Om Ceratophyllum submersum L. i Landskrona
och om nya lokaler i omgivningarna.
Anteckningar om Landskronatraktens flora. III.

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(With a summary in English.)

I kanalerna kring Landskrona slott har vårtsärven, *Ceratophyllum submersum* L. sedan länge ansetts ha sin enda säkra svenska växtplats, och därifrån har den varit känd sedan 1849, alltså i över hundra år. WESTERLUND uppgiver 1863: »*Ceratophyllum submersum* växer vid Landskrona i gravarna kring staden och fästningen i sådan myckenhet, att otaliga lass årligen av den hämtas till föda åt kreaturen. Någon annan *Ceratophyllum* än denna, finnes där ej.» Om vi bortser från lokaluppgifterna i våra floristiska handböcker (HARTMANS, LILJAS, ARESCHOUGS och NEUMANS floror) föreligga under resten av 1800-talet och de två första årtiondena av innevarande sekel inga uppgifter i litteraturen om vårtsärvens förekomst i Landskrona. BACKMAN nämner åtminstone ingenting härom i sin monografi över arten (1943). I våra museer ligga emellertid talrika ex. insamlade under 1800- och 1900-talet; de äldsta daterade 1861 och 1864 (BACKMAN l.c.).

Det såg dock tidvis ut som om vårtsärven skulle ha försvunnit eller var så sparsam att den undgått besökande botanisters uppmärksamhet. Den uppträdde nämligen i slutet av 1920-talet och under 1930-talet mycket sporadiskt och ansågs av SYLVÉN (1935) tillhöra en grupp Skåne-arter, som »i hög grad äro i behov av förnyad inventering med hänsyn till sin nutida förekomst inom landskapet — — — ».

Sommaren 1940 kunde emellertid förf. konstatera, att växten fortfarande fanns kvar i kanalerna, men detta år i ringa mängd. Följande år (1941) »förekom den däremot åter oerhört ymnigt i mycket täta, hela kanalen täckande bestånd» (NILSSON 1942). Under åren 1944—45 var vårtsärven åter totalt försvunnen. Åtminstone kunde den, trots noggranna eftersökningar, icke återfinnas vid Kärleksstigen, där den

tidigare haft sitt huvudtillhåll, eller annorstädes i de delar av det vidsträckta kanalsystemet, som äro tillgängliga för besök. Sommaren 1946 förekom den emellertid åter plötsligt i oerhört rika, täta bestånd, men nu vid Nordkap i kanalernas slutarm mot Öresund. Följande sommar (1947) var den åter borta och kunde icke heller upptäckas annorstädes i kanalvattnen.

Sommaren 1946 tyckes vara *C. submersum*s sista uppträdande i Landskrona. Åtminstone har författaren icke lyckats konstatera densamma i kanalerna under de talrika exkursioner, som företagits varje sommar sedan dess, huvudsakligen med syfte att hålla utkik efter denna växt.

HORN AV RANTZIEN (1946) talar för fridlysning av växten och säger: »På den enda svenska lokal där *Ceratophyllum submersum* bevisligen finnes kvar, slottsgravarna i Landskrona, är den ännu icke fridlyst. En angelägen uppgift för svenskt naturskydd vore att få den helt fredad. Den förekommer visserligen för närvarande ganska rikligt på växtplatsen, men den för några år sedan vidtagna uppmuddringen av slottsgravarna visar, att vårtsärvens förekomst här icke kan anses tryggad utan det skydd, som en fridlysning såväl av lokalen som av växten skulle skänka.»

Det här väckta förslaget om fridlysning av *C. submersum* och dess vatten tyckes dock ha väckts för sent. Redan vid denna tid (1946) var nämligen växten dömd att försvinna därifrån.

Orsaken till att vårtsärven under de två senaste årtiondena synes ha funnit allt mindre trivsel och nu tycks helt försvunnen är med säkerhet att söka däri, att kanalerna i hela sin utsträckning under åren 1931—35 befriades från metertjocka lager av det slam, som samlats under århundradenas lopp (jfr NILSSON l.c.). Att denna muddring icke ensamt har förmått taga död på växten visas dock därav, att den med säkerhet fanns på sina gamla växtplatser under åren 1940—43 och 1946. Alltså måste vårtsärvens periodicitet och slutliga försvinnande ha andra orsaker än brist på diasporer eller vegetativa organ för sitt fortbestånd. Den företagna muddringen har givetvis allvarligt rubbat de gamla stabiliserade förhållandena vad beträffar vattendjup, vattnets näringstillstånd och salthalt m.m., och mycket talar för, att just en ökad saltkoncentration är den direkta orsaken till den katastrof, som drabbat *C. submersum*. Den genom muddringen uppkomna djupa bassängen fylldes efterhand med från Öresund inströmmande tyngre saltvatten. Den utjämnande inverkan, som nederbörd och grundvatten efterhand utöva på kanalvattnens salthalt, har säkerligen i hög grad motverkats

av det koncentrerade havsvatten, som under nordliga eller nordvästliga stormar pressas in i kanalsystemet genom dess förbindelse med Öresund. En gradvis förskjutning mot saltare vatten anser man sig ju också ha kunnat konstatera vad Östersjön beträffar, och även här lär det vara starka höst- och vinterstormar, som pressat Nordsjöns vatten över Öresunds-tröskeln (enligt not. i dagspressen sensommaren 1951).

Att saltkoncentrationen har ökat efter uppmuddringen på 1930-talet, därför talar även det förhållandet, att brackvattnets havstulpan, *Balanus improvisus*, först under de sista åren har invandrat i kanalernas vatten. De första exemplaren av arten ifråga iakttogs år 1948, och numera förekommer den i stort antal sittande på strandkanternas vasstrån och stolpverk m.m. *Balanus improvisus* kan knappast ha undgått min uppmärksamhet vid promenader längs kanalerna under tidigare år. Förekomsten av en havstulpan i kanalernas förmodade starkt utsötade vatten skulle ha varit allt för uppseendeväckande för att kunna förbigås. Till kanalerna har den sannolikt invandrat från sundet utanför med tång (*Fucus* och *Zostera*), som medföljer inströmmande vatten och ofta ses flyta även långt inne i kanalsystemets vatten. LUTHER (1950) nämner just artens stora spridningsmöjligheter genom »blåstång, som i mängd rives lös och kommer i drift, vid vass. som brytes av och flyter — — —». I Landskrona är arten tidigare insamlad i hamnen år 1934 (GISLÉN 1950), och samme förf. säger att artens salttolerans »vid våra kuster torde efter fyndorterna att döma ligga mellan 25 och 4 $^0/_{00}$». Kanalvattnens salthalt bör alltså växla mellan dessa värden. Efter vårtsärvens reaktion att döma närmar den sig sannolikt tidvis den högre siffran.

Med undantag för SAMUELSSONS (1934) uppgift om förekomsten av *Myriophyllum spicatum* i kanalerna föreligga tyvärr inga anteckningar om vårtsärvens följeväxter under artens blomstringsperioder före kanalernas uppmuddring (BACKMAN l.c.). Då jag i slutet av 1930-talet började intressera mig för växten, var den ursprungliga bottenfloran givetvis bortförd med de avlägsnade bottenlagren och ersatt med en gles (med undantag för de år *C. submersum* förekom ymnigt) och mycket artfattig vegetation bestående av *Potamogeton pectinatus* och *Zannichellia* samt den sannolikt förbisedda *Ruppia* (jfr BACKMAN l.c.). Något nytt synes därefter icke ha tillkommit. *P. pectinatus* finnes numera ställvis relativt talrikt, medan däremot de båda andra växterna fortfarande — i den mån vegetationen har kunnat undersökas — synes uppträda sparsamt och i glesa kolonier. Den här nämnda floran är analog med den, som förhärskar på bottnen av det långgrunda Öresund utanför;

dock med den skillnaden att *Ruppia* och *Zannichellia*-formerna här ofta äro mycket ymniga. Diasporer av dessa växter kunna alltså — liksom *Balanus*-arten — ha medföljt inströmmande vatten efter kanalernas upprensning.

Starka inslag av halofyter präglar kanalsträndernas flora, men detta är helt naturligt med hänsyn till havets omedelbara närhet, och det förhållandet, att kanalsystemet delvis ligger inom de forna strandängarnas område.

Av floran kan nämnas: *Lepidium latifolium* samt *Phragmites communis*, som mångenstädes kantar stränderna i ett smalt bälte, h.o.d. avbrutet av *Scirpus maritimus*. I själva den fuktiga strandkanten eller i närheten av denna kan man bl.a. finna följande växter, ofta i stora kolonier: *Agrostis stolonifera, Aster Tripolium, Carex Otrubae, Glaux maritima, Juncus Gerardi, Rumex palustris, Sonchus arvensis, Trifolium fragiferum* och *Triglochin maritimum*.

Ur Skånes flora har emellertid *C. submersum*, som väl är, icke försvunnit i och med sin sorti ur kanalernas vatten. Före jul 1947 råkade jag nämligen i ett akvarium få se denna som akvarieväxt sällan eller aldrig saluförda art. Vid förfrågan om varifrån växten anskaffats meddelades, att den tagits i en märgelgrav belägen i Örja socken i närheten av kyrkan och omedelbart intill järnvägslinjen Landskrona—Billeberga. Efter dessa anvisningar var det lätt att året efter (1948) lokalisera märgelgraven, och det visade sig då, att växten här just förekom i den oerhörda, hela vattnet täckande ymnighet, som utmärkte vårtsärven i WESTERLUNDS (l.c.) beskrivning från mitten av 1800-talet. Sedan detta år har lokalen årligen besökts, och varje gång har växten förekommit i samma frodiga yppighet.

Det antagandet låg nära till hands, att *C. submersum* även skulle kunna förekomma åtminstone i några av traktens övriga talrika märgelgravar, och att en noggrann inventering av dessa därför vore önskvärd. Först under sommaren 1951 hade denna inventering nått så långt, att samtliga märgelgravar besökts inom det område, som bifogade karta visar, alltså öster om Landskrona inom de gamla socknarna Örja, Tofta och Saxtorps gränser. Min förmodan visade sig vara riktig; *C. submersum* påträffades i icke mindre än 7 märgelgravar, av vilka 4 äro belägna i Örja och tre i Tofta socken. De relativt få märgelgravar, som finnas norr om staden, ha emellertid icke hunnit inventeras i nämnvärd omfattning, och därför återstår den möjligheten, att vårtsärven även kan finnas i någon av dem. Det är ju också möjligt, att någon märgelgrav belägen utanför det undersökta området kan hysa växten.

ó Märgelgrav, fylld eller förstörd
ó D:o, ej markerad på ekonom. kartan
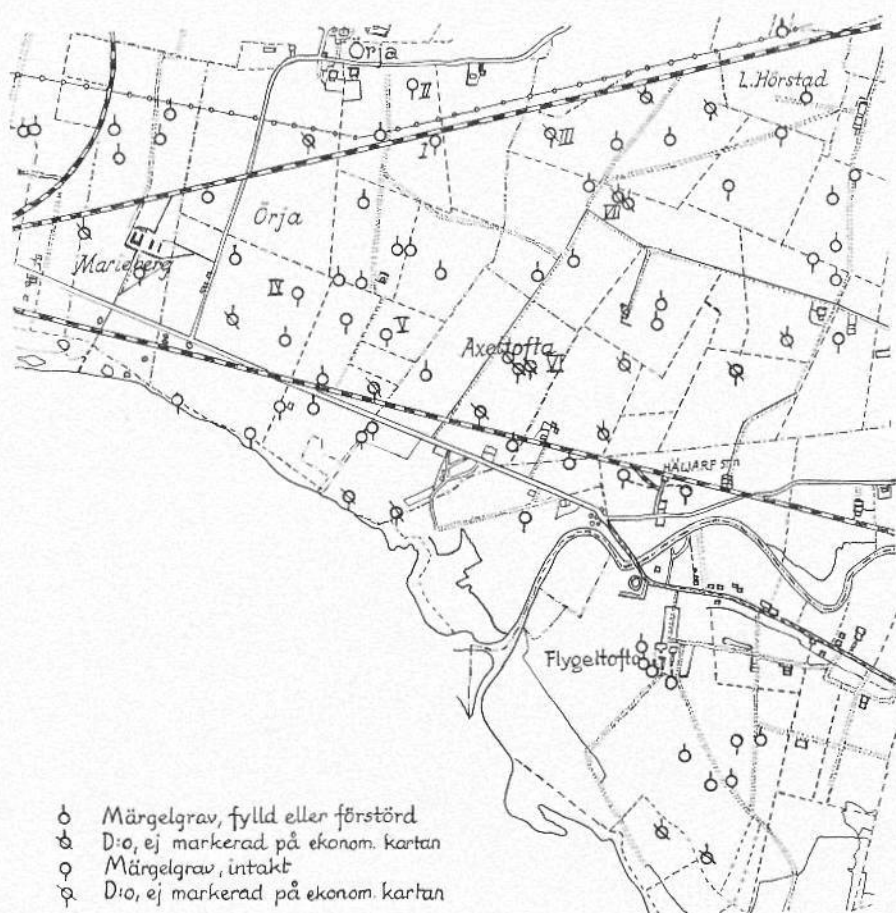♀ Märgelgrav, intakt
♀ D:o, ej markerad på ekonom. kartan

Fig. 1. Förekomsterna av *Ceratophyllum submersum* i Landskrontrakten (I—VII). —
The occurrence of *Ceratophyllum submersum* in the Landskrona district. The marl
pits are denoted, and the localities of *C. submersum* numbered I—VII.
Kartan godkänd för publicering i Rikets allmänna kartverk den 13 maj 1952.

I allt har 81 märgelgravar besökts inom det område, som kartan
visar, och dessa torde representera praktiskt taget alla nu befintliga
samt sådana, som numera endast kunna spåras i terrängen. Av dessa
81 gravar voro 29 i någorlunda naturligt skick. Som intakta har dock
även räknats gravar med ingrepp av relativt liten omfattning, t.ex.
sådana i vilka avverkade *Salix*-buskar fått ligga kvar, eller sådana som
i ringa grad inkräktats av nedkastat jordbruksavfall. De gravar, vilka

brukas som avstjälpningsplats, har däremot räknats som förstörda, även om större delen av vattenytan ännu är fri.

Den kartskiss, som medtagits i denna uppsats, för att visa läget och tillståndet av de märgelgravar, som besökts, har kopierats efter Rikets allmänna kartverks ekonomiska karta över Malmöhus län, Landskrona- och Billeberga-bladet, Stockholm 1930 respektive 1912 (nytryckt 1930). På kartan har med olika tecken markerats huruvida gravarna äro förstörda eller ännu något så när intakta. De märgelgravar, som icke äro markerade på de ekonomiska kartbladen, ha inritats så exakt som möjligt.

I. Ö r j a. Den ovan nämnda först upptäckta lokalen, en medelstor, förmodligen ganska djup grav, nästan runt om kantad av täta *Salix*-snår bestående av *S. cinerea, S. purpurea, S. viminalis* och *S. cinerea*×*nigricans.*

II. Ö r j a. Belägen ett par hundra meter norr om ovan nämnda, ute i åkern mellan järnvägen och landsvägen Landskrona—Asmundtorp. En medelstor, till synes rätt grund grav, till sin ena hälft tätt kantad med *S. viminalis. C. submersum* förekommer i jämförelse med föregående fyndplats relativt sparsamt.

III. T o f t a. Belägen på samma sida av järnvägen som märgelgrav nr I, men längre österut och längre in i åkern, strax innanför gränsen till Tofta. Graven är fritt belägen och saknar lignoser. *C. submersum* har kanske helt nyligen invandrat till denna lokal. Härpå tyder i varje fall det förhållandet, att endast en enda slinga av denna växt kunde iakttagas mellan de vattenytan nästan helt täckande bladen av *Potamogeton natans.*

IV. Ö r j a. En stor i två hälfter delad märgelgrav belägen i åkermarken öster om Mariebergs gård och landsvägen mot Örja kyrka: starkt skuggad av *Salix viminalis. C. submersum* förekommer i så oerhört täta bestånd, att plats knappast ges övrig växtlighet; icke ens för *Lemna*-arterna. Det åkerskifte, varpå denna grav är belägen, hyser ytterligare 5 gravar, av vilka en fortfarande är intakt, en halvfylld och resten praktiskt taget igenfyllda av halmavfall ända upp till kanten.

V. Ö r j a. Denna märgelgrav ligger endast några hundra meter öster om den förra och c:a 200 m norr om en i åkern liggande, med häckar inramad fruktodling. Den är ganska stor och tätt kantad av gamla *Salix viminalis.* De uppvuxna grova stammarna av denna buske ha för något år sedan avverkats och tillåtits att falla ner i vattnet. Den fria vattenytan har på så sätt avsevärt förminskats, i det att grenverket

bildar ett tätt skikt i och under vattenytan, och de på många ställen regenererande grenarna ha gett upphov till täta ruggar av ännu unga skott långt ute i vattnet.

VI. Tofta. Belägen 2—300 m inne i åkern till höger om den mindre väg, som från Axeltofta för till Tofterup. På platsen finns två gravar skilda från varandra av en c:a 3 m bred jordremsa. Båda sakna planterade Salix-buskar och ha därför soligt, fritt vatten. Den östligaste var igenvuxen av C. submersum; den västligaste saknade till synes denna växt, men var istället fylld av Potamogeton natans.

VII. Tofta. En märgelgrav eller rättare två närliggande, belägna ett par hundra meter inne i åkern, där samma väg, som ovan nämnts, kröker på väg mot Tofterup. Ursprungligen har den varit stor och djup men är nu till stor del fylld av halm, ris och annat avfall. Ett oerhört tätt skikt av Lemna minor och trisulca dominerar vegetationen även i djupare lager, och den sparsamt förekommande C. submersum kommer sannolikt att efter hand helt förkvävas däri. Orsaken till Lemna-arternas luxurierande förekomst på bekostnad av vårtsärven är sannolikt att söka i det ändrade, för Lemna gynnsamma näringstillstånd, som uppstår under halmavfallets nedbrytning. Märgelgraven är dömd att snart försvinna.

Med undantag för Ceratophyllum och Salix-formerna har märgelgravarnas övriga flora icke berörts i ovan nämnda kortfattade lokalbeskrivningar. Såväl i vattnet som vid stränderna förekomma emellertid ett mindre antal växter av intresse i detta sammanhang. Förf. har ansett det lämpligast att sammanföra dessa i en överskådlig tabell. Lignoserna ha särskilt antecknats vid inventeringen, dels på grund av den skuggande negativa verkan de, åtminstone som äldre skänka vattnen och dess flora, dels därför att de direkt hota C. submersums existens (jfr märgelgrav V).

De i tabellerna antecknade växterna utgöras av några arter, som med vindens hjälp kunna ha transporterats till märgelgravarna, samt av sådana, som antagligen på zoochor väg ha spritts dit från andra vatten. Till denna sista kategori hör främst C. submersum. Under de över 100 år, som vårtsärven funnits i Slottsgravarna i Landskrona, har säkerligen delar av denna växt åtskilliga gånger medföljt simfåglar vid deras flykt från kanalerna ut över markerna i omgivningarna. Åtminstone i något fall har det, som vi sett, lyckats, att den oskadd nått ett nytt vatten. En sekundär spridning från en tidigare infekterad märgelgrav är emellertid icke endast möjlig utan sannolik.

Tabell över *Ceratophyllum submersum* och dess följeväxter i de
7 märgelgravar, som hysa denna växt.

