935: Die pollenanalytische Zonengliederung der spät- und postglazialen Bildungen Schonens. Geol. Fören. Stockh. Förh. Bd. 57.

Olsen, Carsten. 1938: Undersøgelser over Bundfloraen i danske Egeskove og Egekrat. Botanisk Tidsskr. Bd. 44. København.

Ording, A. 1934: Om nye metoder og hjelpemidler ved pollenanalytiske undersøkelser. Medd. fra det norske Skogsforsøksv. Nr. 17.

Petersen, O. G. 1920: Forstbotanik. 2. Udg. København.

von Post, L. 1920: Postarktiska klimattyper i Sverige. Geol. Fören. Stockh. Förh. Bd. 42.

— 1925: Gotlands-agen (Cladium Mariscus R. Br.) i Sveriges postarktikum. Ymer. Årg. 1925.

— 1929: Die Zeichenschrift der Pollenstatistik. Geol. Fören. Stockh. Forh. Bd. 51.

— 1929 a: Die postarktische Geschichte der europäischen Wälder nach den vorliegenden Pollendiagrammen. Medd. Stockh. Högskolas Geol. Inst. Nr. 16.

Rydbeck, O. 1928: Stenåldershavets nivåförändringar och Nordens äldsta bebyggelse. Kgl. human. vetensk. Lund årsberättelse 1927—28. Lund.

Rørdam, K. 1892: Saltvandsalluviet i det nordøstlige Sjælland. Danm. Geol. Unders. II. R. Nr. 2.

Sarauw, G. L. 1898: Lyngheden i Oldtiden. Aarb. f. nord. Oldk. og Hist. 2. R. *13*. København.

Schröder, D. 1930: Pollenanalytische Untersuchungen in Worpsweder Mooren. Abh. Naturw. Ver. Bremen, 28.

— 1939: Eine bronzezeitliche Wegstrecke in Nordhannover. Darstellungen aus Niedersachsens Urgeschichte Bd. 4.

Schwantes, G. 1939: Die Vorgeschichte Schleswig-Holsteins. Neumünster.

Sjøbeck, M. 1933: Lövängen och dess betydelse för det sydsvenska bylandskapets uppkomst och utveckling. Svenska Skogsvårdsför. Tidskrift. 30. Aarg. 1932.

Steensberg, A. 1939: Brugen af Kortle og Løvkniv i Jernalderen belyst ved nye Fund. Aarbøger f. nord. Oldk. 1939.

Troels-Smith, J. 1937: Pollenanalytisk Datering af Braband-Fundet. Danm. Geol. Unders. IV Række, Bd. 2, Nr. 16.

— 1937 a: Datering af Ertebøllebopladser ved Hjælp af Litorina-Transgressioner og Pollenanalyse. Foredragsreferat. Medd. Dansk Geol. Foren. Bd. 9.

— 1942: Geologisk Datering af Dyrholmfundet. Kgl. D. Vidensk. Arkæol.-kunsthist. Skrifter, Bd. 1. Nr. 1. (In print).

Tüxen, R. 1937: Die Pflanzengesellschaften Nordwestdeutschlands. Mitt. floristisch-soziol. Arbeitsgem. in Niedersachsen, Hannover.

— 1938: Von der nordwestdeutschen Heide. 1. Entstehung der Heide. »Natur u. Volk« 68. Frankfurt a. M.

Vaupel, Chr. 1863: De danske Skove. København.

Westerby, Erik. 1927: Stenalderbopladser ved Klampenborg. København.

Winther, Jens. 1935: Troldebjerg. En bymæssig Bebyggelse fra Danmarks yngre Stenalder. Deutsche Zusammenfassung. Rudkøbing.

— 1938: Tillæg. Rudkøbing.

Wodehouse, R. P. 1935: Pollen Grains, their structure, identification and significance in science and medicine. New York a. London.

Tavle I.

Plate I.

The diagram for Ordrup Mose is in five parts, but they correspond analysis by analysis.

A. Tree-pollen diagram. The calculated total here is the sum of tree pollen, though *Corylus* is not included.

B. The silhouette curves indicate the fluctuations in pollen frequency for herbaceous plants as a whole (less the pollen of water and marsh plants), for plantain (*Plantago lanceolata* + *Pl. major*) and for cereals. The basis of calculation is the sum of tree pollen. The find of "cereal pollen" under the fire deposit is undoubtedly due to *Elymus arenarius* (cf. Note 11).

C. NTP diagram. Calculations based on *Ericales* pollen and the chief pollen types among herbaceous plants (*Gramineae, Cyperaceae, Centrospermeae, Compositae, Rumex, Plantago*). The silhouettes on the right indicate the pollen frequency for cereals, this time reckoned in relation to the said sum of non-tree pollen.

D. indicates the density of charcoal fragments in the slides. The density is expressed by the number of fragments crossed by a line 10 cm long. The determination is microscopic by means of cross-threads in the ocular. The field examination showed that the lower boundary of the fire deposit lies 82 cm below the surface.

E. The number of pollen per sq. cm of slide. In contrast to the curves in A-C, these curves thus express the absolute pollen frequency (see also Note 36 b).

TP: The sum of tree-pollen. NTP: Sum of pollen of plants named under C.

Quercetum mixtum: Quercus + Ulmus + Tilia + Fraxinus

Fag.: Fagus. Carp.: Carpinus. Visc.: Viscum. $\times : < {}^1/_4\,\%$.

Tavle I.

Diagrammet falder i 5 Dele, A-E, der dog korresponderer Analyse fór Analyse.

A. Træpollendiagram. Beregningssummen er her Summen af Træernes Pollen, idet Hasselen dog ikke indgaar i Summen.

B. Silhuetkurverne angiver Svingningerne i Pollenhyppigheden for urteagtige Planter som Helhed (fraregnet Pollen af Vand- og Sumpplanter), for Vejbred (*Plantago lanceolata* + *Pl. major*) og for Korn. Beregningsgrundlag er Træpollensummen. Fundene af „Kornpollen" under Brandlaget skyldes uden al Tvivl Marehalm (sml. Note 11).

C. NTP-Diagram. Beregningsgrundlag er Lyng-Pollen og de vigtigste Pollentyper blandt urteagtige Planter (*Gramineae, Cyperaceae, Centrospermeae, Compositae, Rumex, Plantago*). Silhuetten til højre angiver Pollenhyppigheden for Korn, denne Gang beregnet i Forhold til nævnte Sum af ikke-træagtige Planters Pollen.

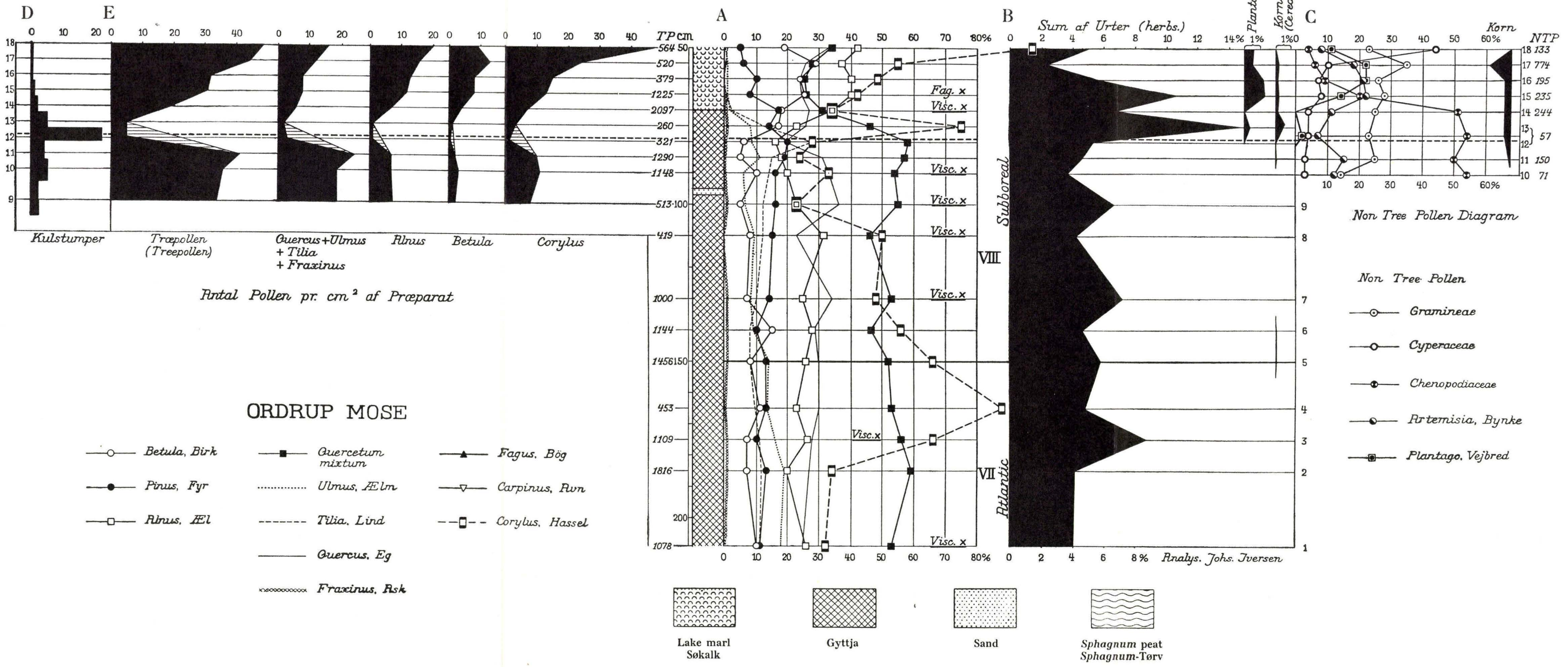
D. Angiver Tætheden af Trækulstumper i Præparaterne. Tætheden er udtrykt ved det Antal Kulstykker, der krydsedes af en Linie paa 10 cm. Bestemmelsen foretoges mikroskopisk ved Hjælp af et Traadkors i Okularet. Kullagets nedre Grænse maaltes ved Markundersøgelsen at ligge ved 82 cm u. O.

E. Antal Pollen pr. cm^2 af Præparat. I Modsætning til Kurverne i A—C giver disse Kurver altsaa Udtryk for den absolute Pollenhyppighed (sml. iøvrigt Note 36 b).

TP: Træpollensummen. NTP: Sum af de under C nævnte Planters Pollen.

Quercetum mixtum: Eg + Ælm + Lind + Ask. *Visc.:* Mistelten. *Carp.:* Avn. *Fag.:* Bøg. $\times : < {}^1/_4\%$.

Den brudte vandrette Linie, der gaar fra A til D, angiver Trækullagets Beliggenhed.


D
E
A
B
C
Kulstumper
Træpollen
(Treepollen)
Quercus+Ulmus
+ Tilia
+ Fraxinus
Alnus
Betula
Corylus
Antal Pollen pr. cm² af Præparat
TP cm
Sum af Urter (herbs.)
Plantago
Korn (Cereals)
Korn
NTP
Subboreal
Atlantic
VIII
VII
Fag. x
Visc. x
Analys. Johs. Iversen
Non Tree Pollen Diagram
Non Tree Pollen
Gramineae
Cyperaceae
Chenopodiaceae
Artemisia, Bynke
Plantago, Vejbred
ORDRUP MOSE
Betula, Birk
Pinus, Fyr
Alnus, Æl
Quercetum mixtum
Ulmus, Ælm
Tilia, Lind
Quercus, Eg
Fraxinus, Ask
Fagus, Bög
Carpinus, Avn
Corylus, Hassel
Lake marl
Søkalk
Gyttja
Sand
Sphagnum peat
Sphagnum-Tørv

Tavle II.

Plate II. Korup Sø. Survey Diagram (cf. Note 39).

The silhouette curves represent the pollen frequencies of *Hedera* and *Plantago* in relation to the tree-pollen total. The bracketed part of the diagram is reproduced as a separate diagram in Plate III.

The diagram was drawn earlier than the others, the result being that the symbols for the sediments in the section-column are different from those employed in the other diagrams; in the latter both fresh-water and salt-water gyttja are expressed by the same symbol (cf. Pl. I).

Ferskvands Gytje
Freshwater Gyttja

Marin Gytje
Saltwater Gyttja

Phragmites Tørv
Phragmites Peat

Fag.: *Fagus*. *Cp.*: *Carpinus*. TP: Sum of tree-pollen. $\times : < {}^{1}/_{4}\,{}^{0}/_{0}$.

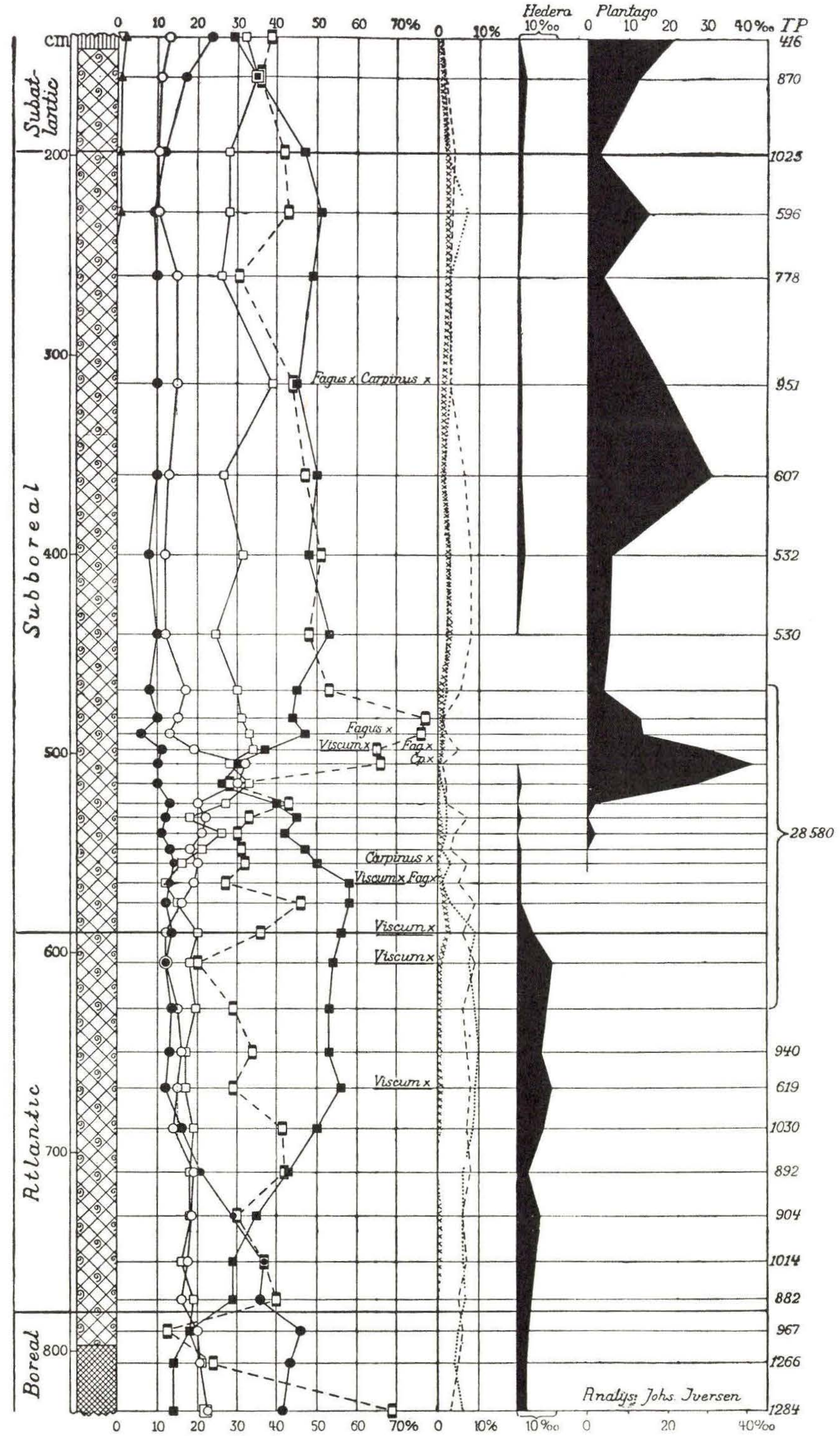
Tavle II.