	I	II	III	IV	V	VI	VII
Ceratophyllum submersum L.	+	+	+	+	+	+	+
Lemna minor L.	+	+	+	+	+	+	+
Lemna trisulca L.	+	+	+	+		+	+
Spirodela polyrrhiza (L.) SCHLEID.				+			+
Potamogeton natans L.				+		+	
Typha latifolia L.	+	+	+			+	+
Phragmites communis TRIN.					+		
Sparganium ramosum HUDS. ssp. *microcarpum* (NEUM.) HYL.							+
Alisma Plantago-aquatica L.	+	+	+			+	+
Berula erecta (HUDS.) COVILLE							+
Filipendula Ulmaria (L.) MAXIM.				+			
Polygonum amphibium L. f. *terrestre*	+	+	+			+	
Epilobium hirsutum L.	+	+				+	+
Epilobium parviflorum SCHREB.	+						
Juncus articulatus L.	+		+				
Lycopus europaeus L.	+		+			+	+
Ranunculus sceleratus L.							+
Bidens tripartita L.			+	+	+		+
Stachys palustris L.			+	+			

Lignoser:

	I	II	III	IV	V	VI	VII
Salix caprea L. × *viminalis* L.							+
— cinerea L.	+			+			
— × *nigricans* SM.	+						
— *purpurea* L.	+						
— *viminalis* L.	+	+			+		+
Fraxinus exelsior L.	+						
Rosa villosa L. var. *pomifera* (HERRM.) DESV.							+

Även det lägre djurlivet har till stor del vattenfåglarna att tacka för sina förekomster i märgelgravarna. Speciellt gäller detta om molluskerna. Dessa kunna emellertid icke eller endast i ringa grad ha transporterats från kanalerna i Landskrona. Även före muddringen hyste nämligen dessa en art- och individfattig fauna. Det ungefär dussin arter — ofta olika i olika märgelgravar — som jag iakttagit måste därför ha kommit från andra vatten, och därvid tänker man först och främst på den närbelägna Saxån med sin rika fauna. Detta vittnar i sin tur om den livliga kommunikation, som råder vattnen emellan, och de stora spridningsmöjligheter, som organismerna ha med vattenfåglarnas hjälp.

Det glädjande faktum, att vi, trots *C. submersums* försvinnande i kanalsystemet i Landskrona, ändå ha vårtsärven kvar som medborgare i vår flora, grumlas genom kunskapen om den fara, som hotar även dess nuvarande växtplatser, märgelgravarna. Jordbrukarna ha som bekant särskilt under de två eller tre sista årtiondena traktat efter att så snart som möjligt utfylla dessa hinder för ett modernt lantbruk. I synnerhet övergångstiden mellan äldre tröskningsformer och skördetröskornas genombrott var farlig för märgelgravarnas tillvaro. Under denna tid placerade man nämligen med förkärlek tröskorna vid sidan om en märgelgrav ute på fälten och fyllde den med halm och agnar. Överhuvudtaget brukas märgelgravarna gärna som avstjälpningsplatser. Dit kastar man det åkeravfall, som icke lämpligen kan brukas ner, och dit brukar man ofta transportera avfall från bebyggelse och gårdar. Följden av detta har blivit, att man åtminstone i Landskronatrakten numera icke påträffar många helt opåverkade märgelgravar, och länge torde det icke dröja förrän de sista försvunnit.

En annan fara är, att den kanske för äldre tiders försörjning betydelsefulla planteringen av *Salix*-arter, numera är en direkt fara för märgelgravarnas existens och därmed för *C. submersums* bestånd. Det bränsle, som de uppvuxna buskarna ge, saknar ju i våra dagar värde, men de skugga den omgivande grödan och måste därför avverkas då och då. Att transportera bort de avverkade buskarna är emellertid ett tidsödande arbete, och därför få de nog i de flesta fall ligga där de falla i gravens vatten.

Det av HORN AV RANTZIEN (1946) framkastade förslaget om fridlysning av *C. submersum* och dess hemvatten är alltså fortfarande fullt aktuellt, trots de många nya lokaler, som tillkommit. Men vi få icke slå oss till ro med tanken, att ännu är det god tid till sådana åtgärder. Den dag är säkert inte långt borta, då den sista av de här skildrade växtplatserna för en av Sveriges sällsyntaste och märkligaste växter även den är förstörd.

Det finns emellertid anledning förmoda, att vårtsärven även förekommer i den närbelägna Saxåns nedre lopp. Det vore för övrigt egendomligt, om icke även detta vatten någon gång blivit infekterat genom gästande vattenfåglar. Denna förmodan har ett visst stöd däri, att förf. sommaren 1947, under bad vid norra sidan av Borstahusens hamn iakttog talrika *Lemna* och delar av andra sötvattensväxter flytande på vattnet och bland dem en liten slinga av *Certophyllum submersum*. Denna drivande sötvattensflora har sannolikt medföljt Saxåns i Sundet utströmmande vatten. Från slottskanalerna i Landskrona kan den i varje fall

inte ha härstammat, därför att dess vatten saknar varje spår av *Lemna*. I litteraturen föreligger flera exempel på dylik havsdrift. SIMMONS (1933) omtalar t.ex., att han anträffat *Lemna gibba* och *Spirodela polyrrhiza* utmed stranden av Öresund norr om Lomma, troligen utkomna från Höjeå.

Summary. Ceratophyllum submersum in the Landskrona district in Scania.

In the canals around the castle of Landskrona (Scania) *Ceratophyllum submersum* has occurred in extraordinary abundance since 1849 and here it has been supposed to have its single certain Swedish occurrence in later decades. The canals were thoroughly dredged in the years 1931—1935 and bottom layers a metre or more in thickness were removed. After that *Ceratophyllum submersum* has had a very sporadical occurrence and since 1946 has quite disappeared from here.

After dredging the canal system was filled with sea water from the adjacent Öresund and the disappearance doubtless is connected with the resulting increase in salt concentration. The high salt content is also maintained by the concentrated sea water which is driven into the canals through their connection with Öresund every year by northerly autumn and winter storms. The importance of the salt factor is also proved by the fact that the sea tulip of brackish water, *Balanus improvisus*, was seen for the first time in the canal waters in 1948 and is now widespread there. The present water vegetation, *Ruppia* and *Zannichellia* forms and *Potamogeton pectinatus*, also indicates a salty water.

Ceratophyllum submersum, however, has not disappeared from the Swedish flora, as the author has been able to establish its occurrence east of Landskrona in 7 marl pits of more than 80 that were investigated. Probably it has been brought to them by water birds from the old locality in Landskrona. The accompanying plants of the species (see the table) cannot, however, have been derived from this place, because they are totally lacking there. The positions of these new localities in the adjoining map have been denoted by the numbers I—VII.

The existence of these new localities, however, is also threatened, as the marl pits are being filled in or destroyed to a great extent in modern times. Some or all of these waters in which the plant has its last Swedish occurrences should be protected by law, if it is not to disappear completely from Swedish flora.

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South African species of Riccardia.

By SIGFRID ARNELL.

Only two species of Riccardia were earlier known from S. Africa, namely, *R. compacta* ST. and *R. fastigiata* L. & L. In 1951 I collected liverworts and among them 8 species of *Riccardia* in some places in S. Africa. It is to be expected that other species will be found in the future, as there are large districts still unexplored in this wide country. A fortunate circumstance is that the South African *Riccardias* nearly always seem to be fertile or at least with inflorescences, thereby facilitating the identification of these critical species. The rich collections of the Paleobotanical Department of the Riksmuseum, Stockholm, have been of great help to me for comparison as well as the special literature and drawings present there, which have been at my disposal during my work with the collections. I should like to express here my thanks for this valuable assistance.

Key for the South-African species of Riccardia.

a. Thallus broad and fleshy, dichotomously or often not branched, male inflorescences long and fleshy, often several side by side.   *R. submarginata* S. ARN.

aa. Thallus narrow, with ± regular subopposite branches.

  b. Main axis and branches with obtuse margins, without wings.

    c. Branches narrow, linear. Dioecious. Calyptra smooth.   *R. compacta* (ST.)

    cc. Branches short, broad and blunt. Monoecious. Calyptra with large lamelliform appendices.   *R. obtusa* S. ARN.

  bb. Branches with wings one cell thick.

    c. Monoecious.

      d. Branches with wings up to 2—3 cells broad, female inflorescences cup-like, with cilia 2—3 cells long, on soil or decaying wood.   *R. saccatiflora* (ST.)

      dd. Branches with wings only one cell broad and one cell thick, female inflorescence usually at the end of a short branch, campanulate, with crenulate and often recurved margin, on wet stones.

                R. campanuliflora S. ARN.

cc. Dioecious.

    d. Small plants, usually growing on bark, axis 4 cells thick.

        e. Branches with wings 3—4 cell rows broad, with the cells obliquely radiating from a median cell band, numerous long male inflorescences.

                                        R. capensis S. ARN.

        ee. Branches with only one row of single cells at the margin, short male inflorescences with margins ending with cilia 2 cells long.

                                          R. rhodesiae S. ARN.

    dd. Plants of medium size, usually on wet stones, axis 5—6 cells thick.

        e. Plant up to 3 cm long, marginal cells with thick walls, cuticula striated, male inflorescences with dentate wings, female inflorescences flat, with broad lobate wings and many archegonia.   *R. reticulata* (ST.)

        ee. Plant up to 2 cm long, marginal cells usually with thin walls, cuticula smooth, male inflorescences bud-like, with slightly crenulated wings.

                                          R. fastigiata (L. & L.)

Riccardia submarginata S. ARNELL nov. spec.

Type: ARNELL no. 1552 and 1766, Cape Prov., Knysna, Deepwall Forest Reserve, $^1/_2$ mile south of the Forest Station, on decaying wood and moist soil (Bolus Herbarium, Cape Town and Riksmuseum, Stockholm). — Knysna, Deepwall Forest Reserve, no. 1843, 1844, 1845. — Knysna, Bracken Hill Forest no. 1766, 1782. — Knysna, Guona Forest Reserve no. 1794, 1803.

Dioica, major, lignicola vel terricola depressa caespitosa, fusco-virens vel flavo-virens, late expansa. Frons repens, ad 2 cm longa, 4—6 mm lata, plana, sine stolonibus, ubique 12—15 cellulas crassa, margine obtusa, cellulae corticales 20—40×40 μ. Ramuli feminei valde carnosi, marginibus papulosis-crenatis et lamellatis. Ramuli masculi carnosi.

Of the same size as *R. pinguis* and somewhat resembling it, fleshy and pale to dark green, grows in depressed mats in admixture with other bryophytes on soil or decaying wood. Thallus often shows bright greenish-white bands on the dorsal surface. Rhizoids numerous, especially at the inflorescences. The axis is prostrate and shows a long continued growth. The living portion $1\ ^1/_2$—2 cm long, 4—6 mm broad. From the thick median portion, which is up to 15 cells high, it gradually thins out toward the rounded margin, which is 1—2 cells thick. The dorsal surface is flat-concave, the ventral surface convex. The thallus is irregularly sinuate and crispate along the margin. The cells of the dorsal surface are about 30—40×40 μ, with convex free wall and contain abundant chlorophyll. On the ventral surface they are

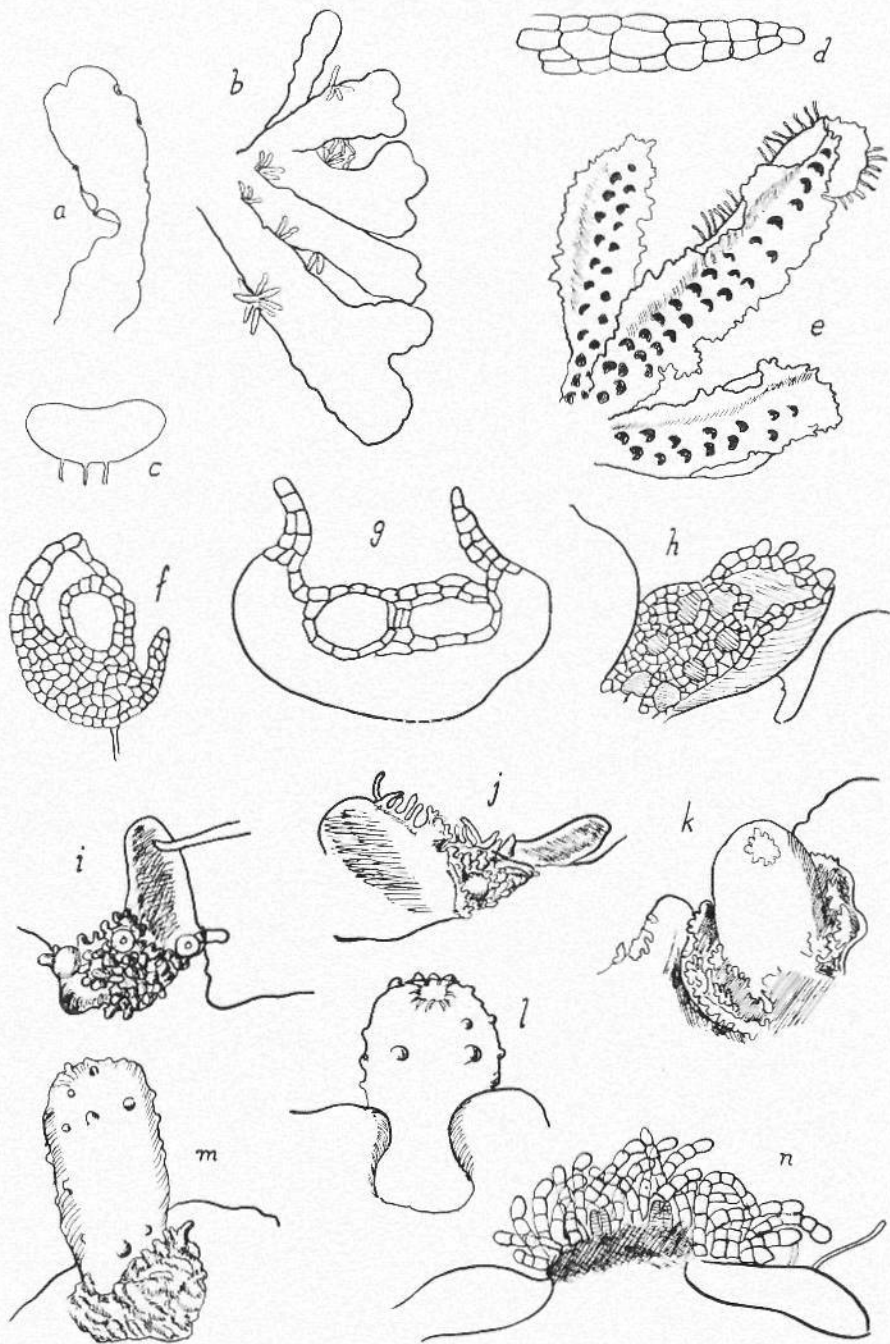Fig. 1. *Riccardia submarginata* S. Arn. *a* Female plant. *b* Male plant. *c* Cross-section of axis. *d* Margin of branch (cross-section). *e* Male inflorescences. *f—g* Cross-sections of male inflorescence. *h* Short male inflorescence. *i, j, k* Female inflorescences in different stages. *l, m* Calyptra seen from the dorsal and ventral side. *n* Female inflorescence.

20×30—40 μ, often with low papillae and invaded with hyphae. From these small surface cells toward the interior a gradual increase in size is apparent, the internal cells being mostly 40×100 μ. The outer walls of the ventral surface cells are slightly thickened, otherwise the cell walls are thin. The fungi often reach the middle part of the thallus, in some hyphae spores can be observed.

The branches are few and mostly of the same width as the main axis. The female inflorescences are situated on short, bud-like, fleshy branches on the ventral side near the margin. The thallus shows an incision at this point and often a short and narrow lobe is developed, covering the inflorescence. In the incision the short brown papillae may be seen that surround the two archegonia, otherwise the inflorescence is hidden. On older inflorescences, after the fertilization of one of the archegonia long cilia and dentated colourless lamellae develop from the surrounding tissue and also on the surrounding margins of the thallus. Calyptra shows large obtuse papillae. Spores and mature capsule were not seen. Male plants are usually of the same size as the female, sometimes smaller, up to 7 mm long and $^1/_2$—1 mm broad. The inflorescences issue from the ventral side of the thallus near the margin, they are fleshy, with up to 20 antheridia, sometimes shorter, with broad, dentate and crenulate margins, with broad erect wings. The antheridial chambers are separated by walls several cells in thickness. Often 3—4 male inflorescences arise close to one another and diverge as a bouquet.

Riccardia compacta (St.) nov. comb.

Cape Prov. Table Mountain, on wet rock on the southern side near the top, no. 963. — Knysna, Guona Forest, Guona River, on slate, no. 1689. — Knysna, Deepwall Forest Reserve, no. 1912.

Oil bodies rare, 3—8$\times$8—22 μ, brownish. Sporophyte on the margin of the thallus, with an irregularly lobated involucrum at the base, perigynium (»calyptra») with low papillae. Spores 12—14 μ, red-brown, smooth. Elaters with one spiral and long twisted ends, 100—200$\times$6—8 μ, yellowish-brown.

Male plant with rather long and fleshy inflorescences with up to 20 antheridia. Wings incurved, with regularly crenulated margins. Walls 2—3 cells thick between the foveolae. On the ventral side of the inflorescences two rows of long papillae. Gemmae 1—2 celled, round.
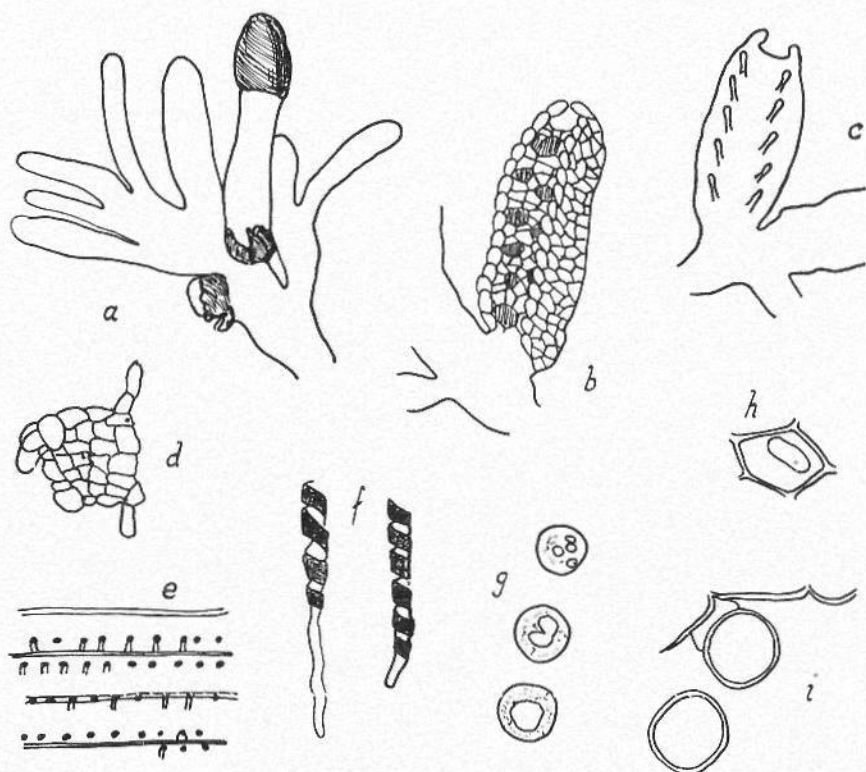
Fig. 2. *Riccardia compacta* (St.) *a* Female plant with sporophyte. *b* and *c* Male inflorescence from dorsal and ventral side. *d* Female inflorescence. *e* Capsule wall. *f* Ends of elaters. *g* Spores. *h* Cell with oil body. *i* Gonidiae.

Riccardia obtusa S. ARNELL nov. spec.

Type: ARNELL no. 1602. Cape Prov., Knysna, Deepwall Forest Reserve, on a wet sandstone-slope (Bolus Herb., Cape Town and Riksmuseum, Stockholm).

Monoica vel dioica, minor, dilute olivacea, dense caespitosa. Frons ad 2 cm longa, irregulariter pinnata, haud alata, medio 9 cellulas crassa, cellulae corticales 14×20—34 μ, cellulae internae 80—90 μ. Truncus pro planta latissimus, repetito breviterque furcatus, pinnulis trunco parum angustioribus. Rami feminei margine apiceque ciliati. Calyptra 2 mm longa, papuloso-lamellata. Sporae 10 μ, viridi-brunneolae. Rami masculi breves, crassi, margine crenulato.