Silhuetkurverne angiver Vedbends (*Hedera*) og Vejbreds (*Plantago lanceolata* + *Pl. major*) Pollenhyppighed udtrykt som pro mille af Træpollensummen. Det indklamrede Stykke af Diagrammet gengives som Specialdiagram i Tavle III.

Diagrammet er tegnet paa et tidligere Tidspunkt end de andre. Dette har medført, at Signaturerne for Sedimenterne i Profilsøjlen er forskellige fra dem, jeg har anvendt i de øvrige Diagrammer; i disse er Ferskvandsgytje og Saltvandsgytje gengivet med samme Signatur.

Fag.: *Fagus*, Bøg. *Cp.*: *Carpinus*, Avn. *TP.*: Træpollensum. $\times : < {}^{1}/_{4}\,{}^{0}/_{0}$.

KORUP SÖ. Oversigtsdiagram



Tavle III.

Plate III. Korup Sø. Separate diagram (cf. Note 39).

A. This part of the diagram actually comprises two things. Firstly, there is the classical tree-pollen diagram, though for the sake of clarity the curves for *Ulmus*, *Tilia* and *Fraxinus* are shown separately on the right alongside the *per mille* curve for *Hedera*. Secondly, it shows the proportions between tree pollen, *Ericales* (*Calluna*) pollen and herbaceous pollen (cf. Plates V a. VI). Thus in this case herbaceous and *Ericales* pollens are included in the calculation total and, through the silhouette for herbs and *Ericales* together (the left border of the *Ericales* curve) we obtain the best expression of the non-timbered area; as will be seen, it cannot have been considerable.

B. The silhouette curves indicate the fluctuations in the pollen frequency for herbaceous plants as a whole (excluding water and marsh plants) as well as for various herbaceous groups. The *Artemisia* curve also comprises *Artemisia maritima* pollen, whereas the sparse pollen occurrences of *Plantago maritima* are not included in the *Plantago* curve. The basis of calculation is the sum of tree pollen.

C. NTP diagram (see explanation to Plate I).

Neol.: Beginning of the Neolithic period (Late Stone Age).

TP: and NTP, see explanation to Pl. I.

Fag.: Fagus. Cp.: Carpinus. Visc.: Viscum. × : < $^1/_4\,^0/_0$.

Tavle III.

A. Denne Del af Diagrammet omfatter i Virkeligheden to Ting. For det første findes det klassiske Træpollendiagram, idet Kurverne for *Ulmus*, *Tilia* og *Fraxinus* dog for Oversigtlighedens Skyld er angivet for sig til højre ved Siden af Promille-Kurven for Vedbend (*Hedera*). Dernæst viser den Forholdet mellem Træpollen, Lyngpollen og Urtepollen (sml. Tavlerne V og VI). Her er Urtepollen og Lyngpollen altsaa taget med ind i Beregningssummen, og man faar gennem Silhuetten for Urter og Lyng tilsammen (Lyngkurvens venstre Grænse) det bedste Udtryk for Størrelsen af det skovfrie Omraade; som man ser, kan det ikke være betydeligt.

B. Silhuetkurverne angiver Svingningerne i Pollenhyppigheden for de urteagtige Planter som Helhed (fraregnet Vand- og Sumpplanter) saavelsom for forskellige Urtegrupper. *Artemisia*-Kurven omfatter ogsaa *Artemisia maritima*-Pollen, derimod er de sparsomme Pollenforekomster af *Plantago maritima* ikke medtaget i *Plantago*-Kurven. Beregningsgrundlag er Træpollensummen.

C. NTP Diagram (se Figurforklaring Tavle I).

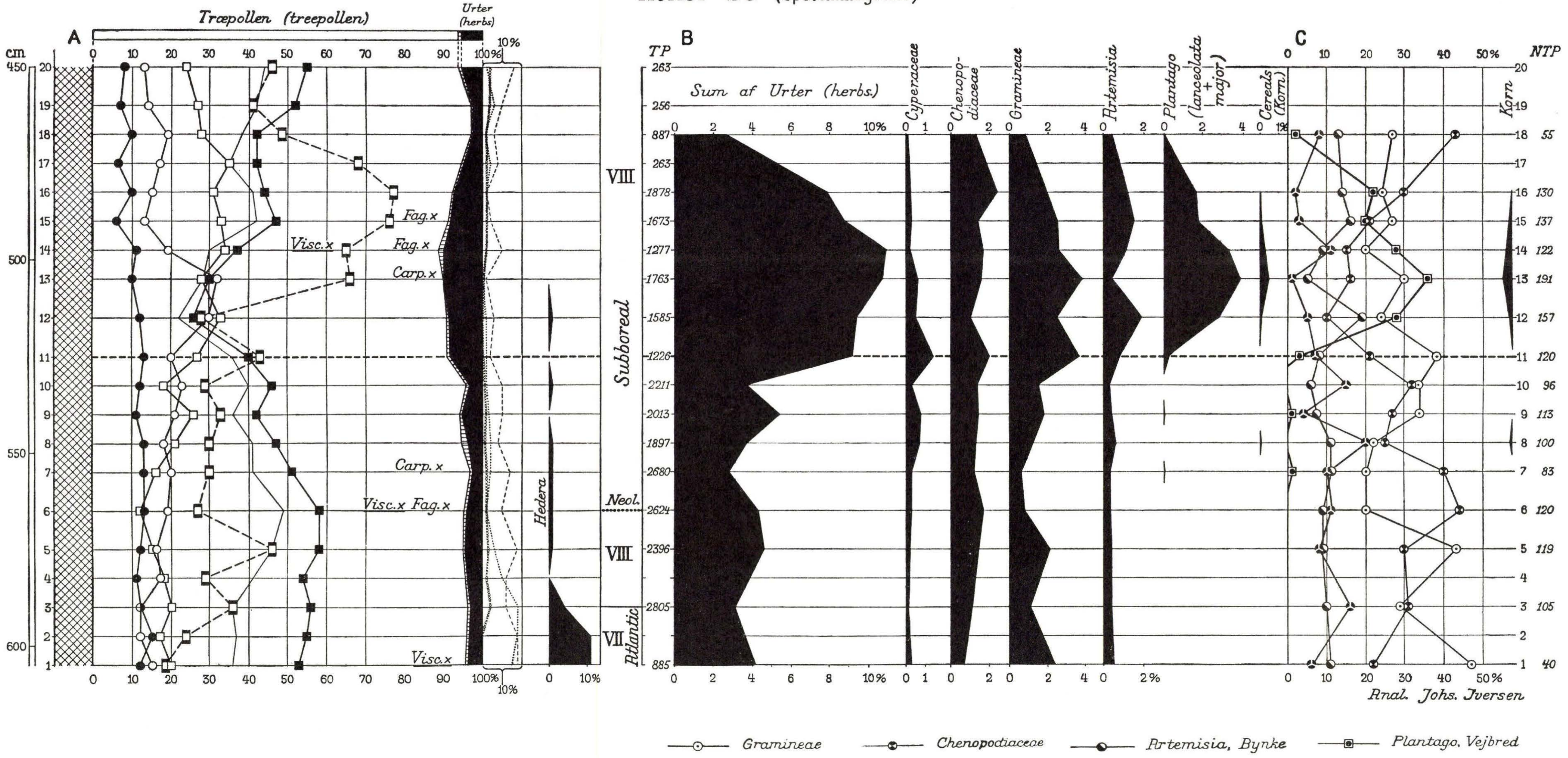
Neol.: Begyndelsen af Neoliticum (Yngre Stenalder).

TP: Træpollensummen.

NTP: Pollensum for urteagtige Planter og Lyng (se Figurforklaring til Tavle I).

Fag.: Bøg. *Carp.:* Avn. *Visc.:* Mistelten. × : < $^1/_4\,^0/_0$.

KORUP SÖ (Specialdiagram)



Tavle IV.

Plate IV. Søborg Sø (cf. Note 37).

A. Tree-pollen diagram and *Hedera*.

B. The silhouette curves represent the fluctuations in the pollen frequency of the herbaceous plants as a whole (excluding water and marsh plants), of *Plantago* and of cereals.

TP: The sum of tree-pollen.

Fjord III: Søborg's third saltwater period.

Fjord IV: Søborg's fourth saltwater period.

Neol.: Beginning of Neolithic period (Late Stone Age).

Tavle IV.

A. Træpollendiagram og *Hedera*.

B. Silhuetkurverne angiver Svingningerne i Pollenhyppigheden for de urteagtige Planter som Helhed (fraregnet Vand- og Sumpplanter), for Vejbred (*Plantago*) og for Korn.

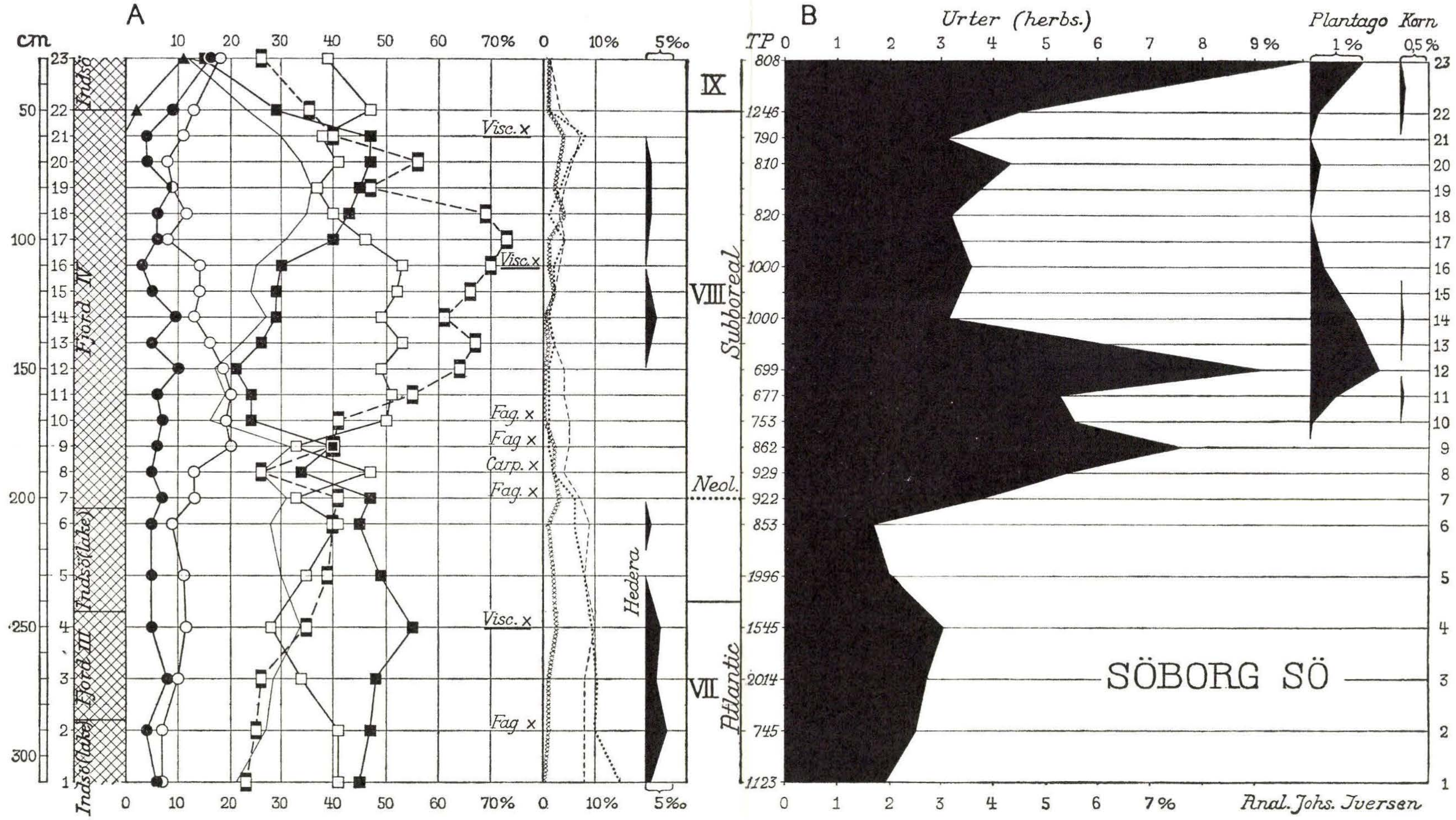
Fjord III: Søborgs 3' Fjordperiode.

Fjord IV: Søborgs 4' Fjordperiode.

Neol.: Begyndelsen af Neoliticum (Yngre Stenalder).

TP: Træpollensummen.

Carp.: Avn. *Fag.:* Bøg. *Visc.:* Mistelten. $\times$: $< 1/4\,\%$.


A
B
cm
Indsö
Fjord IV
Indsö (lake)
Fjord III
Indsö (lake)
Visc. x
Fag. x
Carp. x
Hedera
IX
VIII
VII
Subboreal
Atlantic
Neol.
TP
Urter (herbs.)
Plantago
Korn
SÖBORG SÖ
Anal. Johs. Iversen

Tavle V.

Plate V. Bølling Sø (cf. Note 40).

A. In addition to the tree-pollen diagram this contains a display of the mutual frequencies of tree-pollen, *Sphagnum* spores, *Ericaceae* (*Calluna*) pollen and herbaceous pollen, expressed as percentages of the aggregate total of these pollen and spores. The tree-pollen represents the wooded area, the herbaceous pollen the herb-clad area, the *Ericaceae* pollen the heath area, and the *Sphagnum* spores the *Sphagnum* bog.