Monoecious or dioecious. The main axis is branched and the plant forms a dense carpet of intricate, strongly adhering branches. The
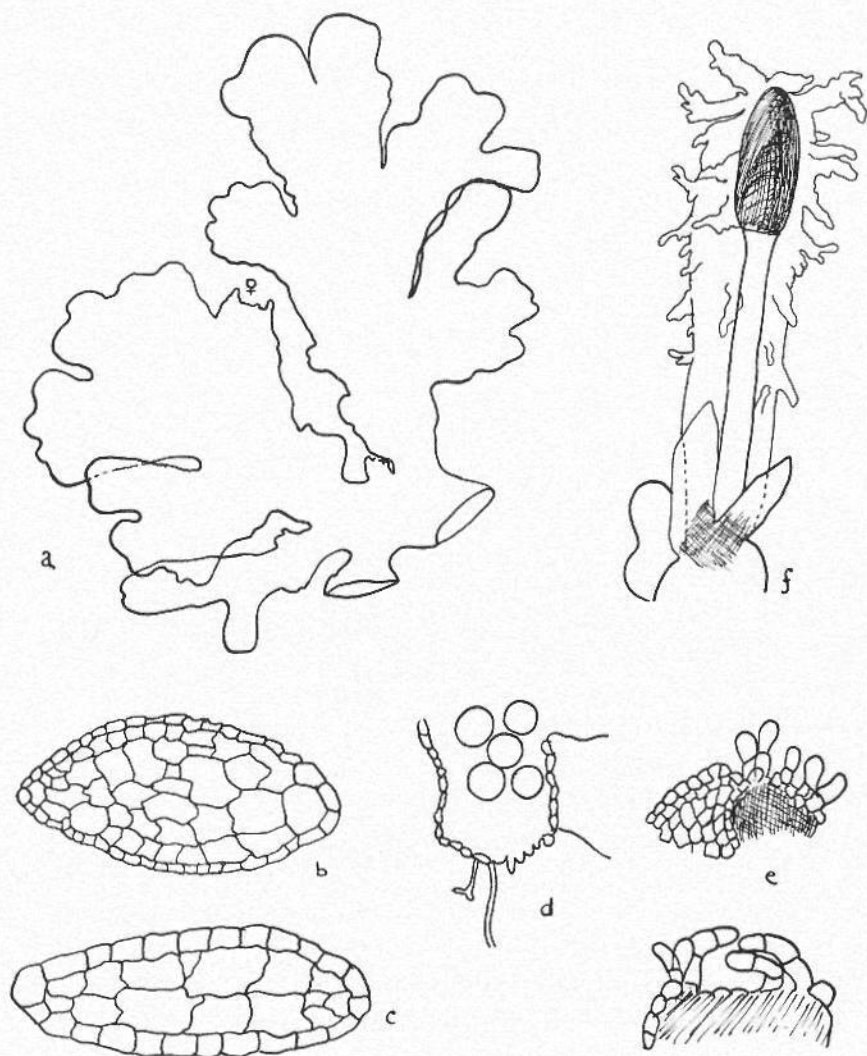
Fig. 3. *Riccardia obtusa* S. ARN. *a* Piece of thallus. *b* Cross-section of axis. *c* Cross-section of secondary branch. *d* Male inflorescence. *e* Female inflorescences. *f* Calyptra.

length is thus difficult to measure, at least 1—2 cm; the breadth about 1—2 mm, in the distal parts somewhat broader. Cross-section shows a breadth twice the height, biconvex with rounded margins, in the median portion up to 9 cells thick. Surface-cells 14×20—34 μ, with slightly thickened walls, inner cells up to 80—90 μ, thin-walled.

Primary branches on each side with intervals of about 1 mm, short and about $^1/_2$ mm wide, giving rise to secondary branches of the same width, also without wings and 4 cells thick. The surface cells are larger than on the axis, about 26×26 μ on cross-section. Marginal cells about 20×20 μ, surface cells in the median portion 30×30—50 μ, with slightly thickened walls, inner cells nearly as large as in the axis with thin walls.

Male inflorescences on the main axis, sometimes opposite to female inflorescences, sometimes on special narrow branches, short, thick, with slightly crenulate margin. Female inflorescences from the ventral side of the margin, bud-formed, short, surrounded by bow-formed cilia 2—3 cells long. Calyptra 2 mm in length, with long, irregularly dentate lamelliform excrescences, especially in the distal portion, at the base long leaf-like bracts with entire margins. Spores 10 μ, with large green centre. Elaters with one spiral, up to 200 μ long and 10 μ broad. Capsule wall with regular semi-circular thickenings.

This plant has a very characteristic habitus, resembling the European *R. latifrons*, with short, blunt branches. The water is coloured yellow-green by the dried plant. The lobes of the capsule-wall are extremely narrow.

Riccardia saccatiflora (St.) nov. comb.

Cape Prov., Knysna, Deepwall Forest Reserve, on decaying wood, no. 1583, 1592, 1597, 1833, 1839, 1843, 1844, 1845, 1849, 1918, 1929, 1952. — Knysna, Buffels Nek, streamside no. 1512, 1515. — Knysna, Garden of Eden, decaying wood, no. 2079, 2133. — Knysna, Guona Forest Reserve, no. 1729, 1738. — Knysna, Bracken Hill Forest, decaying wood, no. 1974. — Above Knysna Town, no. 1672.

Monoecious, on bark or soil. Pale green-olivaceous green. Thallus up to 2 cm long, procumbent, stoloniferous. Main axis biconvex, in the median portion up to 8 cells thick, with obtuse margins sometimes with stolons. In the median portion of the ventral surface the cells are invaded with brown hyphae, sometimes reaching the central part of the thallus. Surface cells about 20×30 μ, central cells of varying magnitude, larger.

Primary branches often long and with $\pm$ short subopposite secondary branches, $\pm$ alate, also here fungi in the ventral median portion, in the central part a band of longer cells. The dorsal surface plane-convex, the ventral slightly convex.
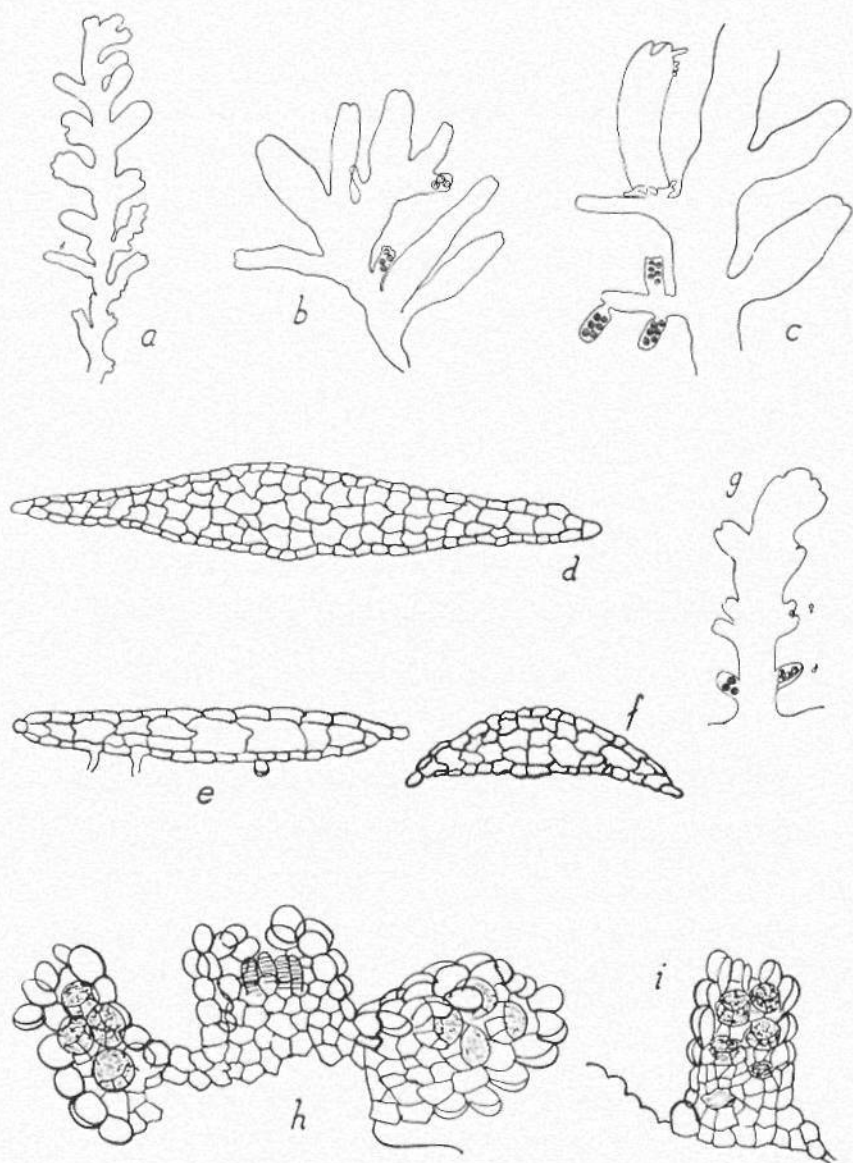
Fig. 4. *Riccardia saccatiflora* (ST.) *a* Thallus with short branches. *b* Plant with male inflorescences. *c* Plant with calyptra and male inflorescences on a special branch. *d* Cross-section of axis. *e—f* Cross-section of ultimate branches. *g* Branch with male and female inflorescences. *h* Male and female inflorescences. *i* Male inflorescence.

Secondary branches thinner with more convex dorsal surface and plane-concave ventral surface, often slightly bow-formed, four cells thick in the median portion and with an indistinct median band, the alae usually 3—4 cells wide, marginal cells 20×50— 40×70 μ, cell walls slightly thickened, sometimes small trigones, the ends bilobed with a sharp incisure.

Inflorescences on the primary or secondary branches, often female and male at a short distance from one another, sometimes on special, narrow branches with both male and female inflorescences.

Male inflorescences linear, with 2—10 antheridia, separated by walls one cell thick, wings erect, one cell broad, margins entire except near the peripheral end, where they are slightly crenulated. Female inflorescences short, bag-like, with 2—4 cells long bow-formed cilia, often ending with clow-like cells, usually two archegonia and a few narrow, long, thread-like »paraphyses» built of very short cells. Calyptra 2—3 mm long, narrow, smooth, only in the distal portion with small phyllous excrescences. Spores 10—14 μ, round, with a rather thin brown »cuticula» and a large green centre. Elaters to 340 μ, 8 μ broad, with one spiral. Capsule wall with regular semicircular thickenings, sometimes forming complete rings. Oii bodies sometimes present, dark, large, composed of very small droplets, one body per cell.

Bisexual branches in the genus *Riccardia* have earlier been demonstrated in three species: *R. androgyna* SCHIFFN. from Java, *R. insularis* SCHIFFN. of the Antarctic islands, St. Paul and New Amsterdam, and *R. diversiflora* Ew. from Chile (EWANS). In South Africa I have found such branches in two species, *R. saccatiflora* and the new species *R. campanuliflora*. *R. saccatiflora* is new for S. Africa.

Riccardia campanuliflora S. ARNELL nov. spec.

Type: ARNELL no. 820—821, Cape Prov., Montagu, Keur Kloof, on stones and rocks in a stream to the right in the bottom of the kloof. — Cape Prov. Table Mountain, Disa Gorge, no. 1060. — Knysna, Guona Forest, no. 1702.

Monoica, olivaceo-viridis, saxicola, dense depresso-caespitans. Frons ad 2 cm longa, 0.6—0.8 mm lata, plana. Truncus haud alatus, medio 6 cellulas crassus. Pinnae medio 4 cellulas crassae, margine unistratae, 1 cellula latae. Rami feminei crassi, margine crenulato. Calyptra clavata glaberrima. Rami masculi breves, margine crenulato.

Monoecious, olivaceous green. The main axis shows a long continued growth, up to 2 cm long and 0.6—0.8 mm wide, very flat. Cross-section
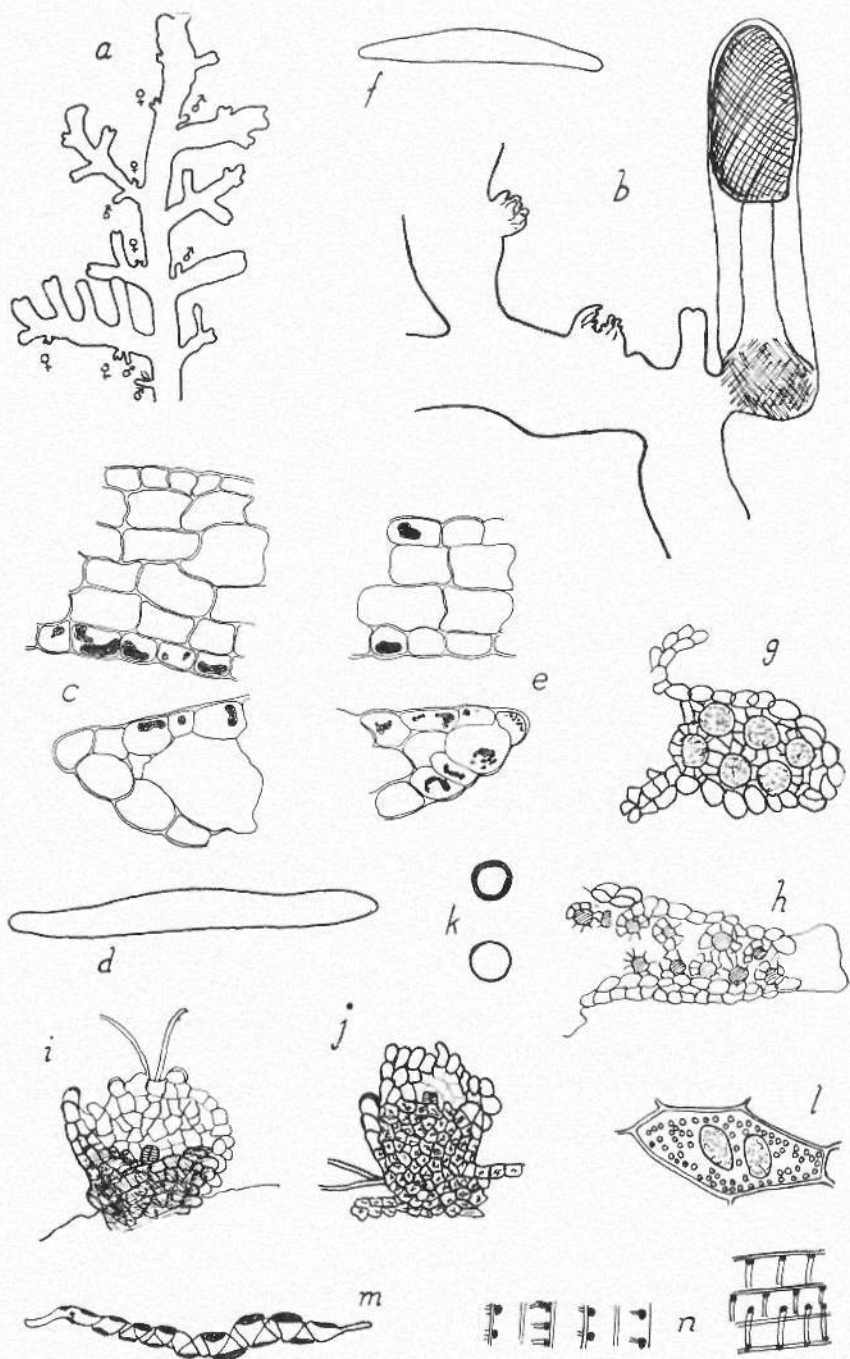
Fig. 5. *R. campanuliflora* S. ARN. *a* Plant. *b* Plant with sporophyte. *c* and *d* Cross-section of axis. *e* and *f* Cross-section of branch. *g—h* Male inflorescences. *i—j* Female inflorescences. *k* Spores. *l* Cell with oil bodies and small chloroplasts. *m* Elater. *n* Sporogonium wall.

shows a slightly convex ventral surface and a dorsal surface with slightly convex margins and flat—slightly concave mid-part. The margins are blunt and have only one row of single cells, in the median portion it is 6 cells thick. The surface cells are on cross-section about 20×20 μ. in the dorsal layer with abundant chlorophyll, the ventral and central cells colourless. In living cells there are often dark-coloured oil bodies composed of very small droplets, 1—2 per cell, 8×10—10×15 μ. The walls of the surface cells have slightly thickened faint brownich walls, cuticula smooth. The central cells are larger, about 40×50 μ, with thin walls. At intervals of about 1 mm the axis gives rise on each side to obliquely (60—70°) spreading branches, either short and limited in growth or mostly long and with 3—5 secondary branches, the latter being alternate, 1—$^1/_2$ mm long and gradually decreasing in length towards the apex. The branches usually have chlorophyll in both the ventral and dorsal surface cells. The dorsal surface is convex and the ventral flat—slightly concave. They are 4 cells thick and show a blunt margin as the axis, with only one row of single cells. The surface cells are rather uniform, hexagonal-rectangular, 20×30—40 μ. Marginal cells 30—100 μ long, varying in breadth, from 10—50 μ, marginal wall thin.

Riccardia capensis S. ARNELL nov. spec.

Type: ARNELL no. 1970, Cape Prov. Knysna, $^1/_2$ mile south Deepwall Forest Station, on bark (decaying log, Ocotea bullata?).

Dioica, pallide viridis, minima, in cortice late expansa. Frons 1—2 cm longa, 0.5 mm lata, 4 cellulas crassa. Pinnae 2—3 cellulas crassae, margine in alas unistratas 3—4 cellulas latas transientes. Rami feminei breves, subplanae, margine crenati, apice subciliati. Calyptra cellulis accumbentibus papulosa. Rami masculi stricti, anguste lineares, margine haud alato, crenulato, erecto. Antheridia ad 20.

Dioecious, 1—2 cm long, 0.5 mm broad. The median portion of the main axis and primary branches is 4 cells thick. The decrease in thickness toward the somewhat pointed margins is gradual and slight. Both surfaces are slightly convex. On cross-section the surface cells are 10×30—16×40 μ. inner cells about 40×50 μ. In the central part of the surface there is a band composed of 40—50×80—100 μ long cells. The lateral cells are shorter, 30—40×50—70 μ. the marginal cells 25—50 μ long, the margin slightly crenulated by prominent cell walls. Branches arise at intervals of about 0.5—1 mm on each side of the axis and spread obliquely (45—60°); they are narrower near the
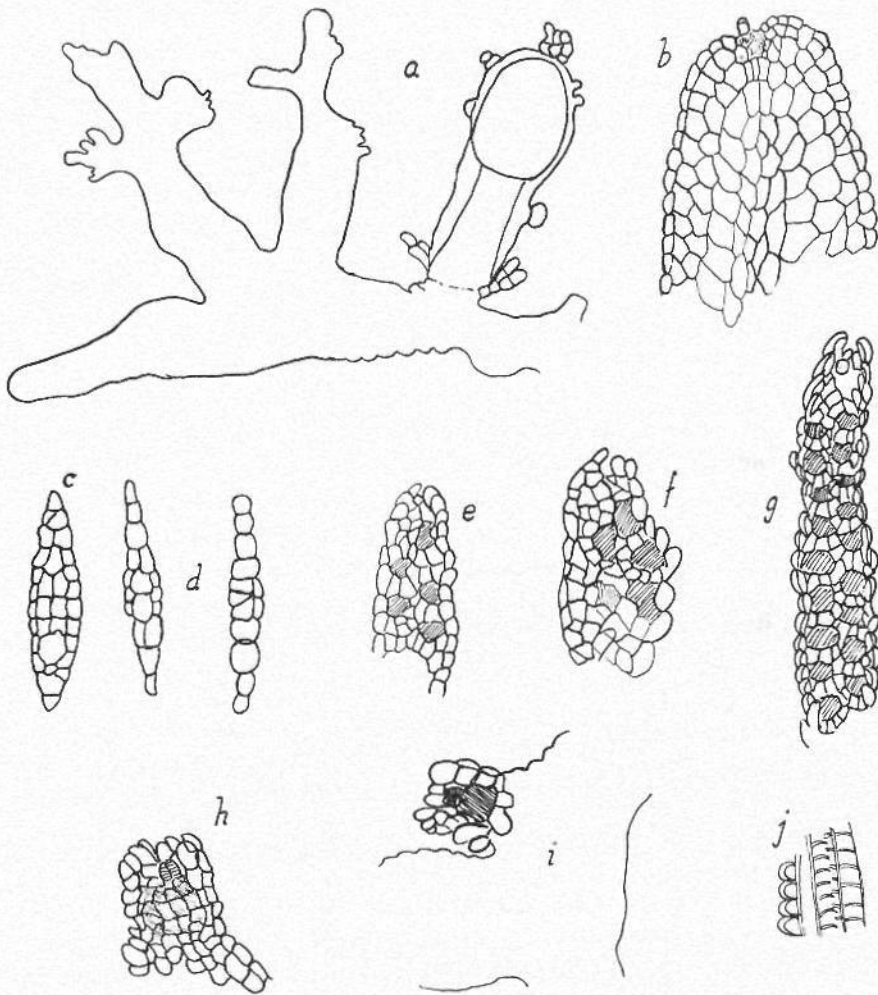
Fig. 6. *R. capensis* S. ARN. *a* Plant with sporophyte. *b* Ultimate branch. *c* Cross-
section of axis. *d* Cross-section of branches. *e—g* Male inflorescences. *h—i* Female
inflorescences. *j* Sporogonium wall.

axis, then become broader and are then linear or decreasing in breadth
towards the end. In the branches the median band is narrower, the
wings one cell thick. In the ultimate branches the median band is
usually only 2—3 cells broad (20—40×50—60 μ) and from this larger
cells (40—50×70—100 μ) diverge towards the margin, which is com-
posed of smaller cells (about 20×30—40 μ), the margin crenulated by

protruding cell-walls. Sometimes there also are narrow, stolon-like branches, 2—4 cells wide. Cell walls thin. The ventral side with numerous slime-papillae and rhizoids, cuticula rough on this side.