B. Silhouette curves for the pollen of plantain (*Plantago*), sorrel (*Rumex*) and cereals expressed as percentages of the tree-pollen total.

C. NTP diagram (cf. explanation to Plate I).

Fag.: *Fagus*. *Carp.*: *Carpinus*. *Pic.*: *Picea*. ×: $< 1/4\ ^0/_0$.

TP and NTP: see explanation to Plate I.

Tavle V.

A. Indeholder foruden Træpollendiagrammet en Fremstilling af det gensidige Hyppighedsforhold af Træpollen, *Sphagnum*-Sporer, Lyngpollen og Urtepollen udtrykt som Procenter af den samlede Sum af disse Pollen og Sporer. Træpollenet repræsenterer det skovdækkede, Urtepollenet det urteklædte Areal, Lyngpollenet Heden og *Sphagnum*-Sporerne Højmosen.

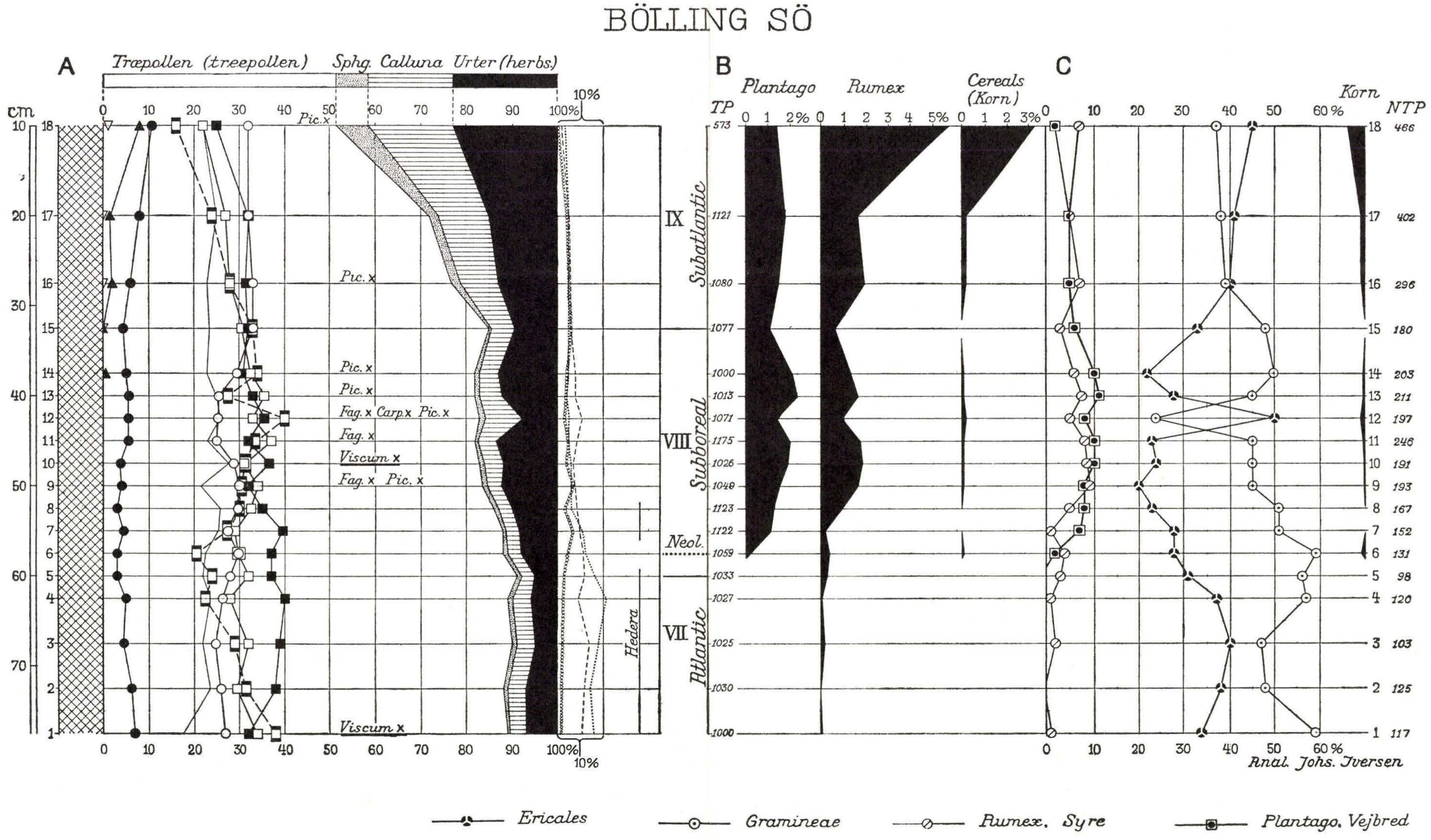
B. Silhuetkurver for Pollen af Vejbred (*Plantago*), Syre (*Rumex*) og Korn udtrykt som Procenter af Træpollensummen.

C. NTP Diagram (sml. Figurforklaring til Tavle I).

TP: Træpollensummen.

NTP: Pollensum for urteagtige Planter og Lyng (se Figurforklaring til Tavle I).

Fag.: Bøg. *Carp.*: Avn. *Pic.*: Gran (kun indtegnet i dette Diagram). ×: $< 1/4\ ^0/_0$.


BÖLLING SÖ
A
Træpollen (treepollen)
Sphg.
Calluna
Urter (herbs)
B
Plantago
Rumex
Cereals (Korn)
C
Korn
NTP
TP
cm
Subatlantic
Subboreal
Atlantic
IX
VIII
VII
Neol.
Hedera
Viscum x
Fag. x
Pic. x
Carp. x
Anal. Johs. Iversen
Ericales
Gramineae
Rumex. Syre
Plantago. Vejbred

Tavle VI.

Plate VI. Hostrup Sø (cf. Note 41).

A. The tree-pollen diagram and the mutual frequencies of tree pollen, *Sphagnum* spores, heather pollen and herbaceous pollen calculated as percentages of the total of these pollens and spores.

B. The silhouette curves indicate the frequencies of *Plantago*, *Rumex* and *Chenopodiaceae* pollen through the series, expressed as percentages of the tree-pollen total.

C. NTP diagram, cf. Note 3. The sign for *Sphagnum* is connected with a stippled line to show that it is not included in the calculated total (cf. von Post 1929).

Tavle VI.

A. Træpollendiagram og den gensidige Hyppighed af Træpollen, *Sphagnum*-Sporer, Lyngpollen og Urtepollen beregnet som Procenter af Summen af disse Pollen og Sporer.