The inflorescences are on the side of the main axis and the primary branches. Male inflorescences are long and numerous. They arise singly, usually from a primary branch. The inflorescence occupies nearly the whole length of the branch. The wings are one cell wide, erect or connivent, the margin crenulated by projecting cells. The antheridia 4—20, seldom more. The openings for the chambers are separated by walls one cell thick. The female inflorescences are simple and short, flat and with short crenulated wings, single or in subopposite pairs on the main axis or primary branches. »Calyptra» smooth or with some protruding cells and tipped by a corona of sterile archegonia. The capsule opens with four long and narrow valvules, the capsule wall with regular semi-circular thickenings. Elaters 120—200 μ long and about 8 μ broad, with one spiral and often very long ends. Spores 8 μ, smooth, with thin brown wall and green centre.

Riccardia rhodesiae S. ARNELL nov. spec.

Type: ARNELL no. 1311. S. Rhodesia, Victoria Falls rainforest, on bark.

Dioica, coriacea, olivaceo-virens. Frons 5 mm longa, 0.3 mm lata, medio 5 cellulas crassa, cellulis externis $10 \times 12 - 20 \times 30 - 40$ μ, cellulis internis 20×40 μ. Pinnae oppositae, partim angustae. Rami feminei brevissimi, margine crenulati. Rami masculi breves.

Dioecious, dark olivaceous green, growing on bark. The axis shows a continued growth and is about $^{1}/_{3}$ mm wide, the plant up to 5 mm long. It has a tendency to broaden towards the apex, especially when the basal portion is narrow. It is biconvex, about 5 cells thick with smaller surface cells (about $8 - 10 \times 20 \times 40$ μ) with slightly thickened cuticula and thin-walled inner cells about $34 - 36 \times 44$ μ on cross-section, the cell walls often being contorted and sinuous, the margin rounded, without wings. In the broader parts and primary branches the thallus usually is 4 cells thick and often has a margin of one, seldom two cell rows only one cell thick. Marginal cells $12 \times 30 - 40$ μ, other surface cells $20 \times 30 - 40$ μ, on cross-section surface cells about 10×20 μ, inner cells 20×40 μ.

Fig. 7. *Riccardia rhodesiae* S. ARN. *a* Male plant. *b* Cross-section of axis. *c* and *d* Cross-section of a primary branch. *e* Female plant. *f* Male inflorescences. *g* Female inflorescence.

d

c

a

b

e

f

g
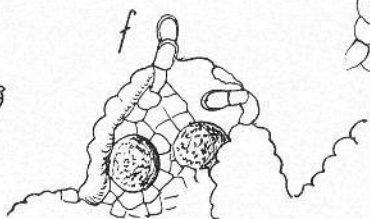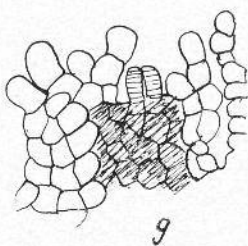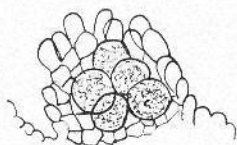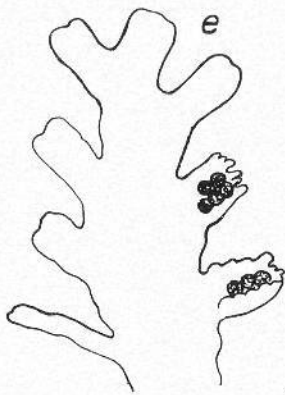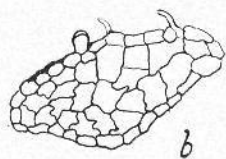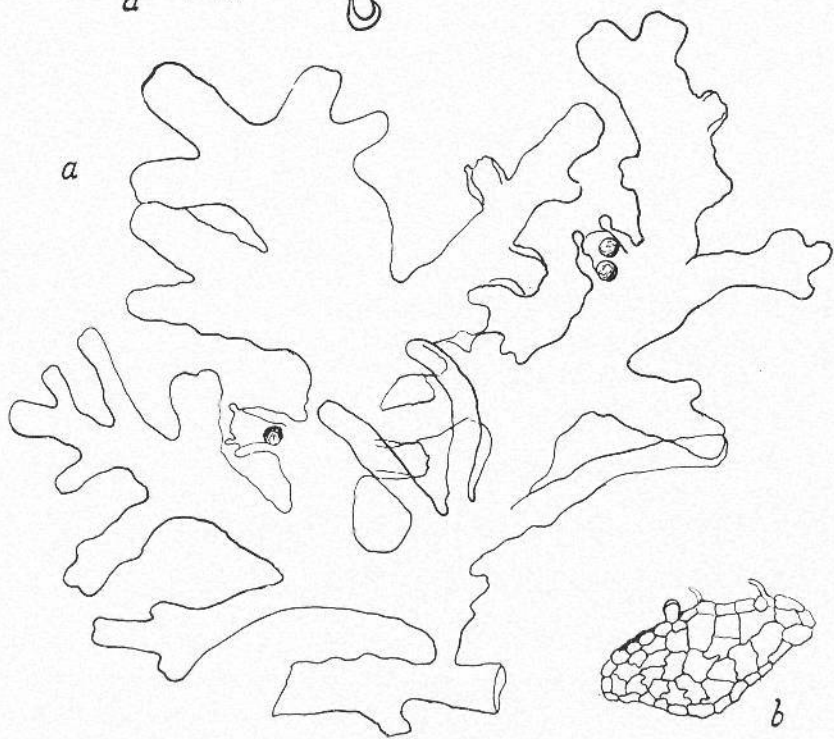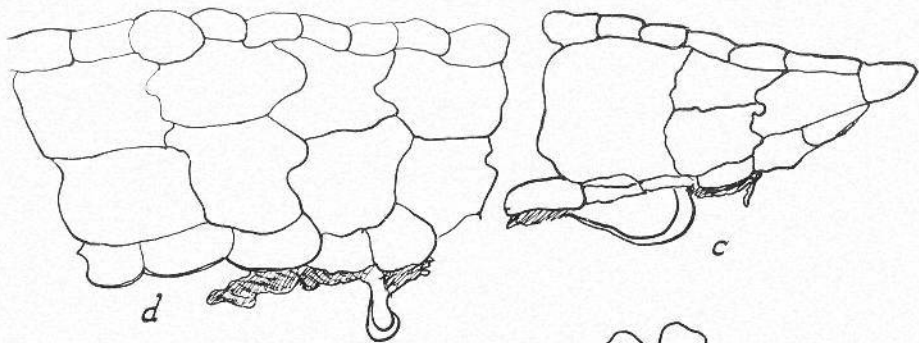
The primary branches show a tendency to opposite arrangement and continue the growth in the same manner and often function as a new axis, the plant thus developing many branches, partly covering one another. The branches spread out obliquely and usually are linear. At the basis of the axis there often are long narrow branches. The primary branches usually give rise to very few secondary branches.

The sexual branches are short and arise from the axis, one or two on each side. The male inflorescences are short, with wings 1—3 cells broad, ending with a few blunt cilia 1—2 cells long, the antheridia 2—6, lying in direct contact with one another.

The female inflorescence is very short, with wings consisting of large, round cells, forming a strongly crenulated margin.

Calyptra and capsule were not seen.

Characteristic for the species are the two types of branches, stolon-like and normal, the small surface cells, the male inflorescences with antheridia without separating walls.

Riccardia reticulata (STEPH.) nov. comb.

Cape Prov. Peninsula, above Muizenberg, PILLANS no. 3978.

Dioecious, dark green. The axis shows a living portion up to 3 cm long, about 1 mm broad. The median portion is up to 5 cells thick (according to STEPHANI up to 8 cells thick) and the decrease in thickness toward the rounded margin is gradual and slight. Both surfaces are slightly convex. The surface cells are small, 30×30—36×70 μ, with thick cell walls and sometimes small trigones and strongly striated cuticula, especially in the median parts. The marginal cells on the axis are usually long, about 20×60 μ, shorter and broader on the branches, at the ends up to 40×60 μ, with thicker walls than on the median surface-cells. The inner cells large, about $70 \times 70 \times 40$ μ, thin-walled, translucent, especially in the branches. The branches arise at intervals of 2—3 mm on each side and spread obliquely. They are linear or sometimes narrower near the axis. An occasional branch represents a new axis and exhibits indefinite growth, but most branches soon stop growing and their length varies between 1—2 mm.

Male plants of the same size, inflorescences short (according to STEPHANI long, with up to 25 antheridia), usually from the side of a secondary branch, with narrow base and sharply crenulated wings 2—5 cells broad and 3—5 antheridia. Sometimes a secondary branch ends with a male inflorescence.
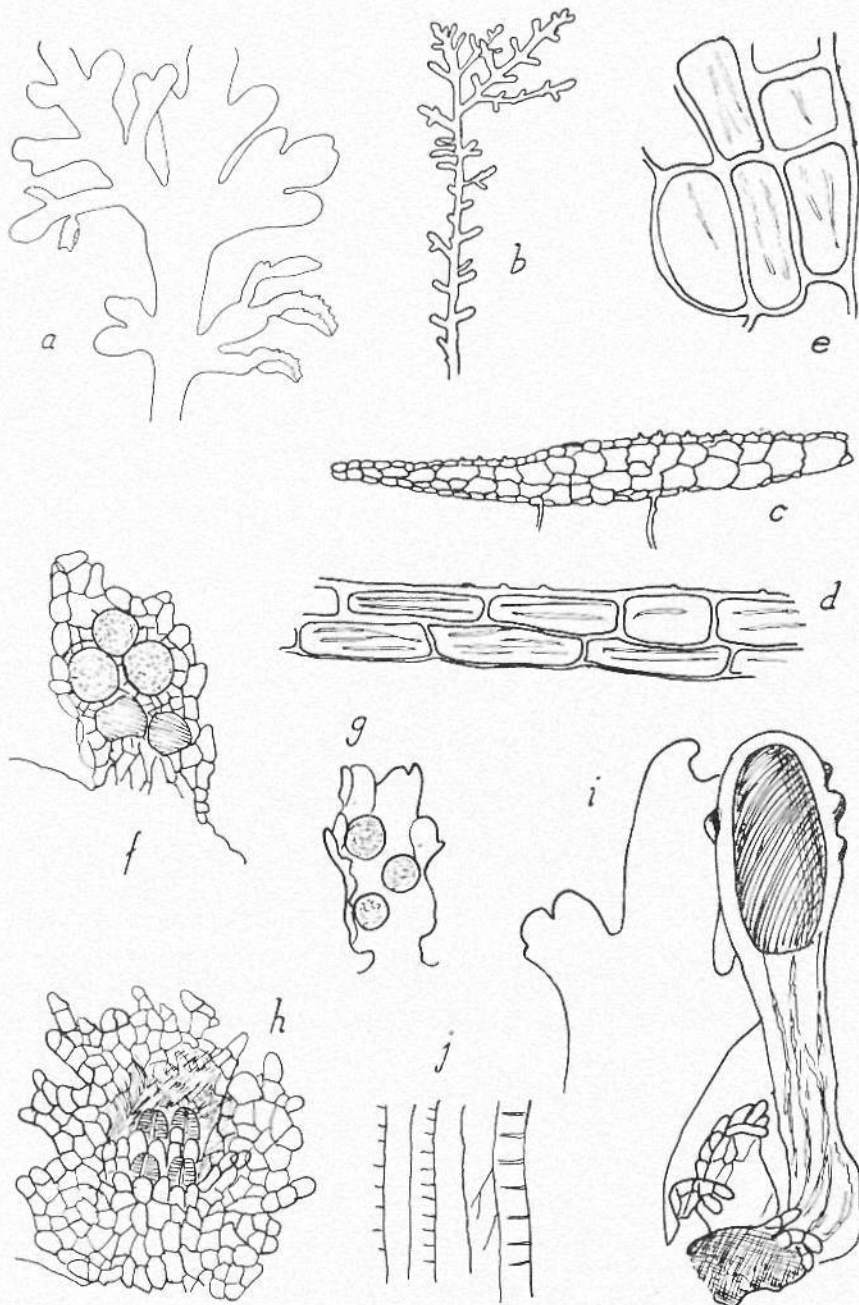
Fig. 8. *Riccardia reticulata* (ST.) *a* and *b* Barren and male plant. *c* Cross-section of primary branch. *d* Marginal cells from the axis. *e* Marginal cells from an ultimate branch. *f—g* Male inflorescences. *h* Female inflorescences. *i* Sporophyte. *j* Capsule wall.

Female plants with inflorescences on the margin of the main axis,
with many archegonia and broad, shortly lobate and ciliate wings. The
sporogonium-wall thin, pale yellow, with thin cell walls and very thin
semi-circular thickenings and slightly striated cuticula. Spores 8 μ in
diameter, pale yellow. Elaters 3—4 μ thick.

The characteristic long, dark green thallus and the thick striated
cell-walls distinguish it at once from the other South African species
of *Riccardia*. It is new for S. Africa.

Riccardia fastigiata (LEHM. & LDBG.) nov. comb.

Cape Prov., Cape Peninsula, W. of the plateau on the Muizenberg,
shaded bank of Marsh stream below the waterfall, PILLANS no. 3250. —
Table Mountain: Window Gorge, no. 407, 411. — Skeleton Ravine, no.
539, 548. — Orange Kloof Forest Dept., streamside, no. 2029. — Knysna,
Bracken Hill Forest, streamside, no. 2029.

In dark green, as wet somewhat glistening, carpets in spray from
streams and waterfalls, seldom on dry streambanks. The main axis is
usually 1.5—2 cm long and 0.6—0.7 mm wide, continues in growth
indefinitely. Both ventral and dorsal surface slightly convex, the edges
are rounded and show no indications of wings, marginal cells slightly
smaller. The median portion is usually 5—6 cells thick, all cells have
thin walls. The cells of the surface layer are mostly 20—40×30—50×
×12—20 μ, the marginal cells 20—24×30×12—14 μ, the interior cells
about 60×90×120 μ.

At intervals of about 1 mm on each side the axis gives off obliquely
(about 45°) spreading branches, either short with limited growth or
2—3 mm long, sometimes giving rise to a new axis, sometimes also
narrow, stolon-like branches. The longer primary branches give rise
to subopposite secondary branches of 1—1/2 mm in length. The primary
and secondary branches have a convex dorsal and plane-concave ventral
surface, the margins often deflexed. The median portion is 4—5 cells
thick, the structure is essentially like that of the axis except that the
margins are thinner and winged with 2—3 rows of cells in one layer,
the margin slightly crenulate. Surface cells 12—20×30 μ, inner cells
to 70×100 μ. The ends have a shallow and not quite sharp incision
at the vegetation-point, which is protected by a pair of brown slime-
papillae. Single slime-papillae are also often seen on the ventral surface
of the thallus. Oil bodies absent.

Male inflorescences on special branches from the ventral side of
the axis and primary branches near the margin, spoon-formed, with
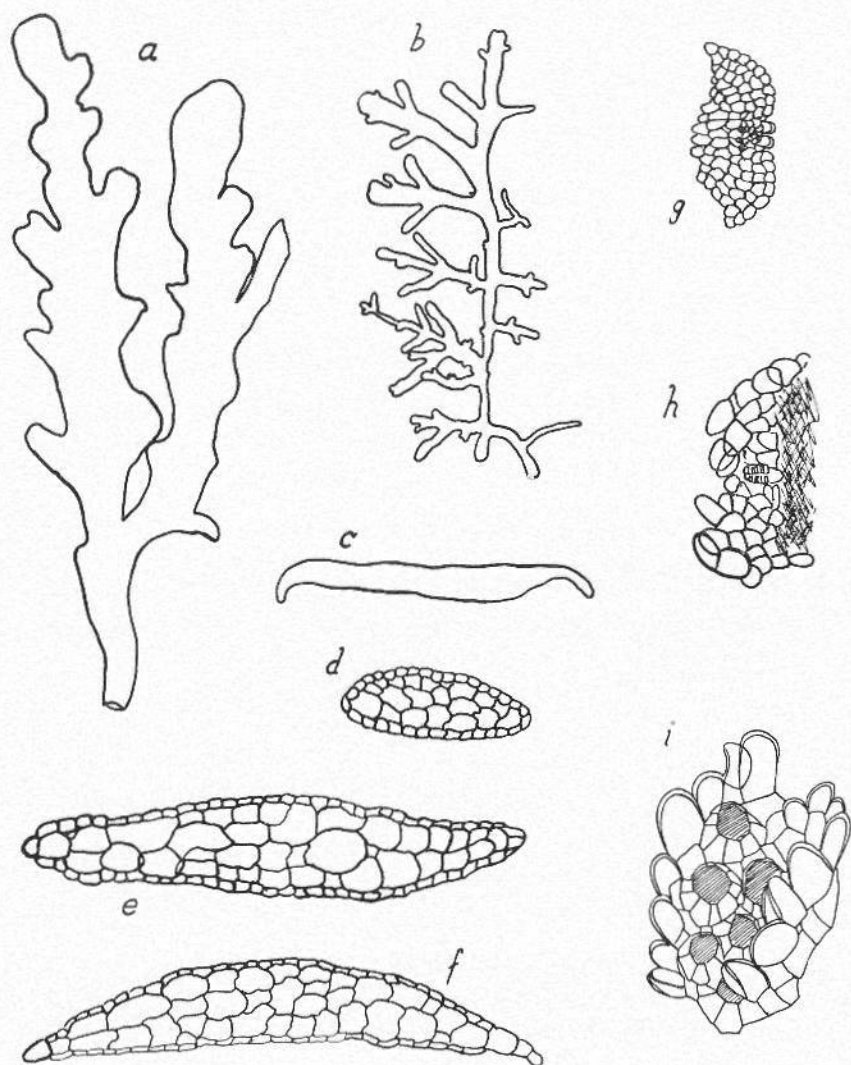
Fig. 9. *R. fastigiata* (L. & L.) *a* Plant (type-specimen, coll. ECKLON). *b* Plant (no. 539). *c* and *e* Cross-section of primary branch. *d* Cross-section of axis. *f* Cross-section of ultimate branch. *g* End of a branch. *h* Female inflorescence. *i* Male inflorescences.

crenulate margins often with clow-like cells. Antheridia 4—5, 80—90 μ in diameter, separated by walls one cell thick. Female inflorescences on special short branches, bud-like, on the margin of the thallus, with short wings and short cilia, ending with mostly ellipsoid, sometimes

clow-like, triangular, sharply pointed cells. »Calyptra» smooth. Capsule-wall opens with 4 valvules, with regular long cells and regular, semi-circular thickenings. Spores 12—14 μ, smooth, with a brown »cuticula» and a large chloroplast in the centre. Elaters about 140 μ long and 8—10 μ broad, with one spiral, orange-brown, up to 6 μ broad.

Summary.

The author describes 5 new species of *Riccardia* from South Africa, namely *R. submarginata* S. ARN., *R. obtusa* S. ARN., *R. campanuliflora* S. ARN., *R. capensis* S. ARN., *R. rhodesiae* S. ARN.

R. saccatiflora (ST.) S. ARN. nov. comb. and *R. reticulata* (ST.) S. ARN. nov. comb. are reported as new for S. Africa. The descriptions of the earlier known species *R. compacta* (ST.) S. ARN. nov. comb. and *R. fastigiata* (L. & L.) S. ARN. nov. comb. are made complete. A key for the South African species of *Riccardia* is given.