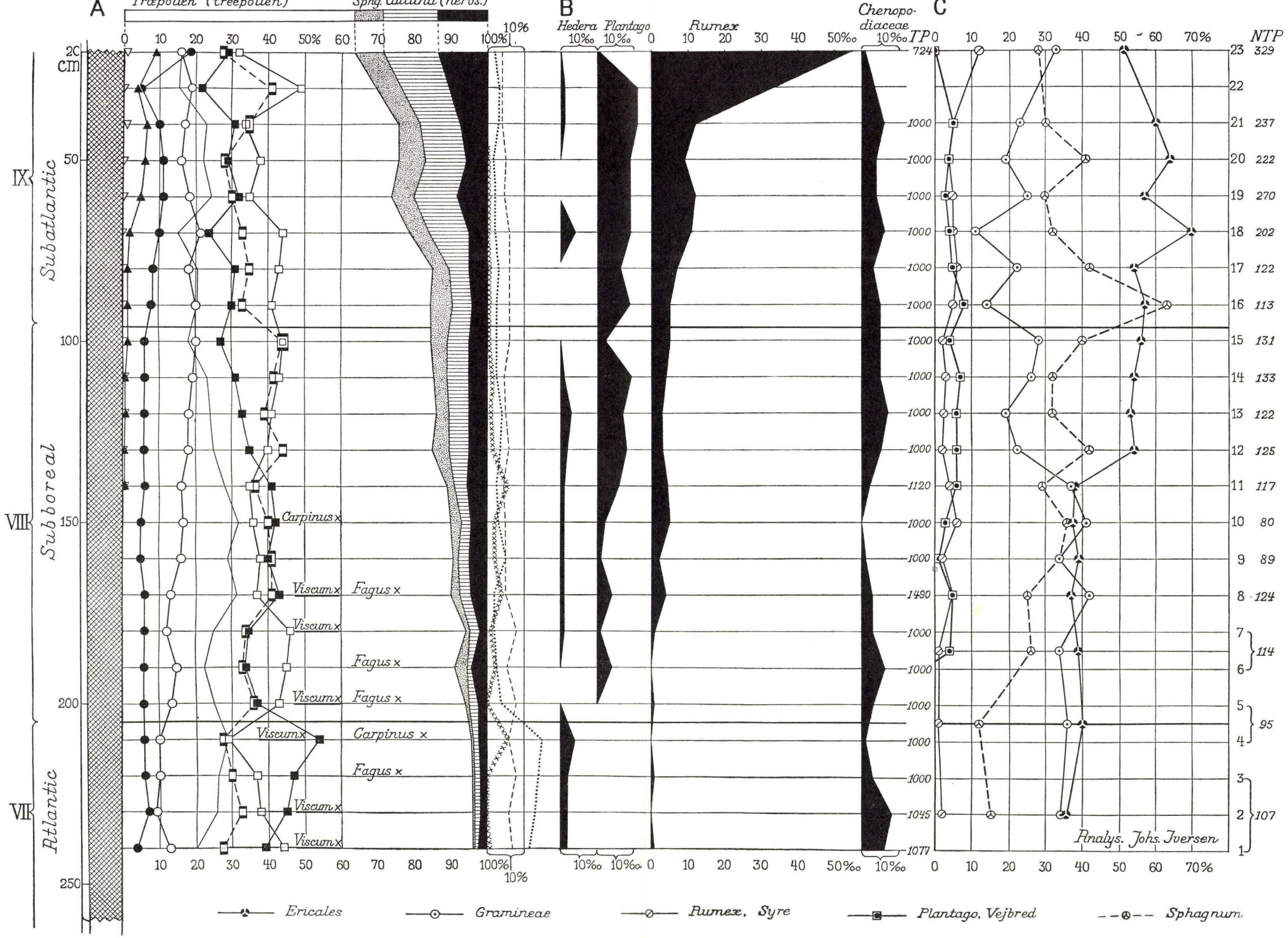
B. Silhuetkurverne angiver Hyppigheden af *Plantago-*, *Rumex-* og *Chenopodiaceae*-Pollen gennem Lagfølgen udtrykt i pro mille af Træpollensummen.

C. NTP-Diagram, sml. Figurforklaring til Tavle I. Signaturen for *Sphagnum* er forbundet med stiplet Linie, for at tilkendegive, at den ikke indgaar i Beregningssummen (sml. von Post 1929).

TP: Træpollensummen.

NTP: Pollensum for urteagtige Planter og Lyng (se Figurforklaring til Tavle I). $\times$: $< 1/4$ ‰.

HOSTRUP SÖ


A
Træpollen (treepollen)
Sphg.
Calluna
Urter (herbs.)
B
Hedera
Plantago
Rumex
Chenopodiaceae
C
TP
NTP
cm
IX
Subatlantic
VIII
Subboreal
VII
Atlantic
Carpinus ×
Viscum ×
Fagus ×
Analys. Johs. Iversen
Ericales
Gramineae
Rumex, Syre
Plantago, Vejbred
Sphagnum

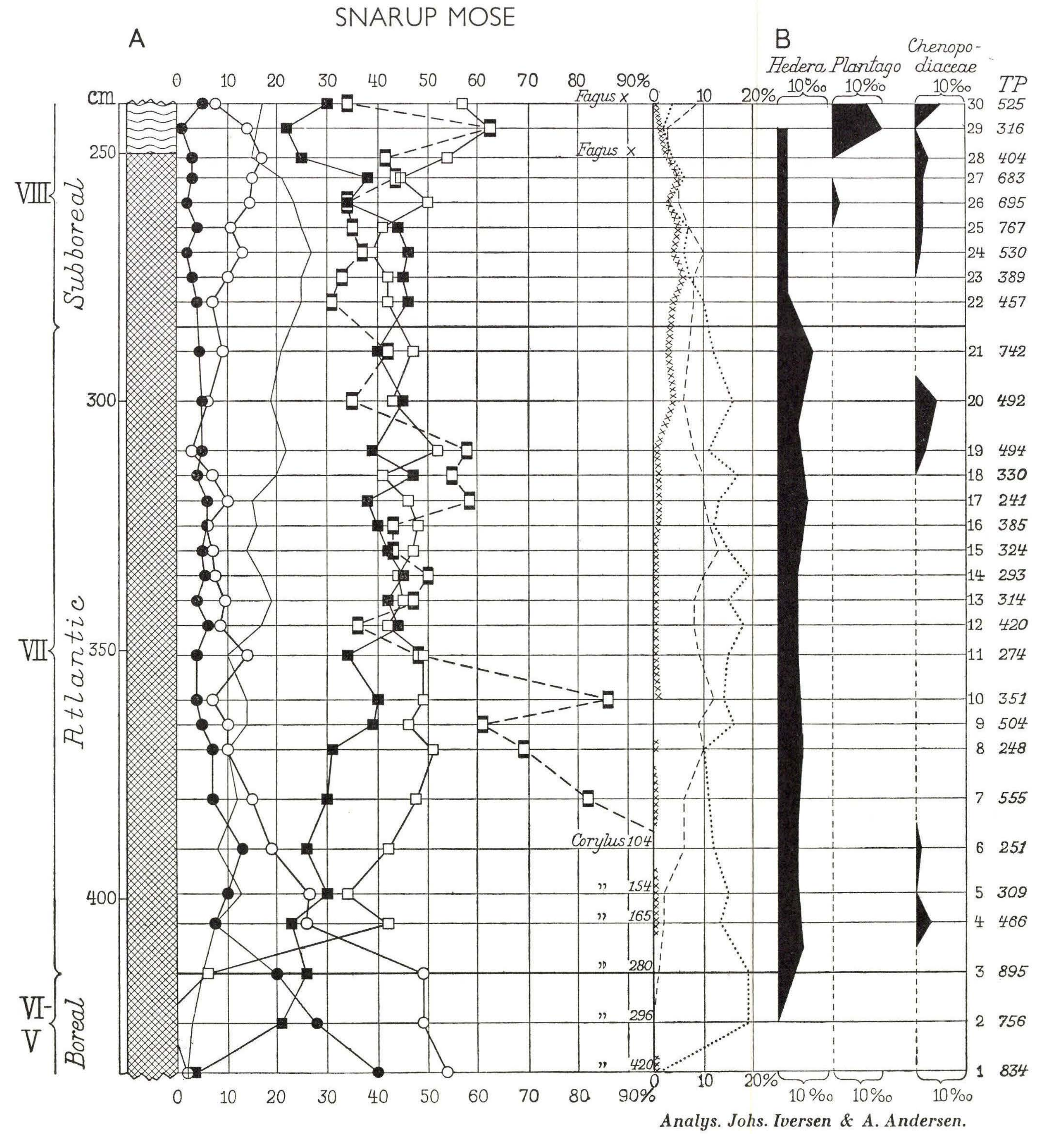
Tavle VII.