Diatoms in trumpet-formed catching-nets of Neureclipsis bimaculata L. in Sweden.

By NIELS FOGED.
Odense, Denmark.

Since in 1900 C. WESENBERG-LUND noticed the first catching-nets of larvae of *Trichoptera* in the outlet of the Fiil Sö (Lake Fiil) in Western Jutland in Denmark, such nets have been observed in many other localities of Denmark and the rest of Scandinavia. The most regular and elegant catching-nets are made by the larva of *Neureclipsis bimaculata* L., its nets being as a rule more or less trumpet-formed (C. WESENBERG-LUND 1948, fig. 164, 165). The species is usually found in running water in Central or Northern Europe. From Sweden it was stated by G. ALM (1917, p. 217) from several localities of Central and Southern Sweden.

At times the catching nets are very conspicuous, being completely coated with microorganisms filtered from the water that flows through the nets, the latter simply working as so many excellent plankton-nets. The colour of the caught material changes with the time of the year according to the rythm of the plankton-flora. In the periods of spring and autumn the nets will (in Denmark) be brown or yellowish brown with coats of diatoms, whereas in midsummer they may be green or bluish green because of the green and bluish *Chlorophyceae* and *Cyanophyceae* dominating at that time.

The nets, being fastened to pebbles or plants in the flowing water, will be run through by a considerable quantity of water, and there can be no doubt that almost the whole of the organisms floating in the water and of the micro-organisms carried with the water will be retained in the nets, the width of their meshes being very small. The thickness of threads is given by G. ALM (1926, p. 255) to be that of 0.0015—0.0025 mm. Their durability is only slight. If the strength of current increases beyond a certain limit, the threads will be rent at

once, and if the current stops, they will collapse, thus making their original form undiscernible. The duration of the nets in nature is probably fairly small. ESBEN PETERSEN (1906, p. 145) e.g. observed the first nets in a certain locality on the 14th of September, and on the 22th of the same month they were gone. Perhaps the plankton-nets are made only during a rather short period of the life of the larva and under special circumstances, for the nets are far from having been observed in every such place where the larvae were observed.

It ought perhaps to be added that the catching-net spinning larvae use their nets for catching as well vegetable as animal plankton, which is thereafter devoured by the larvae.

In what follows there will be accounted for the diatoms observed in material from two Swedish localities. In both places there were collected some trumpet-formed nets consisting in either locality of two samples, which were taken with intervals of few meters. One locality (Kåbdalis) was a small river with brown water and forming the outflow of a rather small lake in Lappland between Jokkmokk and Älvsbyn (about 2 km South of Kåbdalis, about latitude North 66°, longitude East 20°). Here were found in 1947 on the 20th of July in a stretch of 20—30 m innumerable trumpet-formed nets of *Neureclipsis bimaculata* L. fastened to plants and to bed-sides of the river. All of them were brown with their coats of diatoms and thereby very conspicuous in the sunshine. The other locality is the Dalälv at Gysinge (latitude North about 60° 20', longitude East about 17°) North West of Uppsala. On the 23rd of July, also in sunshine, were observed over a similar stretch as at Kåbdalis large quantities of the same net type. Here, however, most of the nets were fastened to big stones in the river-bed in shallow water.

In either place the speed of the current was exactly such as to keep the delicate nets stretched with their mouths against the current, and here too all the nets were brown-coloured with diatoms.

The collected nets were treated with conc. sulphuric acid by means of which organic matter was removed. As mounting media for the production of microscopic preparations were used Sirax and Realgar. The drawings were made by means of Reichert's drawing apparatus with a magnification of about 4000 ×.

As mentioned above the majority of the diatoms found in or on the nets must be considered having been caught in quite the same way as plankton-samples are collected by means of plankton-nets. Still there is the possibility that the very nets might be the settlement and place of growth of certain diatom-species i.e. constituting a special and

characteristic biotope. Several milieu-factors may well here be optimal in particular to rheobiontic and rheophilous forms. It may be the case as for electrolytes, inasmuch as the running water of the locality in question is, moreover, well supplied with such; the supply of oxygen and carbon dioxide will most often be favourable, light-conditions and temperature too are capable of yelding good chances of the development of diatoms. So the conditions presumably must often be such that many diatoms, being caught in the nets and being capable of dividing, will at once begin multiplying on these. The nets then will very quickly be covered with a brown and very nutritive coating which then can be grazed off by the larvae living in the nets, the former becoming »self-supplying» to a certain degree. As far as I know, there have been made no investigations on the matter. The very fact that the number of species found in the samples examined here is so large, does not, it is true, point exactly into that direction. The large number of forms rather implies that the question is here mainly that of displaced — allochtonic — forms, whereas real and established — autochtonic — forms seem to be fairly few.

It is a characteristic thing, that there were found numerous quite small forms (in particular *Achnanthes*- and *Navicula*-species), whose valve-length often constitutes no more than 5 —7 μ, i.e. less than the size of the erythrocytes. The catching power of the nets must be considered exceedingly effective. Also long and thin *Fragilaria*- and *Nitzschia*- and *Synedra*-forms constitute a considerable portion of the total number of valves.

Most of the forms found are littoral ones, a fairly large part are plankton-forms, whereas bottom-forms proper were found in very small number.

The author regrets that no exact information of the milieu-conditions of the two localities have been available to him. It can only be discerned from the character of the water and from the surroundings, that the surroundings of the locality of Kåbdalis must be considered being of an »oligotrophic» character and with but slightly nutritive water with a pH-reaction of about 7 or even a little less. The waters of the Gysinge-locality are more »eutrophic», their amount of nutrient is larger and their pH probably more than 7. This opinion is confirmed by examining the diatom-material. The genera: *Eunotia, Gomphonema* and *Pinnularia* are (at a rough estimate) more frequent in the Kåbdalis-material than in the Gysinge-material. The latter evidently contain more *Fragilaria*- and *Navicula*-valves than the samples from Kåbdalis

do. The distribution of the centric genera is curious. The *Cyclotella*-genus, being usually the dominating centric genus in Nordic oligo-trophic localities is nearly not represented in the Kåbdalis-samples (only one single *C. Meneghiniana*-valve was found), while several species are common in the Gysinge-samples. As for the *Melosira*-species there is no difference to be discerned in the two places. *Stephanodiscus*-species were found only in Gysinge.

The richness in forms is larger in Gysinge. Every one of the genera found in Kåbdalis with the exception of *Coscinodiscus* were found in Gysinge, which furthermore contains representatives of these 12 genera: *Amphipleura, Amphiprora, Attheya, Cymatopleura, Denticula, Didymosphenia, Mastogloia, Meridion, Opephora, Peronia, Rhizosolenia, Stephanodiscus*. Out of these the representatives of the three first genera are very hyalinous forms, which often disappear quickly from deposits in nature and possibly suffer from the fairly rough treatment of the material during the cleansing and the production of preparations.

Many of the found forms were hitherto met with in only very few places, several of them have evidently not been detected before in Sweden. Some of them will be briefly mentioned below, and a number of them are depicted in the plates.

It will be seen from the subsequent flora-list that in the two localities there were detected in all 43 genera, 317 species and 411 forms. In the Kåbdalis-material were found 241 forms in all, comprised by 184 species and 31 genera, while the Gysinge-material contains 374 determined forms belonging to 295 species in 42 genera.

For the sake of comparison it is added that A. CLEVE (1895) in Lule Lappmark found 270 forms in all (out of which 34 in Ancylus-deposits), that F. HUSTEDT (1942) from the Abisko-area mentions 274 forms (215 species in 36 genera) and that G. KRASSKE (1949) in the Lappland-area in 166 samples, peculiarly from the Finnish Lappmark, found 419 forms belonging to 323 species in 36 genera.

From the investigation it appears

1. that not only plankton — but also epiphytic and littoral fresh-water diatoms are carried by running water for shorter or longer distances,
2. that part of the carried valves, even the smallest, are caught by *Neuroptera*-nets in running water while alive (cell content intact); final sedimentation probably takes place when the nets are destroyed,
3. that a far larger number of diatom-forms than generally supposed are dragged with the current in the running water away from their

original place of growth in order to be sedimented farther down in the riverbed.

4. that a large amount of marked lake forms are carried for shorter or longer distances in the outlet of the lake and

5. that the number of valves carried by the current must be very large, as only a slight portion of the water will normally pass through the nets, which are fastened on plants, pebbles or to the sides of the river-bed or to its bottom.

Enlarged investigations of the diatoms in nets of caddis flies will be able to give information of

1. the local diatom-flora, a summary one, it is true, but fairly copious,

2. the extent of the transport, if there is a chance of an examination of nets in various places down the outlet of a lake or other locality having a characteristical diatom-flora.

3. the extent of the transport of other microphytes and

4. whether the nets themselves are the place of growth for diatom-species (or other microorganisms) which the net-makers can feed on.

In the following survey the forms found in the two localities are stated in systematic succession. Within the separate genera the species are always given in alphabetic order.

As to each form it is tried to state its relative frequency in the nets of the locality, using a 6-partite scale (1: rare, 2: not rare, 3: fairly common, 4: common, 5: very common, 6: extremely frequent).

It must be emphasized, that though out of each sample several preparations were inspected with a great magnification, the following list ought not to be considered complete. A number of forms, particularly some of the very small ones, could not possibly be determined within the time at disposal. It also ought to be emphasized that the samples treated were not collected with special reference to a study of the flora of the *Neuroptera*-nets but as part of a general orientation in the diatom-flora of Scandinavia.

Some new or rare Diatoms found in Trichoptera nets in Sweden.

Cyclotella pseudostelligera HUSTEDT (1939). Fig. I: 1.
    FR. HUSTEDT 1939, p. 445, fig. 8.

This small *Cyclotella*-species with its characteristic marginal spines is perhaps a fairly wide-spread plankton-form in nordic fresh-water. In the Gysinge-material it is fairly common. Earlier

observed in Germany (HUSTEDT, 1950) and in Denmark (FOGED, in lakes of Funen and Jutland, not publ.).

C o c c o n e i s   t h u m e n s i s A. MAYER (1919). Fig. 1: 2 a, b.
    FR. HUSTEDT 1950, p. 347, plate XXXV, fig. 37—40.

This species seems to be rather wide-spread in Central Europe as well as in Northern Europe. From Sweden it was stated by ASTA LUNDH (1951, p. 109) from 9 localities of Southern Sweden. In Denmark it seems to be commonly wide-spread as well in lakes as in springs (FOGED, 1951, p. 44).

A c h n a n t h e s   d i d y m a HUSTEDT (1937). Fig. 1: 10 a, b, c.
    FR. HUSTEDT 1930—37 II, p. 405, fig. 837.

This species is very characteristic and seems to be wide-spread and frequent in nordic fresh-water. It is probably overlooked because of its small size and thin valves. Found earlier in Finland (HUSTEDT, 1937, p. 405, KRASSKE, 1949, p. 13).

Common in the Kåbdalis — as well as in the Gysinge-material.

A c h n a n t h e s   g r a c i l l i m a HUSTEDT (1927) emend. FOGED. Fig. I: 9 a, b.
    FR. HUSTEDT 1927, p. 161, plate V, fig. 10, 11.

To the original diagnosis should be added: Rapheless valve with 36—38 nearly parallel striae in 10 μ. Raphe-valve with 36—38 weakly radial striae in 10 μ. The dots of the striae are inconspicous. Length 25—31 μ.

Described by HUSTEDT from material from Lake Aokiko in Japan.

In material from Gysinge this very thin-valved species is fairly common. Most of the specimens are a little larger than those described by HUSTEDT, namely 26—31 μ long as against HUSTEDT's 25 μ. None of the valves found in the Gysinge material were smaller than 25 μ long. It proved possible to dissolve their structure by using realgar as mounting medium and optics with a high numerical aperture, monochromatic blue and oblique light.

As *A. gracillima* is fairly common in the Gysinge material, it must be supposed to appear as a plankton form either in the Dalälv itself or in one or more localities (lakes?) above Gysinge. The species is probably more wide-spread in Nordic freshwater, but has hitherto been overlooked.

The diatom-flora of the Aokiko lake has a subalpine stamp and
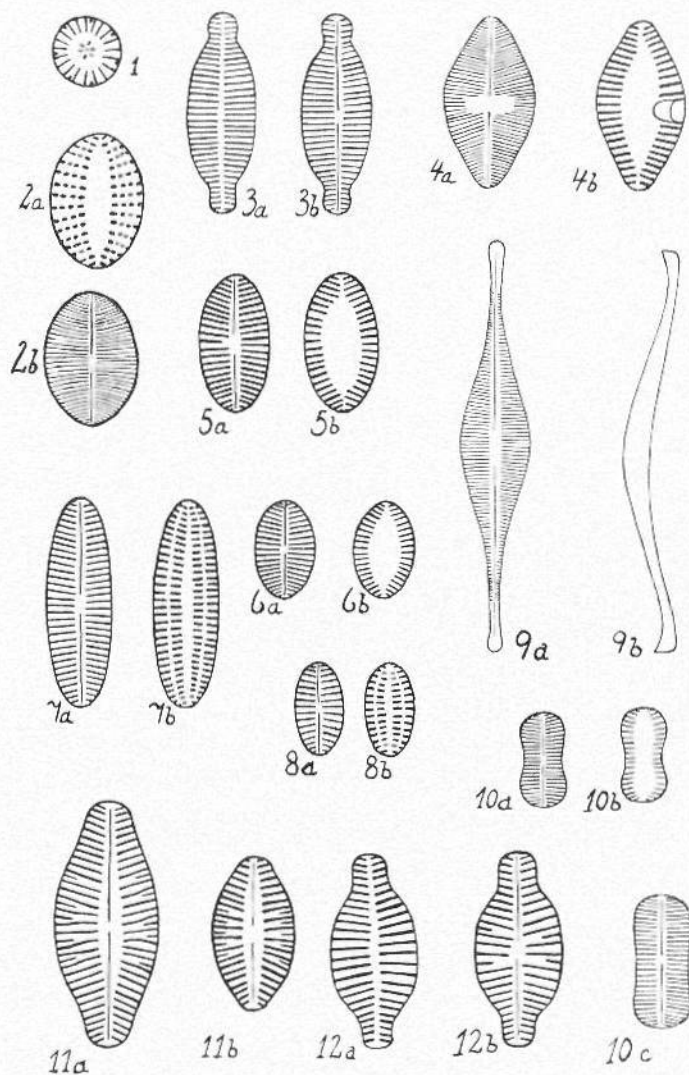
Fig. 1. 1. *Cyclotella pseudostelligera* HUSTEDT. 2 a, b. *Cocconeis thumensis* A. MAYER. 3 a, b. *Achnanthes Biasolettiana* (KÜTZ.) GRUN. 4 a, b. *Achnanthes Ostrupii* (CLEVE) HUSTEDT. 5 a, b and fig. 6 a, b. *Achnanthes Levanderi* HUSTEDT. 7 a, b and fig. 8 a, b. *Achnanthes Suchlandti* HUSTEDT. 9 a, b. *Achnanthes gracillima* HUSTEDT emend. FOGED. a. raphe valve. b. in girdle view. 10 a, b c. *Achnanthes didyma* HUSTEDT. 11 a, b. *Achnanthes laterostrata* HUSTEDT fo. *Krasske* nov. fo. 12 a, b. *Achnanthes laterostrata* HUSTEDT. — Ca. 1750 ×.

contains a considerable number of forms that usually are considered nordic or subalpine (particularly species of these genera: *Melosira, Surirella, Achnanthes, Cymbella, Gomphonema, Pinnularia, Tetracyclus, Diatomella*) a diatom association which seems very like that in which the species is met with here.

Found, but rare, in Finland by A. CLEVE (1934, p. 40) and by KRASSKE (1949, p. 13).

Achnanthes laterostrata HUST. *fo. Krasske* nov. fo. Fig. I: 11 a, b.

Syn.: *A. laterostrata* HUST. *fo.*, KRASSKE 1943, p. 85, fig. 8, 9.

Deviation from the species: Valves not narrowing towards the ends or very little so.

The form depicted here is, undoubtedly, identical to the one depicted by KRASSKE, 1943, fig. 8. It is so characteristic and apparently constant that I should consider it well based to set it up as a special variant. The species *A. laterostrata* as it appears in fig. 840 in HUSTEDT 1930—37 II is fairly common in the Gysinge material, the valves having a constant stamp. In Fig. I: 12 a, b is seen a representative of the species from the Gysinge-material. This species was found earlier in Finland by HUSTEDT (1930—37 II, p. 392) and by KRASSKE (1943, p. 85).

Achnanthes Levanderi HUSTEDT (1937). Fig. 1: 6 a, b.

FR. HUSTEDT 1930—37 II, p. 404, fig. 612.

Rapheless valve here depicted: 7.4 μ l.; 4.5 μ b.; 22—24 striae in 10 μ. Found formerly in Finland (HUSTEDT 1930—37 II, p. 405; KRASSKE 1949, p. 13).

Achnanthes Suchlandti HUSTEDT (1937). Fig. I: 7 a, b and 8 a, b.

FR. HUSTEDT 1930—37, p. 406, fig. 859 b.

Also this fairly small *Achnanthes* species is probably wide-spread and not rare in nordic freshwater. Found in Finland by KRASSKE (1949, p. 13), but in one locality only. Fairly common in the Kåbdalis as well as in the Gysinge-material.

Frustulia Weinholdi HUSTEDT (1936).

FR. HUSTEDT 1930—37 II, p. 731, fig. 1101. A. SCHMIDT's Atl. pl. 406, fig. 7, 8.

Hitherto stated in Germany by HUSTEDT. Easily distinguished by its characteristic appendices of the central nodi, the appendices

passing off in a transapical direction, and its characteristic extensions at the apices of the raphe.

Some valves were observed in the Gysinge-material. This species is probably wide-spread in Sweden.

Neidium decoratum J. BRUN (1900).

J. BRUN 1900, p. 18, pl. 2, fig. 6, 7.

In the Gysinge-material was found a valve having all the peculiar and very characteristic structural traits given in BRUN's description and being in accordance with his drawings. The number of striae in the Gysinge-specimen is, however, somewhat larger than that stated in the specimens from Hurry Inlet (Scoresby Sound, Eastern Greenland). Possibly it is a sporangialform of *Anomoeoneis* (*exilis*?).

Neidium Hitchcockii EHB. (1843).

A. SCHMIDT's Atl. pl. XLIX, fig. 35, 36.

Syn.: *N. Huitfeldtii* HOLMBOE (1899); J. HOLMBOE 1899, p. 40, pl. I, fig. 11.

Observed earlier in several places, in peculiar in Northern Sweden (CLEVE Syn. I, p. 69. HUSTEDT 1924, Sarek, p. 555. KRASSKE 1943, p. 85, KRASSKE 1949, p. 15 (Finnish Lappland).

Not rare in the Gysinge-material.

Neidium (*Caloneis*) *ladogensis* CLEVE (1891).

P. T. CLEVE 1891, p. 35, pl. II, fig. 3.

The species seems to be rarer than the variant *densestriata*. In the Gysinge-material only a few valves were observed.

Neidium ladogensis var. *densestriata* ØSTRUP (1910).

E. ØSTRUP 1910, pl. I, fig. 4.

Only few valves were found in the Gysinge-material. This form is, however, fairly wide-spread in Scandinavia. In Sweden found by QUENNERSTEDT, among others (1949, p. 93). In Norway it is pretty common (FOGED 1952).

Navicula amygdalina HUSTEDT. Fig. II: 10.

A. SCHMIDT's Atl. pl. 404, fig. 1—5.

The depicted valve from the Gysinge-material is 7.8 μ b.; 18.2 μ l. and has 17—18 dotted striae in 10 μ.

This species was found earlier in the Ladoga and in Suistamon järvi in Finland (A. S. Atl. pl. 404, fig. 1—5).
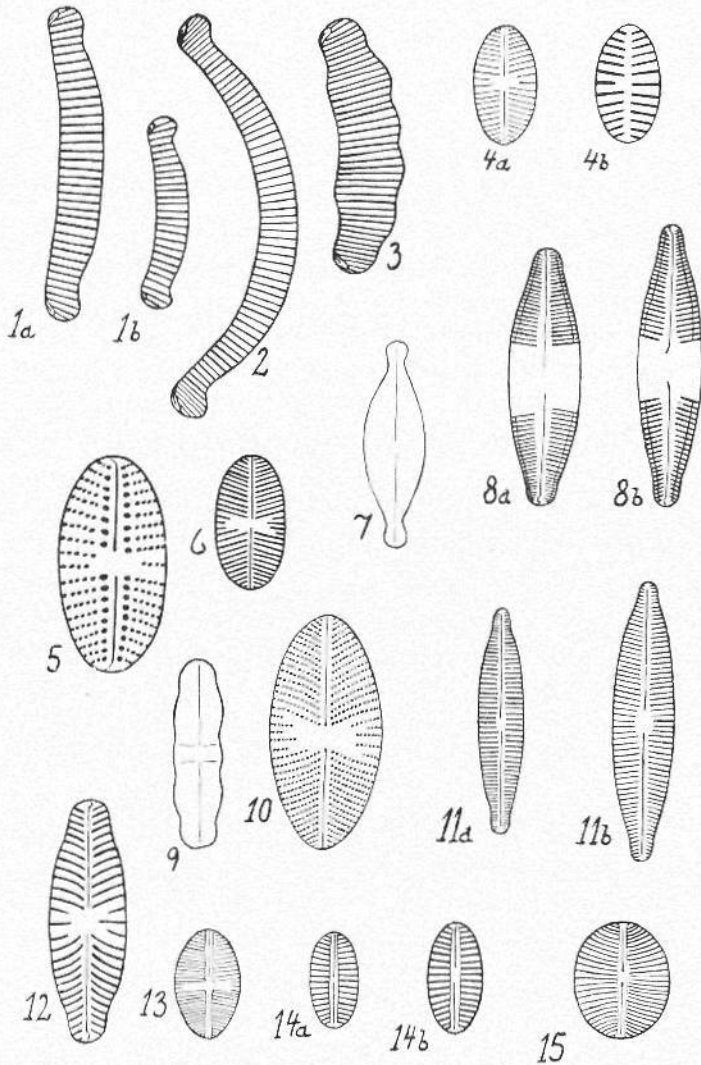
Fig. II. 1 a, b. *Eunotia tenella* (GRUN.) HUSTEDT. 2. *Eunotia elegans* ØSTRUP. 3. *Euno-tia polydentula* BRUN. 4 a, b. *Achnanthes saxonica* KRASSKE. 5. *Navicula farta* HU-STEDT. 6. *Navicula subrotundata* HUSTEDT. 7. *Navicula Gysingensis* nov. spec. 8 a, b. *Caloneis bacillum* (GRUN.) MERESCHK. var. *lancettula* (SCHULZ) HUSTEDT. 9. *Navicula tridentula* KRASSKE. 10. *Navicula amygdalina* HUSTEDT. 11 a, b. *Navicula falaisiensis* GRUN. var. *lanceola* GRUN. 12. *Navicula dicephala* (EHR.) W. SMITH var. *elginensis* (GREG.) CLEVE. (?). 13. *Navicula subatomoides* HUSTEDT. 14 a, b. *Navicula Vaucheriae* BOYE PETERSEN. 15. *Navicula Järnefeldti* HUSTEDT. — Ca. 1750 ×.

Navicula disjuncta HUSTEDT (1930). Fig. III: 7 a. b.

FR. HUSTEDT 1930, p. 274, fig. 450.

The depicted valves from the Gysinge-material are a: 4.5 μ b.; 22.7 μ l. b: 4.6 μ b.; 26.0 μ l. and have ca. 24 striae in 10 μ. Fairly rare in the Gysinge-material.

Navicula falaisiensis GRUN. var. *lanceola* GRUN. Fig. II: 11 a. b.

FR. HUSTEDT 1930, p. 302, fig. 525.

Fig. II. 11 a: 4.0 μ b.; 17.1 μ l.; 24—26 striae in 10 μ. Fig. II, 11 b: 5.2 μ b.; 21.0 μ l.; 22—24 striae in 10 μ.

Fairly rare in the Gysinge-material.

Navicula farta HUSTEDT. Fig. II: 5.

A. SCHMIDT's Atl. pl. 397, fig. 7—9.

No diagnosis seems to be available to this species, which according to A. S. Atl. pl. 397, fig. 7—9, was found by HUSTEDT in material from the lake Aokiko in Japan. One single valve was found later on by KRASSKE in material from Southern Finland (KRASSKE 1943, p. 86). In a sample from Gysinge 4 valves were observed. The depicted one is 8.0 μ b. and 17.0 μ l. It has 10—11 distinctly radial and distinctly dotted striae in 10 μ. The central striae are somewhat shortened. The axial area is distinct. The raphe-ends deflect to the same side. The valve are elliptic.

The species is not seen to be mentioned in HUSTEDT 1927.

Navicula festiva KRASSKE.

FR. HUSTEDT 1930, p. 289, fig. 489.

Syn.: *Frustulia vitrea* ØSTRUP, 1901, p. 262, fig. 30. *Navicula vitrea* (ØSTRUP) HUST., 1930, p. 289, fig. 489.

Fairly common in Finland (KRASSKE 1949, p. 18). Not rare in Gysinge.

Navicula Gysingensis nov. spec. Fig. II: 7.

Valves elliptic-lanceolate with capitate apices, 14—17 μ l., 4 μ b.

The branches of the raphe are straight, axial area narrow, striae denser than 40 in 10 μ (not visible). Valves exceedingly thin.

In freshwater. Common in the Gysinge-material.

Navicula Levanderi HUSTEDT.

A. SCHMIDT's Atl. pl. 397, fig. 30—32.

Can be mistaken for the *Pinnularia gracillima* but is told from it especially by differences in the striae.

Found before by HUSTEDT (A. S. Atl. pl. 397) and by KRASSKE (1943, p. 86 and 1949, p. 20) in Finland. Not rare in the Gysinge-material.

Navicula minuscula GRUN. var. *alpestris* HUSTEDT. Fig. III: 12.

A. SCHMIDT's Atl. pl. 400, fig. 92—95.

Fig. III, 12: 6.0 μ b.; 19.4 μ l.; 28—30 striae in 10 μ.

Not rare in the Gysinge-material.

Navicula seminulum GRUN. var. *intermedia* HUSTEDT (1942). Fig. III: 8.

FR. HUSTEDT 1942 b, p. 110, fig. 25—28.

HUSTEDT (1937—39, p. 239) has stated a species *N. seminuloides* with 20—22 striae in 10 μ, 3—3.5 μ b. and 5—10 μ l., while *N. seminulum* var. *intermedia* is 3—3.5 μ b. and 10—18 μ l. He concludes (1942, p. 110): »Es liegt somit nahe, beide miteinander zu verbinden und *N. seminuloides* in *N. seminulum* einzubegreifen». *N. seminuloides* is found in the Sunda Islands and *N. seminulum* var. *intermedia* is found in the Abisko area; the Gysinge specimens naturally are classed with the latter, even though they are somewhat shorter than the specimens of HUSTEDT.

Navicula subatomoides HUSTEDT (1950). Fig. II: 13.

FR. HUSTEDT 1950, p. 437, pl. XXXVIII, fig. 77—79.

The depicted specimen is 5.2 μ broad, 9.0 μ long and has 34—36 striae in 10 μ. In the description of the species (HUSTEDT 1950, p. 437) the breadth is given as 4—5 μ and the length as 6—9 μ with about 40 striae in 10 μ. The original material is from Finland and depicted in A. S. Atl. pl. 404, fig. 33—35. It resembles *N. minima* GRUN but is told from it by its considerably more delicate structure (*N. minima* has only about 26 striae in 10 μ).

Not common in the Gysinge-material.

Navicula trichoptera nov. spec. Fig. III: 6.

Valve linear-lanceolate with obtuse apices, 21 μ long, 4.6 μ broad. Axial area narrow, central area circular. Striae radial in the middle and parallel towards the apices, 22—23 in 10 μ, conspicuously dotted, 20—21 dots in 10 μ.

In freshwater. Rare in the Gysinge-material.
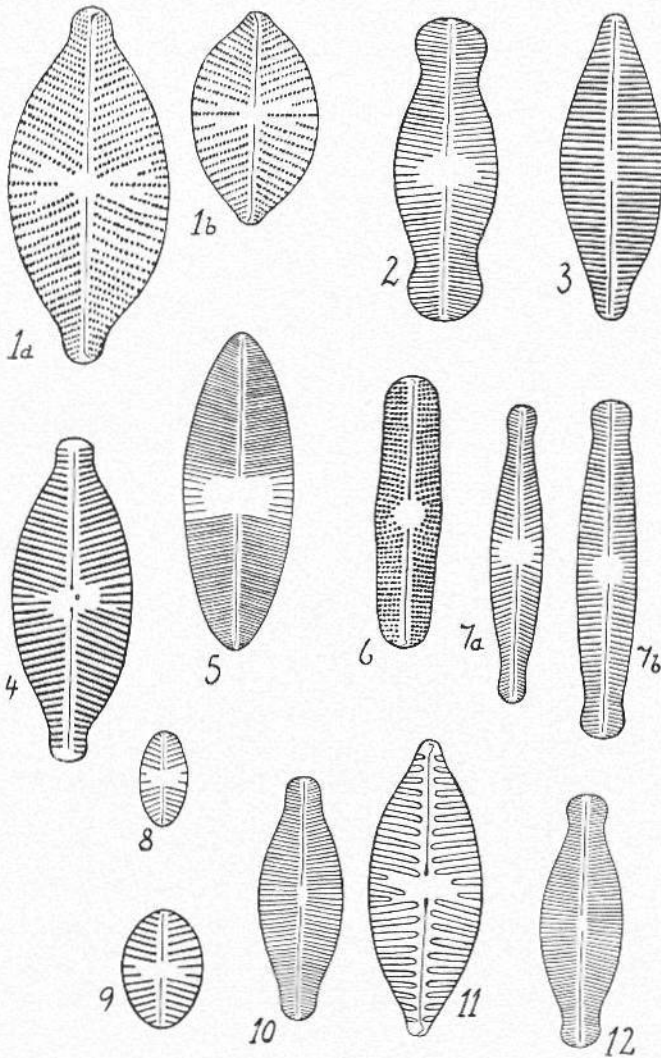
Fig. III. 1 a, b. *Navicula exigua* (GREG.) O. MÜLLER. 2. *Navicula ventralis* KRASSKE.
3. *Navicula halophila* (GRUN.) CLEVE. 4. *Navicula latens* KRASSKE. 5. *Navicula vario-
striata* KRASSKE. 6. *Navicula trichoptera* nov. spec. 7 a, b. *Navicula disjuncta* HUSTEDT.
8. *Navicula seminulum* GRUN. var. *intermedia* HUST. 9. *Navicula rotundata* HUSTEDT.
10. *Navicula minuscula* GRUN. 11. *Navicula menisculus* SCHUM. 12. *Navicula minuscula*
GRUN. var. *alpestris* HUSTEDT. Ca. 1750 ×.

Navicula Vaucheriae BOYE PETERSEN (1915). Fig. II: 14 a, b.
    J. BOYE PETERSEN 1915, p. 23 fig. 13.

This species is somewhat similar to *N. atomus, N. muralis, N. insociabilis* and *N. pseudatomus*, but *N. pseudatomus, N. atomus* and *N. muralis* possess considerably denser striae (about 30 in 10 μ). *N. insociabilis* KRASSKE (A. S. Atl. pl. 440, fig. 103—105) has striae that are almost parallel. *N. pseudatomus* J. W. G. LUND (1945) has characteristical central striae, a fact which has not been observed on the valves of the localities in question. J. W. G. LUND (1945, p. 75) writes of *N. Vaucheriae*: »This diatom is allied to the usually clearly smaller *N. pseudatomus*, from which it differs in the less dense, less radial striae, of which the central ones are as prominent as the rest and never shortened». The here depicted ones must accordingly be classed with *N. Vaucheriae*. They are 4.0 μ. b.; 8.5 μ. l. with 21—22 striae in 10 μ. Pl. II, fig. 14 b, and 4.0 μ. b.; 7.4 μ. l. with 22—23 striae in 10 μ. Pl. II, fig. 14 a. They show accordance with those found in the springs of Djursland (FOGED 1951, pl. III, fig. 5).

Navicula ventralis KRASSKE. Fig. III: 2.
    FR. HUSTEDT 1930, p. 274, fig. 450.

The depicted valve is 6.5 μ. b.; 23.0 μ. l. with 24—26 striae in 10 μ. KRASSKE (1949, p. 17) has found it seldom in Finland. Rare in Gysinge.

Pinnularia Kriegeriana KRASSKE emend. FOGED. Fig. IV: 9.
    G. KRASSKE 1943, p. 86, fig. 15.

To the original diagnosis should be added: 32—33 weakly radial striae in 10 μ, faintly dotted.

The *P. Kriegeriana* described by KRASSKE is undoubtedly the same species as that found in the Gysinge-material. KRASSKE found the species in Lappland (Kilpis järvi).

In the realgar preparation you are able to discern a striae-structure in the broad length-area. This delicate striation (about 32—34 striae in 10 μ) is indistinctly dotted. Monochromatic blue and oblique light is used by the examination.

I give cand. pharm. MAX MØLLER my best thanks for his valuable help especially in the examination of species like this and others possessing an inconspicuous structure.

I am somewhat sceptic as to placing *P. Kriegeriana* in the genus of *Pinnularia*.

Pinnularia polyonca (BRÉB.) O. MÜLLER. Fig. IV:7.
    A. S. SCHMIDT's Atl. pl. 45, fig. 54.

The depicted species is in regard to outlines, size and number of striae in accordance with A. S. Atl. pl. 45, fig. 54 called *Navicula mesotyla* E. It differs, however, considerable from HUSTEDT's drawing (1930, fig. 576) of *P. polyonca*. In CLEVE Syn. II, p. 76 are mentioned *P. mesolepta* var. *polyonca* BRÉB. (1849) syn. *N. polyonca* BRÉB. as appearing in freshwater in Sweden (Uppsala).

Rare in the Gysinge-material.

Pinnularia semicruciata E. Fig. IV:3.
    A. SCHMIDT's Atl. pl. 44, fig. 43.
    Not rare in the Gysinge-material.

Compare *P. Hyyppäi* MÖLDER (1939, p. 21) of a coarser structure than *semicruciata* and found only fossil.

Cymbella hybrida GRUN. (1878). Fig. IV:5.
    CLEVE I, 1894, p. 166, pl. IV, fig. 23.

According to CLEVE (1894, p. 166) this species was observed earlier in Sweden (in the island of Gotland and in Skåne).

Not rare in the Gysinge-material.

Gomphonema olivacioides HUSTEDT (1950). Fig. IV:4.
    FR. HUSTEDT 1950, p. 397, pl. XXXVII, fig. 9—12.

Very similar to *G. olivaceum* (LYNGBYE) KÜTZ., but it differs from the latter in possessing 4 isolated dots — two on each side — in the central area. It is wide-spread in lakes in Denmark (FOGED, in lakes of Funen and Jutland, not publ.) and Norway (FOGED 1952). It was also observed by the author in material from other Swedish localities (not publ.).

Nitzschia plana var. *fennica* HUSTEDT fo. *ornata* KOLBE (1948).
    R. W. KOLBE 1948, p. 460, fig. 4, 5.

Found by KOLBE in oligotrophic water in Sweden (Gladökvarnsjö). Besides here in Gysinge-material I have myself observed this large *Nitzschia* form in a river near Hudiksvall (Sweden) and in Vannsjö in Southern Norway (FOGED 1952).
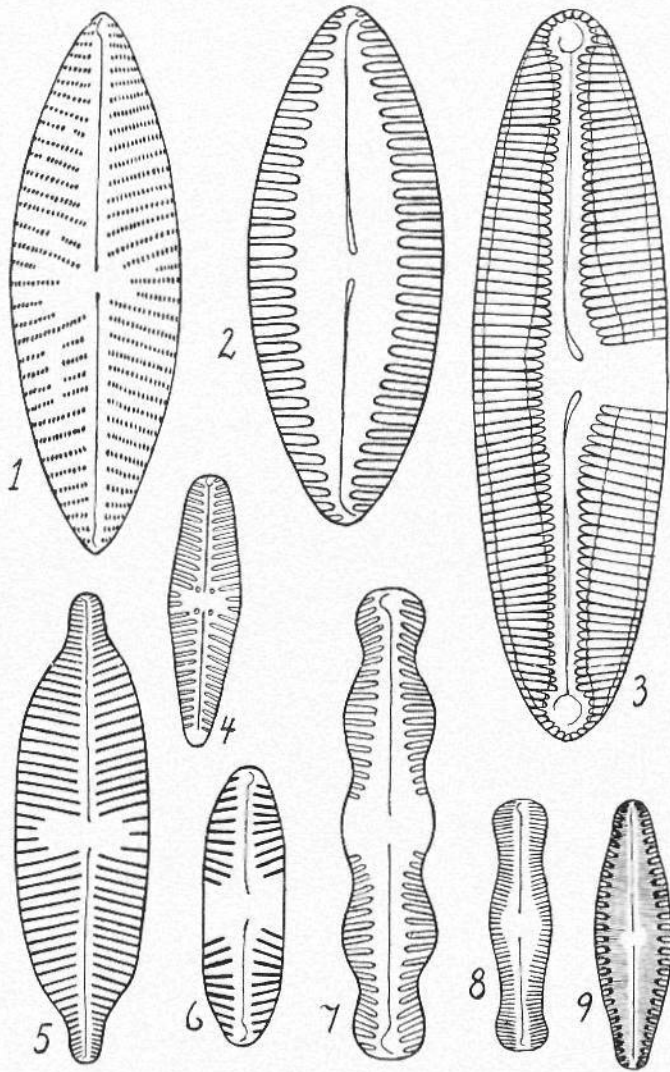
Fig. IV. 1. *Navicula meniscus* SCHUM. 2. *Pinnularia hemiptera* (KÜTZ.) CLEVE.
3. *Pinnularia semicruciata* E. 4. *Gomphonema olivacioides* HUSTEDT. 5. *Cymbella hybrida* GRUN. 6. *Pinnularia intermedia* LAGERSTEDT. 7. *Pinnularia polyonca* (BRÉB.) O. MÜLLER. 8. *Pinnularia Krockii* GRUN. 9. *Pinnularia Kriegeriana* KRASSKE emend. FOGED. — Ca. 1750 ×.

In the samples from Kåbdalis and from Gysinge as well as in numerous other samples from Sweden and Norway spines were observed on the valves of several diatom species, on which species spines, according to former description, do not seem to have been stated. This is the case as for species of the genera *Amphicampa, Fragilaria, Peronia* and *Tabellaria*.

As, moreover, chiefly the centric plankton forms of the genera *Cyclotella, Melosira* and *Stephanodiscus* are supplied with such spines it may be presumed that pennate forms bearing spines may likewise appear in plankton, as the spines most probably have to be considered floating apparatus.

List of Diatoms found in Trichoptera nets at Kåbdalis and Gysinge in Sweden.