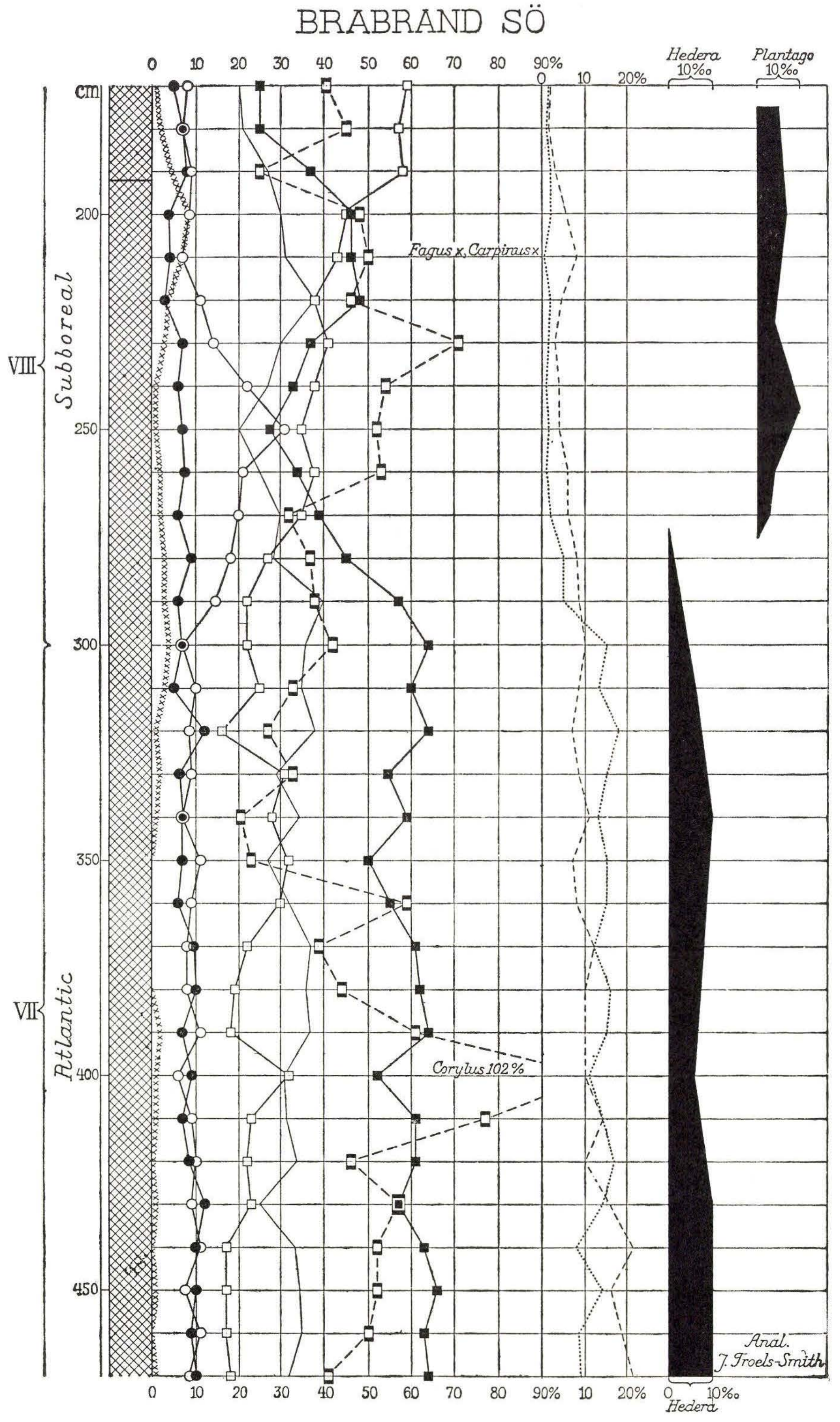
Plate VII.

Snarup Mose (cf. Note 38).
Braband Sø. After J. TROELS-SMITH. Re-drawn. (cf. Note 42).
TP: The sum of tree-pollen.

Tavle VII.

Snarup Mose (sml. Note 38).
Brabrand Sø. Efter J. TROELS-SMITH. Omtegnet (se Note 42).
TP: Træpollensum. $\times$: $< {}^{1}/_{4}\,\%$.


SNARUP MOSE
A
B
Hedera 10‰
Plantago 10‰
Chenopodiaceae 10‰
cm
TP
VIII Subboreal
VII Atlantic
VI-V Boreal
Fagus x
Corylus 104
Analys. Johs. Iversen & A. Andersen.


BRABRAND SÖ
Hedera 10‰
Plantago 10‰
cm
VIII Subboreal
VII Atlantic
Fagus x Carpinus x
Corylus 102%
Anal. J. Troels-Smith

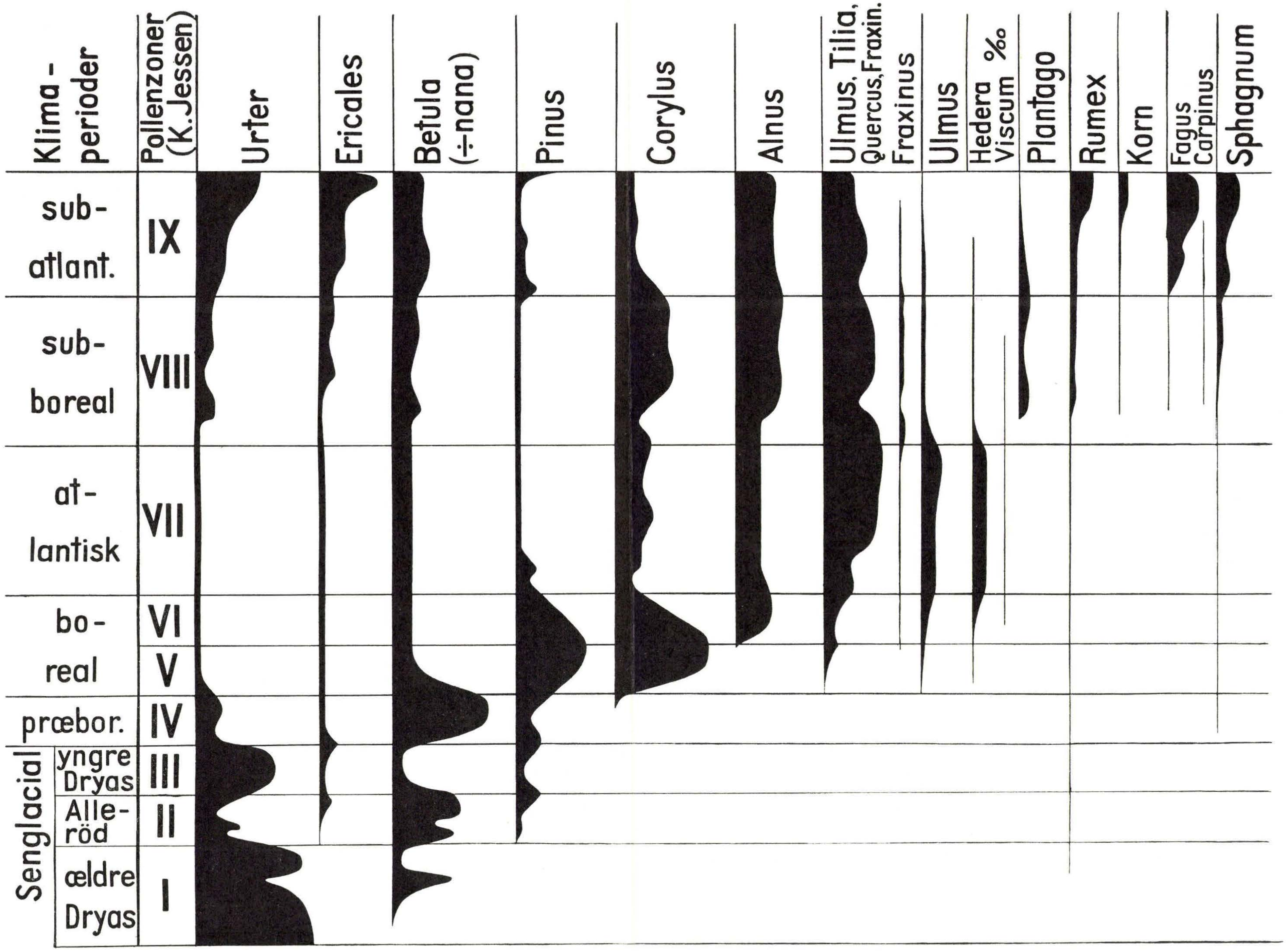
Tavle VIII.