A. Centrales.

I. Coscinodiscaceae.

	Kåbdalis	Gysinge
Melosira ambigua (GRUN.) O. MÜLL.	1	1
— *arenaria* MOORE	—	2
— *distans* (EHR.) KÜTZ.	4	4
— — v. *lirata* (EHR.) BETHGE	4	4
— — fo. *seriata* O. MÜLL.	1	—
— *granulata* (EHR.) RALFS	1	2
— — v. *angustissima* O. MÜLL.	3	3
— *islandica* O. MÜLL. subsp. *helvetica* O. MÜLL.	3	2
— *italica* (EHR.) KÜTZ.	2	2
— — subsp. *subarcuata* O. MÜLL.	4	4
— *nummuloides* (DILLW.) C. A. AG.	2	—
— *Pfaffiana* (REINSCH) GRUN.	2	4
— *Roeseana* RABH.	1	1
Cyclotella comta (EHR.) KÜTZ.	—	5
— *Kützingiana* THWAITES v. *planetophora* FRICKE	—	4
— — v. *radiosa* FRICKE	—	4
— — v. *Schumaniana* GRUN.	—	2
— *Meneghiniana* KÜTZ.	1	2
— *ocellata* PANT.	—	2
— *pseudostelligera* HUST.	—	4
— *stelligera* CLEVE & GRUN.	—	5
Stephanodiscus astraea (EHR.) GRUN.	—	1
— — v. *minutula* (KÜTZ.) GRUN.	—	2
— *dubius* (FRICKE) HUST.	—	2
— *Hantzschii* GRUN.	—	2
Coscinodiscus lacustris GRUN.	1	—

	Kåbdalis	Gysinge

II. Soleniaceae.

Attheya Zachariasi J. BRUN.	—	2
Rhizosolenia eriensis H. L. SMITH	—	1
— *longiseta* ZACH.	—	4

B. Pennales.

III. Fragilariaceae.

Tabellaria binalis (EHR.) GRUN.	1	—
— *fenestrata* (LYNGBYE) KÜTZ.	3	3
— — v. *intermedia* GRUN.	3	3
— *flocculosa* (ROTH.) KÜTZ.	3	3
Tetracyclus lacustris RALFS	3	3
— — v. *elongata* HUST.	1	—
— — v. *strumosa* (EHR.) HUST.	3	1
— *emarginatus* (EHR.) W. SMITH	—	2
Diatoma elongatum AGARDH	1	3
— *hiemale* (LYNGBYE) HEIBERG v. *mesodon* (EHR.) GRUN.	1	2
— *vulgare* BORY	—	2
Meridion circulare AGARDH	—	2
— — v. *constricta* (RALFS) VAN HEURCK	—	2
Ceratoneis arcus KÜTZ.	1	—
— — v. *linearis* HOLMBOE	3	3
Fragilaria bicapitata A. MAYER	2	2
— *brevistriata* GRUN.	2	2
— — v. *inflata* (PANT.) HUST.	—	1
— *capitellata* (GRUN.) BOYE PETERSEN v. *Peterseni* FOGED	—	2
— *capucina* DESMAZ.		3
— — v. *mesolepta* (RABH.) GRUN.	1	2
— *constricta* EHR.	2	2
— — fo. *stricta* CLEVE	2	2
— *construens* (EHR.) GRUN.	1	2
— — var. *binodis* (EHR.) GRUN.		2
— *lapponica* GRUN.	2	2
— *leptostauron* (EHR.) HUST.	—	2
— *pinnata* EHR.	2	2
— — v. *trigona* (BRUN. & HERIB.) HUST.	—	1
— *Vaucheriae* (KÜTZ.) BOYE PETERSEN	2	2
— *virescens* RALFS	2	2
Asterionella formosa HASSALL.	5	5
Synedra acus KÜTZ.	—	2
— — v. *angustissima* GRUN.	2	2
— *crystallina* (AG.) KÜTZ.	1	—
— *nana* MEISTER	1	2
— *parasitica* W. SMITH	—	2
— — v. *subconstricta* GRUN.	2	3
— *rumpens* KÜTZ.	2	4

	Kåbdalis	Gysinge
Synedra rumpens v. *fragilarioides* GRUN.	—	2
— *tabulata* (AG.) KÜTZ.	1	1
— *tenera* W. SMITH	2	2
— *ulna* (NITZSCH) EHR.	2	3
— — v. *aequalis* (KÜTZ.) HUST.	—	1
— — v. *biceps* KÜTZ.	1	1
— — v. *danica* (KÜTZ.) GRUN..................................	—	2
Opephora Martyi HÉRIBAUD	—	2

IV. Eunotiaceae.

	Kåbdalis	Gysinge
Peronia Héribaudi BRUN & PEREGALLO	—	1
Eunotia alpina (NAEG.) HUST.	3	3
— *arcus* EHR.	—	3
— *bigibba* KÜTZ.	1	1
— — v. *pumila* GRUN.	2	—
— *diodon* EHR.	2	—
— *elegans* ØSTRUP	—	1
— *exigua* (BRÉB.) GRUN.	2	2
— *faba* (EHR.) GRUN.	2	1
— *flexuosa* KÜTZ.	2	2
— *formica* EHR.	2	2
— *gracilis* (EHR.) RABENH.	2	2
— *lunaris* (EHR.) GRUN.	2	2
— — v. *subarcuata* (NAEG.) GRUN.	3	3
— *monodon* EHR. v. *maior* (W. SMITH) HUST.	1	1
— — — fo. *bidens* W. SMITH	2	2
— *parallela* EHRB.	2	—
— *pectinalis* (KÜTZ.) RABENH.	1	2
— — v. *minor* (KÜTZ.) RABENH.	2	2
— — — fo. *impressa* EHRB.	—	2
— — v. *ventralis* (EHR.) HUST.	4	4
— *polydentula* BRUN	2	1
— *polyglyphis* GRUN.	1	1
— *praerupta* EHRB.	2	1
— — v. *bidens* GRUN.	1	2
— — v. *muscicola* BOYE PETERSEN	—	1
— *rhomboidea* HUST.	1	2
— *robusta* RALFS v. *diadema* (EHR.) RALFS	2	1
— — v. *tetraodon* (EHR.) RALFS	2	1
— *septentrionalis* ØSTRUP	—	2
— *tenella* (GRUN.) HUST.	2	2
— *veneris* (KÜTZ.) O. MÜLLER	1	2

V. Achnanthaceae.

	Kåbdalis	Gysinge
Cocconeis diminuta PANT.	1	—
— *placentula* EHRB.	1	3

	Kåbdalis	Gysinge
Cocconeis scutellum EHRB. v. parva GRUN.	1	1
— thumensis HUST.	—	2
Achnanthes Biasoletiana (KÜTZ.) GRUN.	—	2
— brevipes AGARDH	1	—
— calcar CLEVE	—	2
— Clevei GRUN.	—	2
— depressa (CLEVE) HUST.	4	2
— didyma HUST.	4	4
— exigua GRUN.	—	3
— — v. heterovalvata KRASSKE	—	2
— flexella (KÜTZ.) BRUN	2	4
— — v. alpestris BRUN	2	2
— gracillima HUST.	—	3
— hungarica GRUN.	—	1
— lanceolata BRÉB.	2	2
— — v. elliptica CLEVE	—	3
— — v. rostrata HUST.	2	2
— lapponica HUST.	2	1
— laterostrata HUST.	3	3
— Levanderi HUST.	—	2
— linearis (W. SMITH) GRUN.	4	4
— — v. pusilla GRUN.	—	2
— marginatula GRUN.	—	2
— minutissima KÜTZ.	4	4
— — v. cryptocephala GRUN.	4	4
— obliqua (GREG.) HUST.	—	2
— Peregalli BRUN & HÉRIB.	2	2
— saxonica KRASSKE	1	—
— Suchlandti HUST.	3	3
— Østrupii (CLEVE) HUST.	—	3

VI. Naviculaceae.

Mastogloia Smithii THWAITES v. amphicephala GRUN.	—	1
Amphipleura pellucida KÜTZ.	—	5
Frustulia rhomboidea (EHR.) DE TONI	2	1
— v. amphipleuroides GRUN.	—	3
— v. saxonica (RABH.) DE TONI	1	3
— — fo. capitata A. MAYER	2	2
— — fo. undulata HUST.	—	2
— Weinholdi HUST.	—	2
— vulgaris THWAITES	2	2
Caloneis alpestris (GRUN.) CLEVE	—	1
— amphisbaena (BORY) CLEVE	—	1
— bacillum (BRUN) MERESCHK.	2	3
— — v. lancettula (SCHULZ) HUST.	—	2
— silicula (EHR.) CLEVE	3	3
— — fo. claviceps HUSTEDT	—	1

	Kåbdalis	Gysinge
Neidium affine (EHR.) CLEVE v. *amphirhynchus* (EHR.) CLEVE ..	1	1
— — v. *longiceps* (GREG.) CLEVE	2	2
— *decoratum* J. BRUN	—	1
— *bisulcatum* (LAGERSTEDT) CLEVE	2	2
— *dubium* (EHR.) CLEVE	1	1
— *Hitchcockii* EHRB.	1	2
— *iridis* (EHR.) CLEVE	2	2
— — v. *amphigomphus* (EHR.) VAN HEURCK	-	1
— — v. *ampliata* EHRB.	2	2
— — fo. *vernalis* REICHELT	2	2
— *productum* (W. SMITH) CLEVE	2	2
— (*Caloneis*) *ladogensis* CLEVE	—	2
— (—) — v. *densestriata* ØSTRUP	—	2
Diploneis elliptica (KÜTZ.) CLEVE	1	2
— *finnica* (EHR.) CLEVE	2	2
— *Mauleri* (BRUN) CLEVE	—	2
— *minuta* PETERSEN	1	—
— *oculata* (BRÉB.) CLEVE	1	2
— *ovalis* (HILSE) CLEVE	—	2
— — v. *oblongella* (NAEG.) CLEVE	—	1
— *puella* (SCHUM.) CLEVE	—	2
Stauroneis acuta W. SMITH	1	1
— *anceps* EHR.	3	3
— — fo. *gracilis* RABH.	2	2
— — v. *hyalina* BRUN & PEREG.	—	2
— — v. *linearis* (EHRB.) GRUN.	—	1
— *Kriegeri* PATRICK	1	—
— *legumen* EHRB.	2	1
— *parvula* GRUN.	—	2
— — v. *prominula* GRUN.	1	—
— *phoenicenteron* EHRB.	2	3
— *Smithii* GRUN.	1	3
— — v. *incisa* PANT.	—	2
Anomoeoneis exilis (KÜTZ.) CLEVE	4	4
— — v. *lanceolata* A. MAYER	3	3
— *serians* (BRÉB.) CLEVE	—	1
— — v. *brachysira* (BRÉB.) HUST.	3	3
— *styriaca* (GRUN.) HUST.	—	1
— *zellensis* (GRUN.) CLEVE	1	2
Gyrosigma attenuatum (KÜTZ.) RABH.	—	2
— *Kützingii* (GRUN.) CLEVE	2	3
Navicula americana EHRB.	—	1
— *amphibola* CLEVE	—	1
— *amygdalina* HUST.	—	2
— *anglica* RALFS	2	2
— *bacillum* EHRB.	3	3

	Kåbdalis	Gysinge
Navicula bacilliformis GRUN.	3	3
— *brekkaensis* PETERSEN	—	1
— *cari* EHRB.	3	3
— — v. *angusta* GRUN.	3	3
— *cincta* (Ehr.) KÜTZ.		2
— *clementis* GRUN.	—	2
— *cocconeiformis* GREGORY	3	3
— *costulata* GRUN.		2
— *cryptocephala* KÜTZ.	3	3
— — v. *intermedia* GRUN.	—	2
— *cuspidata* KÜTZ.		2
— *dicephala* (EHR.) W. SMITH	1	2
— — v. *undulata* ØSTRUP	—	1
— *disjuncta* HUST.		2
— *exigua* (GREG.) O. MÜLLER	—	2
— *farta* HUST.		2
— *falaisiensis* GRUN. v. *lanceola* GRUN.	—	2
— *festiva* KRASSKE	—	2
— *gastrum* EHRB.		1
— *graciloides* A. MAYER	—	2
— *Gysingensis* nov. spec.	—	3
— *halophila* (GRUN.) CLEVE	—	2
— *hungarica* GRUN. v. *capitata* (EHRB.) CLEVE	—	2
— *Hustedtii* KRASSKE	1	—
— *Jentzschii* GRUN.	—	2
— *Järnefeldti* HUST.	3	4
— *lacustris* GREGORY	—	1
— *lanceolata* (AGARDH) KÜTZ.	1	1
— *Levanderi* HUST.	—	2
— *laterostrata* HUST.		1
— *latens* KRASSKE		1
— *menisculus* SCHUM.	—	2
— — v. *obtusa* HUST.	—	2
— *minima* GRUN.	1	—
— *minuscula* GRUN. var. *alpestris* HUST.	—	2
— *mutica* KÜTZ.	1	2
— — v. *Cohnii* (HILSE) GRUN.	1	2
— — v. *gracilis* HUST.	1	—
— *placentula* (EHR.) GRUN.		1
— *peregrina* (EHR.) KÜTZ. var. *menisculus* SCHUM.		2
— *protracta* GRUN.		1
— *pseudoscutiformis* HUST.	3	3
— *pupula* KÜTZ.	2	3
— — v. *capitata* HUST.	2	2
— — v. *rectangularis* GREG.	1	—
— *radiosa* KÜTZ.	3	3
— *rhyncocephala* KÜTZ.	2	2

	Kåbdalis	Gysinge
Navicula Rotaeana (RABH.) GRUN.	3	3
— *rotundata* HUST.	1	2
— *salinarum* GRUN.	1	1
— *scutelloides* W. SMITH	—	2
— *scutiformis* W. SMITH	—	2
— *radiosa* KÜTZ. v. *tenella* (BRÉB.) GRUN.	1	1
— *seminulum* GRUN.	3	3
— v. *intermedia*	—	2
— *subatomoides* HUST.	—	2
— *subhamulata* GRUN.		1
— *subtilissima* CLEVE	—	1
— *subrotundata* HUST.	1	2
— *tenelloides* HUST.		1
— *trichoptera* nov. spec.	—	2
— *tridentula* KRASSKE	1	1
— *torneensis* CLEVE	—	2
— *tuscula* (EHR.) GRUN.		1
— *variostriata* KRASSKE	—	1
— *ventralis* KRASSKE	—	1
— *viridula* KÜTZ.	2	2
— *vulpina* KÜTZ.	1	1
Pinnularia acrosphaeria BRÉB.	1	1
— *Brandelii* CLEVE	—	2
— *borealis* EHRB.	2	2
— *Braunii* (GRUN.) CLEVE v. *amphicephala* (A. MAYER) HUST.	2	1
— *brevicostata* CLEVE	2	—
— *divergens* W. SMITH	2	2
— *divergentissima* (GRUN.) CLEVE	1	2
— *gentilis* (DONK.) CLEVE	2	1
— *gibba* EHR.	2	1
— fo. *subundulata* A. MAYER	—	1
— *globiceps* GREG.		1
— *gracillima* GREG.	2	1
— *hemiptera* (KÜTZ.) CLEVE	—	1
— *intermedia* LAGERSTEDT	—	1
— *interrupta* W. SMITH	2	2
— *karelica* CLEVE	—	2
— *kriegeriana* KRASSKE emend. FOGED	—	2
— *Krockii* GRUN.	—	1
— *legumen* EHRB.	2	1
— *maior* KÜTZ.	2	1
— *mesolepta* (EHRB.) W. SMITH	2	2
— *microstauron* (EHRB.) CLEVE	1	1
— v. *Brébissonii* (KÜTZ.) HUST.	1	2
— *nobilis* EHRB.	2	—
— *nodosa* EHRB.	2	2
— *polyonca* (BRÉB.) O. MÜLLER	—	2

	Kåbdalis	Gysinge
Pinnularia semicruciata E.	—	1
— *stomatophora* GRUN.	2	1
— *subcapitata* GREG.	3	1
— — v. *Hilseana* (JANISCH) O. MÜLLER	1	—
— *subsolaris* (GRUN.) CLEVE	2	1
— *undulata* GREG.	—	2
— *viridis* (NITZSCH) EHRB.	2	2
Amphiprora ornata BAILEY	—	2
Amphora ovalis KÜTZ.	1	1
— — v. *libyca* (EHR.) CLEVE	3	3
— — v. *pediculus* KÜTZ.	—	2
— *veneta* KÜTZ.	—	2
Cymbella affinis KÜTZ.	1	1
— *amphicephala* NAEGELI	1	1
— *aspera* (EHRB.) CLEVE	2	2
— *Cesati* (RABH.) GRUN.	1	1
— *cistula* (HEMP.) GRUN.	2	2
— *cuspidata* KÜTZ.	2	1
— *Ehrenbergii* KÜTZ.	1	1
— *gracilis* (RABH.) CLEVE	3	3
— *hebridica* (GREGORY) GRUN.	2	2
— *helvetica* KÜTZ.	—	2
— *heteropleura* EHR. var. *minor* CLEVE	2	2
— *hybrida* GRUN.	—	2
— *incerta* GRUN.	1	2
— *lanceolata* (EHRB.) VAN HEURCK	3	2
— *leptoceros* (EHRB.) GRUN.	—	1
— *microcephala* GRUN.	3	3
— — v. *robusta* HUST.	—	2
— *naviculiformis* AUERSWALD	3	3
— *norvegica* GRUN.	—	1
— *obtusa* GREGORY	1	1
— *perpusilla* CLEVE	1	1
— *prostrata* (BERKELY) CLEVE	2	2
— *sinuata* GREGORY	—	2
— *tumida* (BRÉB.) VAN HEURCK	2	1
— *turgida* (GREGORY) CLEVE	2	2
— *ventricosa* KÜTZ.	3	3
Didymosphenia geminata (LYNGBYE) M. SCHMIDT	—	1
Gomphonema acuminatum EHRB.	3	3
— — v. *Brébissonii* (KÜTZ.) CLEVE	3	3
— — v. *coronata* (EHRB.) W. SMITH	2	2
— — v. *trigonocephala* (KÜTZ.) RABH.	1	1
— *angustatum* (KÜTZ.) RABH.	2	—
— — v. *linearis* HUST.	1	—
— — v. *producta* GRUN.	2	1
— — v. *sarcophagus* (GREGORY) GRUN.	1	—

	Kåbdalis	Gysinge
Gomphonema augur EHRB.	1	—
— — v. *Gautieri* VAN HEURCK	2	—
— *constrictum* EHRB.	3	3
— *gracile* EHRB.	1	—
— — v. *lanceolata* (KÜTZ.) CLEVE	1	—
— *intricatum* KÜTZ.	2	2
— *lanceolatum* EHRB.	2	2
— *longiceps* EHRB.	1	2
— — v. *montana* (SCHUM.) CLEVE	1	—
— — — fo. *suecica* GRUN.	2	—
— — v. *subclavata* GRUN. fo. *gracilis* HUST.	—	1
— *olivacioides* HUST.		3
— *parvulum* KÜTZ.	2	3
— — v. *micropus* (KÜTZ.) CLEVE	—	1
— *subtile* EHRB.	1	1
— — v. *sagitta* (SCHUM.) CLEVE	1	—

VII. Epithemiaceae.

	Kåbdalis	Gysinge
Denticula tenuis KÜTZ.	—	1
— — v. *crassula* (NAEGELI) HUST.	—	2
Epithemia sorex KÜTZ.	—	1
— *turgida* (EHR.) KÜTZ.	1	1
— *zebra* (EHR.) KÜTZ.	—	2
— — v. *porcellus* (KÜTZ.) GRUN.	1	1
— — v. *saxonica* (KÜTZ.) GRUN.	2	—
Rhopalodia gibba (EHR.) O. MÜLLER	2	1
Hantzschia amphioxys (EHR.) GRUN.	1	2
— — v. *maior* GRUN.	1	1
— — v. *vivax* (HANTZSCH) GRUN.	2	2
Nitzschia acicularis W. SMITH	—	3
— *acuta* HANTZSCH	3	3
— *amphibia* GRUN.	—	2
— *angusta* (W. SMITH) GRUN.	—	2
— *Clausii* HANTZSCH	—	1
— *communis* RABH.	—	1
— *dissipata* (KÜTZ.) GRUN.	—	3
— *frustulum* KÜTZ.	1	—
— — v. *perpusilla* (RABH.) GRUN.	1	—
— *gracilis* HANTZSCH	3	3
— *Hantzschiana* RABH.	—	1
— *ignorata* KRASSKE	—	2
— *Kützingiana* HILSE	2	—
— *microcephala* GRUN.	—	2
— *linearis* W. SMITH	1	1
— *perminuta* GRUN.	—	2
— *plana* v. *fennica* HUST. fo. *ornata* R. W. KOLBE	—	1
— *palea* (KÜTZ.) W. SMITH	—	2

	Kåbdalis	Gysinge
Nitzschia recta HANTZSCH	1	2
— *romana* GRUN.	—	2
— *sigmoidea* (EHR.) W. SMITH	—	1
— *stagnorum* RABH.	—	1
— *thermalis* KÜTZ.	—	1
— *tryblionella* HANTZSCH v. *victoriae* GRUN.	—	2

IX. Surirellaceae.

Cymatopleura solea (BRÉB.) W. SMITH	—	1
Stenopterobia intermedia LEWIS	3	3
— — fo. *subacuta* FRICKE	—	2
Surirella angusta KÜTZ.	2	1
— *biseriata* BRÉB. v. *bifrons* (EHR.) HUST.	—	1
— *Caproni* BRÉB.	—	2
— *delicatissima* LEWIS	2	2
— *elegans* EHR.	1	1
— *gracilis* (W. SMITH) GRUN.	—	3
— *linearis* W. SMITH	3	3
— — v. *constricta* (EHR.) GRUN.	2	1
— *Moelleriana* GRUN.	—	3
— *birostrata* HUST.	—	2
— *ovalis* BRÉB.	1	—
— *ovata* KÜTZ.	1	3
— — v. *pinnata* W. SMITH	—	3
— *robusta* EHR.	2	2
— — v. *splendida* (EHR.) VAN HEURCK fo. *punctata* HUST.	1	1
— *tenera* GREG.	—	1
— — v. *nervosa* A. SCHMIDT	—	1
— *turgida* W. SMITH	—	1

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The real signification of pollen diagrams.