Plate VIII.

The plate provides a somewhat schematic survey of the vegetal development in the sandy parts of Jutland, drawn up on the basis of pollen diagrams. The course of the curves in the late-Glacial period depends mainly on analyses taken from Bølling Sø, which will be published in the near future. A noteworhty feature is the transitory birch advance in the Early Dryas period, which bears evidence of a climatic oscillation earlier than the Allerød oscillation.

Tavle VIII.

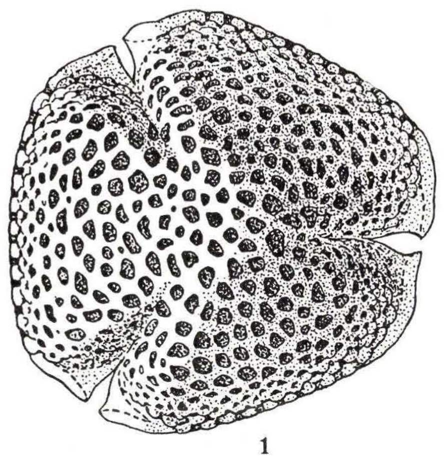
Tavlen giver en noget skematiseret Oversigt over Vegetationsudviklingen i Jyllands Sandegne udarbejdet paa Grundlag af nogle Pollendiagrammer. Kurveforløbene i Senglacialet bygger væsentlig paa Undersøgelser i Bølling Sø, som i nær Fremtid vil blive publiceret. Bemærkelsesværdigt er det forbigaaende Birkefremstød i ældre Dryastid, der vidner om en klimatisk Oscillation ældre end Allerødoscillationen.


Klima-perioder
Pollenzoner (K. Jessen)
Urter
Ericales
Betula (÷nana)
Pinus
Corylus
Alnus
Ulmus, Tilia, Quercus, Fraxin.
Fraxinus
Ulmus
Hedera ‰
Viscum
Plantago
Rumex
Korn
Fagus
Carpinus
Sphagnum
sub-atlant.
IX
sub-boreal
VIII
at-lantisk
VII
bo-real
VI
V
præbor.
IV
Senglacial
yngre Dryas
III
Alleröd
II
ældre Dryas
I

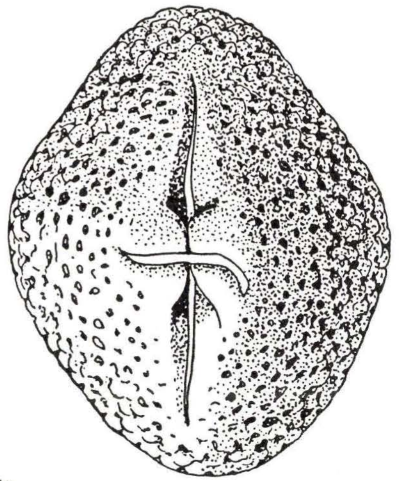
Tavle IX.

Tavle IX.

1. *Hedera helix*. Polar view. × 1600.
2. *Hedera helix*. Equatorial view. × 1600.
3. *Hedera helix*. Exine sculpture. × 4800.
4. *Viscum album*. × 800.
5. *Plantago lanceolata*. × 800.
6. — *major*. × 800.
7. — *maritima*. × 800.
8. — *coronopus*. × 800.



1



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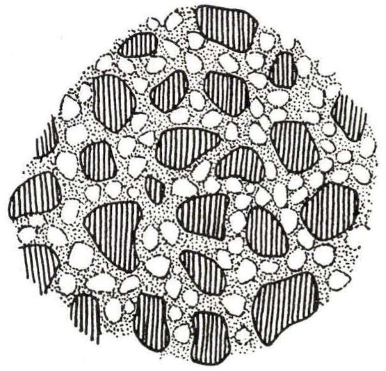
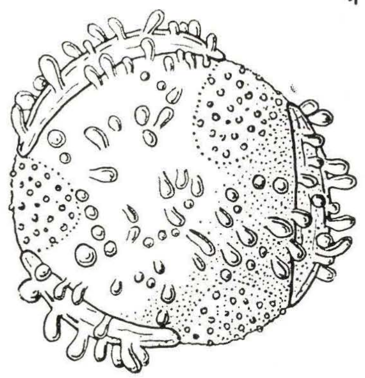
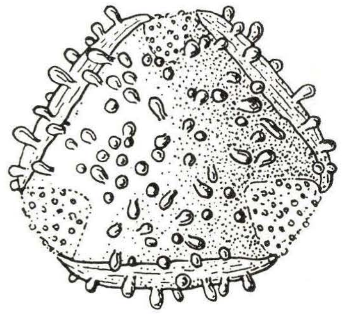


3





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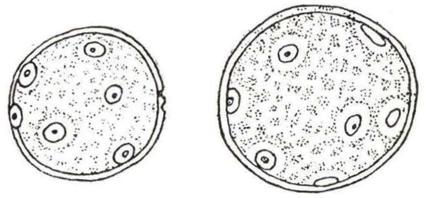
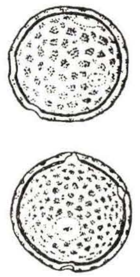
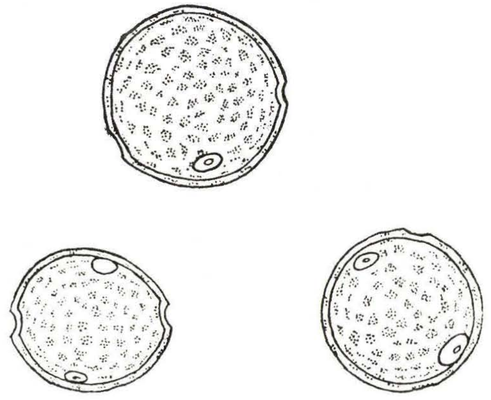


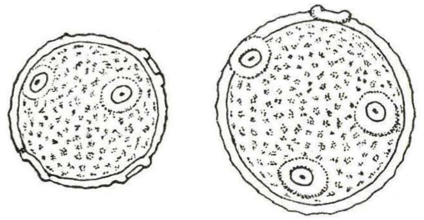
5



6



7



8

S. L. MØLLERS BOGTR. KBHVN.