By Folke Fagerlind.

Contents.

Introduction.

Pollen diagrams have often been utilized in studies of the history of vegetation and climate. In this matter scientists have followed different methods. Some of them, in drawing conclusions from the diagrams obtained, have been cautious: others have been extremely optimistic. I think that the present paper shows that the former method is to be recommended. I consider that the moderation displayed by, for instance, Malmström in his works is worthy of imitation.

The following quotation (here translated into English [1]) is from Fægri (1947): »When the first percentage pollen analyses were published in 1905, Witte wrote in his comments on the percentages: 'To draw any conclusions from these is naturally very difficult'. In view

[1] Translator: Miss K. Pain, Lidingö.

of the many conclusions subsequently drawn from the pollen percentages, WITTE's words may seem rather amusing to us, but there is no doubt that he is right: To draw reasonable conclusions from a pollen diagram is by no means so simple as many people pretend, and the further one comes from the heart of the North European forest region, the more difficult does it become. The reasonable working out of a pollen diagram requires not only a good grounding in statistics but still more in botany as well as geology, meteorology, archaeology, etc. But the primary need is for common sense and that, unfortunately, appears to be a rare commodity».

FÆGRI is not the only one, however, to have realized the difficulties. Remarks to the same effect although less incisively expressed have been made both before and since (cf., for instance, HESSELMAN 1916, 1919, MALMSTRÖM 1923, FAGERLIND 1949, FÆGRI & IVERSEN 1950).

In the case of scientific problems requiring quantitative analysis, it is necessary to take into consideration the size of the range of variation which is represented by each given quantity. It is not sufficient merely to take into consideration the variation conditioned by the material. One must also know the variations that are a consequence of the comparative suitability or unsuitability for the purpose of the »instrument» used and of the registration method. If pollen diagrams are the instruments employed in researches on vegetation and climate, the real signification of the different percentage figures in the diagrams must be realized; one must find out under what circumstances these really illustrate the true ratios and under what circumstances they exhibit deviation. It is absolutely unwarrantable simply to accept the fluctuations of the curves as proof that the vegetation ratios fluctuated in a similar manner.

The sources of error which are generally operative (though to a varying extent in different cases) in connection with studies on vegetation and climate on a pollen-analytical basis have been touched upon by several authors but usually more or less cursorily. L. VON POST, who has made the greatest contributions to the science of pollen analysis, appears to have lacked any particular interest in the sources of error (cf., however, Geol. För. i Stockholm Förh., 69, 1947). The first more definite statements about the occurrence of sources of error that could render the diagrams extremely misleading, were made by HESSELMAN, as far as I am aware. The first more comprehensive analysis — the sources of error in connection with statistical treatment of the material

were not included. however — was published by MALMSTRÖM (1923). The latest survey is given in FÆGRI & IVERSEN's new Text-book.

Interest in the sources of error appears to have been greater in the »childhood» of pollen analysis than it is today. FÆGRI & IVERSEN, who are by no means blind to this question and its significance, evidently consider that this interest during the »childhood» period was exaggerated. They write: »During the first decade of pollen analysis these errors were much discussed, more, however, on the basis of theoretical considerations of what *could* happen than on the basis of actual knowledge of what *does* happen.»

FÆGRI & IVERSEN's above-cited remark may be true in some cases. The rest of the sources of error are such that they have a disturbing effect on the results with absolute necessity. Thus it is not a case of factors that might possibly be thought to exert some influence, but of truly important matters.

As a result of the sources of error the pollen diagram values often require adjustment before they can be accepted as a basis for reasonable conclusions. By means of formulae and diagrammatic illustrations I shall endeavour in the following, on the one hand, to show how the adjustment should be made and, on the other, to indicate the conditions that must be fulfilled in order to make it possible at all to base conclusions on the pollen diagrams. Most of the terms introduced and the symbols used will be found in Chapter 1.

I. Brief survey of the sources of error. Some definitions and symbols.

1.

Pollen diagrams can naturally be misleading owing to failure in correctly distinguishing the kinds of pollen occurring in the substratum mass. This source of error is not discussed in the following.

2.

The term »PD-area» is used by me to define the area comprising plant specimens which have delivered pollen up to the point where the pollen analysis mass was collected.

If a certain plant species covers U surface units in the »PD-area» and each such unit produces Pr pollen grains of the said species, the mass of pollen grains of the said species produced in the »PD-area»

will be UPr. De% of this pollen mass is assigned to the point where the pollen analysis sample was taken. The »sample point» consequently accommodated temporarily UPrDe/100 grains of pollen of the species in question.

The factors symbolized above by means of Pr and De% may suitably be called the »production» and the »delivery factors» respectively. Their product indicates the ratio between the number of pollen grains temporarily present in the substratum of the »sample point» and the number of producing surface units. This product may suitably be termed the »primary product factor»; it is expressed as F_p.

The »sample point» thus contained temporarily UF_p pollen grains. Co% of this pollen mass is conserved until the very moment when the sample was taken. Thus the sample contains $UF_pCo/100$ pollen grains on this occasion. Ma% of this pollen mass is found when the sample mass is analyzed. Thus the amount of pollen found is symbolized by the product $UP_pCoMa/10000$. Co% and Ma% may suitably be termed the »conservation» and »manipulation factors» respectively.

The statement with regard to the number of pollen grains found is, however, correct only on the assumption that all the pollen grains have sunk equally deep in the sample mass after having »landed». If the grains sink to different depths the figures are upset. (FÆGRI & IVERSEN state that MALMSTRÖM's experiments show that the differences in sedimentation ability must be insignificant. The time factor must not be ignored, however. MALMSTRÖM's preliminary experiments by no means embraced periods of time which can be compared with those during which pollen grain displacements in the natural substrata are theoretically conceivable.) The phenomenon can involve »profit» as well as »loss». The ratio between their size is determined by the abundance of pollen during the different periods of time. Transference of pollen grains in a lateral direction after »landing» also upsets the figures. (Pollen grains can be washed away; they can be brought together to forms clusters.) Here, too, the result can be »profit» or »loss».

The comparison figure which gives the ratio between the number of pollen grains occurring in the sample mass at the time of analysis and the number delivered up to the sample point, may be termed the »secondary product factor» ($=F_s$). As will be seen, it consists of a product which includes the »conservation factor». The comparison figure which gives the ratio between the number of pollen grains found at the analysis and the number of pollen grains occurring in the sample mass, is called the »tertiary product factor» ($=F$). If the statistical

errors are included in the »manipulation factor» this alone forms the »tertiary product factor».

The product $F_p F_s F_t$ is termed below the »total product factor» $(=F)$ or briefly the »product factor». It gives the ratio between the number of pollen grains found and the relative extent of the surface covered by the actual plant species.

<div align="center">3.</div>

In the discussion below the term »antagonists» is used. By this I mean the two species, species groups or the species and the species group which are compared with each other in each of the pollen curves of the pollen diagrams. If a point on a pollen curve shows the value $D\%$ this accordingly means that one antagonist has exhibited a pollen frequency of $D\%$ and the other a frequency of $(100 - D)\%$ in the sample analyzed. The former antagonist usually gives its name to the pollen curve. This antagonist, which can thus be said to be the object of comparison, is called below the »numerator antagonist»; the other the »denominator antagonist». They are abbreviated in the following to NUM and DENOM respectively. For the theoretical exposition it is immaterial whether NUM and DENOM symbolize species or species groups; whether in the latter case they represent warmth-demanding species, cold-resistant species, xerophytes, hygrophytes or anything else. If each symbol represents a single species I speak of simple pollen curve; if NUM consists of a species and DENOM of a species group I speak of a complex curve; if NUM also consists of two or more species it is a case of a so-called summation curve.

<div align="center">4.</div>

The surface covered by NUM comprises on a given occasion $R_1\%$ of the surface covered by NUM and DENOM together. This means that DENOM covers $(100 - R_1)\%$. On other occasions the corresponding figures are R_2 and $(100 - R_2)$, R_3 and $(100 - R_3)$, etc., etc. The figures given thus indicate the real vegetation ratio occurring. They are called below the »real values».

In the pollen diagrams the real values are not found, however; their place is taken by more or less strongly deviating values. They are called below »diagram values». To the real values R_1, R_2, R_3, etc., etc. correspond accordingly the diagram values D_1, D_2, D_3, etc., etc.

In analyzing pollen diagrams one diagram value (or diagram value system) is compared with the other. When it is the case of such com-

parisons I symbolize the basis for comparison chosen for that occasion by d and the other partner by D. In the same way I employ the symbols r and R when different real values are compared.

The differences (R — r) and (D — d) are sometimes expressed below as Δr and Δd respectively; they are called the »real» and the »diagram difference» respectively. Both can naturally be positive as well as negative. When the diagrams give the impression — rightly or wrongly — that there is »status quo» $\Delta d = 0$. When there is real »status quo» $\Delta r = 0$. In the latter case I speak of »eu status quo» (abbreviated to ESQ); in the former of »pseudo status quo» (abbreviated to PSQ).

The change in the real ratio can also be expressed as the ratio between the fractions R: (100 — R) and r: (100 — r). This quantity is expressed below as C_r; C_d is used to express the change in the diagram ratio in an analogous manner. When there is real status quo thus $C_r = 1$; when $C_d = 1$ the diagrams give the impression — rightly or wrongly — that there is status quo.

The product factor which corresponds to the different epochs represented in the pollen curve (those when the real values and the diagram values respectively were R_1 and D_1 respectively, R_2 and D_2 respectively, R_3 and D_3 respectively, etc.), is expressed below as F_{1N}, F_{2N}, F_{3N}, etc., when it is a case of the NUM-vegetation and as F_{1D}, F_{2D}, F_{3D}, etc., when it is a case of the DENOM-vegetation. The fraction $F_{1N} : F_{1D}$, $F_{2N} : F_{2D}$, $F_{3N} : F_{3D}$ etc., is called the »product factor ratio» or the PFR-value.

When two points on the same pollen curve are compared, the product factor of NUM and DENOM at the point of time fixed upon as a basis for comparison is expressed as f_N and f_D respectively. At a point of time whose pollen frequency figures are compared with the basic values, these product factors have changed; their magnitude is then expressed as F_N and F_D respectively. The change can be expressed as the ratio between the different values; as $F_N : f_N$ and $F_D : f_D$ respectively. The ratio between these two fractions — $(F_N : f_N) : (F_D : f_D)$ — is of great interest for the discussion; it is in the following symbolized as **K** and called the **K**-value.

5.

It is shown below that sections of diagrams sometimes register the change of the true vegetation conditions too high or too low. I then speak of »quantitative deviation». It sometimes happens, too, that an increase in the real ratio is registered as a decrease or a standstill; that

a decrease in the real ratio is registered as an increase or a standstill; that a standstill is registered as a change. In such cases I speak of »qualitative deviation».

6.

The meaning of the principal terms and symbols mentioned above is summarized below:

Terms, Symbols	Explanations
PD-area	The area comprising plant specimens which have delivered pollen up to the point where the pollen analysis mass was collected.
NUM or NUM-antagonist	The species, species complex, etc., whose frequency figures are given directly in the diagrams.
DENOM or DENOM-antagonist	The species, species complex, etc., whose frequency figures form the 100 % sum together with those of NUM.
Diagram values — D_1, D_2, D_3, D_n, D_x, D_y, etc.	NUM's pollen frequency according to the diagram (in samples Nos. 1, 2, 3, n, x, y, etc.).
Real values — R_1, R_2, R_3, R_n, R_x, R_y, etc.	The extent — in % — of the surface covered by the NUM-vegetation (according to samples Nos. 1, 2, 3, n, x, y, etc.).
d and D	The diagram values from samples which are compared with each other. d is then the »basis for comparison».
r and R	The real values corresponding to d and D respectively.
Δd and Δr (the diagram- and the real difference)	The difference of (D-d) and (R-r) respectively.
C_d and C_r	$D/(100-D) : d/(100-d)$ and $R/(100-R) : r/(100-r)$ respectively.
Productfactor — F	The ratio between the number of pollen grains found at the analysis and the relative extent of the surface covered by the actual plant species.
Primary product factor — F_p	The ratio between the number of pollen grains delivered up to the sample point and the relative extent of the surface covered by the actual plant species.
Secondary product factor — F_s	The ratio between the number of pollen grains occurring in the sample mass at the time of analysis and the number delivered up to the sample point.
Tertiary product factor — Fl	The ratio between the number of pollen grains found at the analysis and the number of pollen grains occurring in the sample mass at the time of analysis.

f_N, F_N, F_{1N}, F_{2N}, F_{3N}, etc., and   The product factors of NUM and DENOM respec-
f_D, F_D, F_{1D}, F_{2D}, F_{3D}, etc.   tively corresponding to the different samples.

PFR-value (the product factor $f_N : f_D$, $F_N : F_D$, $F_{1N} : F_{1D}$, etc.
ratio)

K-value $F_N / f_N : F_D / f_D$

Eu status quo — ESQ   Status quo in the reality ($\Delta r = 0$; $C_r = 1$)

Pseudo status quo — PSQ   When the diagram gives the wrong impression that
there is status quo ($\Delta d = 0$; $C_d = 1$).

Qualitative and quantitative   Cf. p. 190 (paragraph 5).
deviation

II. The "PD-area".

1 a.

The term »PD-area» was defined in Chapter I as the area com-
prising plant specimens which have delivered pollen up to the point
where the pollen analysis mass was collected. It may be taken for
granted that most or all of the plant species occurring at the sample
point or in its immediate vicinity deliver pollen to the sample mass.
At a shorter or longer distance from this there is a limit; beyond it
specimens belonging to any one species or any species, no longer con-
tribute as deliverers to the point in question. Determinative for the
distance of this limit to the sample point is naturally the extent of the
pollen production and dispersal of the plants in question. The distance
from the sample point to the limit is besides different in different places
and directions as a result of topography, wind direction, intermediate
masses of vegetation, etc. Peripheral to this limit is a sequence of similar
boundary-lines. Furthest out in the periphery there is finally the outer-
most limit of the delivery area.

1 b.

It is clear from the above that the PD-area has many zones. The
zones are characterized by different delivery capacities. The delivery
factors will thus be different even for one and the same species when
the representatives of that species are situated in different zones. When
it is the question of the whole PD-area the delivery factor of each
species thus consists of an average. This need not be the same when it
is a case of different PD-areas.

1 c.

The pollen diagrams naturally show the composition of the mass of pollen grains found and treated. If the manipulation errors — here the statistical errors are also included — are so insignificant as to be negligible or if they are the whole time proportionally the same. the diagrams at the same time show the composition of the supply of pollen in the sample mass. If also the secondary product factor for the different species deviates slightly from 1 or if they have changed in a proportional manner, the pollen diagram also illustrates the composition of the mass of pollen grains delivered up to the sample point during the periods of time illustrated in the diagram. T h u s   i t   s h o w s the c h a r a c t e r   o f   t h e   d e l i v e r y   a r e a   in   q u e s t i o n   inas m u c h   a s   i t   d e m o n s t r a t e s   p h e n o m e n a   w h i c h   con stitu t e   t h e   r e s u l t   o f   t h e   l a t t e r's   p e r c e n t a g e   com position   in   r e s p e c t   o f   e x i s t i n g   v e g e t a t i o n   a n d   t h e delivery   c a p a c i t y   o f   i t s   c o m p o n e n t s.   T h i s   m e a n s in o t h e r   w o r d s t h a t   t h e   e x i s t i n g   f l u c t u a t i o n s   in t h e curves   a r e   o f   r e a l   s i g n i f i c a t i o n;   that they can be used for curve connection — the pre-requisite is naturally that the postulate given above is fulfilled. O n   t h e   o t h e r   h a n d,   i t   i s   o n l y seldom   p o s s i b l e,   a s   w i l l   b e   s e e n   b e l o w,   t o   deter m i n e   w h e t h e r   t h e   i n d i v i d u a l   f l u c t u a t i o n   i s   d u e   t o a c h a n g e   in t h e   p e r c e n t a g e   c o m p o s i t i o n,   t o   a   c h a n g e in t h e   p r o d u c t i o n   a n d   d e l i v e r y   c a p a c i t y   o f   t h e   com p o n e n t s,   o r   t o   b o t h   t h e s e   f a c t o r s.

1 d.

The position is fairly simple if the delivery area is homogeneous, i.e. if its separate components have a uniform climate, uniform edaphic conditions, uniform vegetational history, etc., etc. Within the entire PD-area competition then takes place between plant species which fluorish in the entire area. The NUM-vegetation will then be in the main evenly distributed over the entire area; the same applies to the DENOM-vegetation. If, for instance, a more abundant supply of water makes the NUM-types more strongly competitive and a less abundant supply of water makes them less strongly competitive, the ratio between NUM and DENOM will fluctuate backwards and forwards according as the changes in climate lead to an increased or diminished water supply. The averages of the product factors will nevertheless

remain unchanged owing to the existing homogeneity. The fluc-
tuations of the pollen diagrams indicate in this
case fluctuations in the vegetation ratios (the pre-
requisite is naturally that the postulate given above is fulfilled).

1 e.

Truly homogeneous PD-areas are, however, lacking in reality. In
reality the areas are always more or less heterogeneous. When the
sample point forms part of a mire in an otherwise homogeneous
forested area, it itself constitutes as do also the mire in question and
the area between it and the forest disturbances in the homogeneity.
These are without signification only if the plant species of the diagrams
are lacking in the aberrant area. If they are present there, they can
cause great deviation even if the aberrant area is of small size; namely
if it is a case of abundant pollen-producing and ready pollen-delivering
types. (Here it need by no means or even chiefly be a case of so-called
»macroscopic pollen delivery», i.e. delivery of stamens, flowers, in-
florescences, or still larger parts of plants with pollen masses.) In these
cases the delivery factor is very great owing to the short distance to
the sample point. This implies that even changes which are most
insignificant when the delivery area is considered as a whole, may
strongly influence the product factor and consequently also the pollen
diagrams.

Far less »disturbing» are the aberrant areas if they are situated on
the periphery of the »PD-area». In view of the relatively low delivery
factors in that case, the changes here will usually only influence the
diagrams if they are specially strong. One cannot, however, disregard
the possibility of there being cases in which the aberrant and remote
area accommodates types with a very high product factor, owing to
abundant pollen production and good dispersal capacity.

1 f.

If the PD-area is extremely heterogeneous conditions become extra-
ordinarily complicated. Let us assume that the area is a mosaic of
rainy and dry areas and that the »pieces of mosaic» are not evenly
distributed. In each piece of mosaic there is then mutual competition
between plants which are lacking in the »antagonist areas», which are
greatly hampered in the competition in these or which are there re-
presented by other biotypes or by similar biotypes that have become

adapted in another way. Climatological changes here give a series of different effects. The differences between the »pieces of mosaic» become accentuated or smoothed out, the various parts of the area increase or decrease in extent, changing in their relation to each other. This results not only in changes in the ratio between the various species in the different areas and in the entire PD-area but also in changes in the extent of the latter and alterations in the magnitude of the delivery factors. The two last-mentioned changes can be violent. An important part is here played by the local differences conditioned by topography and wind direction.

Appraisement becomes particularly difficult if the PD-area contains »blind spots», i.e. larger or smaller areas where the species shown in the diagrams are missing. If, for example, some kind of change — it need have no connection at all with the changes in humidity — causes such a »blind spot» in a dry area to be invaded by xerophytic species that are shown in the diagrams, an uncritical observer will form the opinion that the xerophytic vegetation has increased at the expense of the hygrophytic.

It is clear from the above that one and the same change in a diagram may indicate a change in some of the »pieces of mosaic», a change in their size, a decrease or increase in their distance in relation to the sample point as well as any combination of these whatever when it is a case of a strongly heterogeneous PD-area. The natural consequence of this: in that case it is extremely difficult, not to say absolutely impossible, to reconstruct the changes that have taken place with the help of the pollen diagrams. A knowledge of the ecology of the species included and of the topographical and other characteristics of the PD-area may perhaps sometimes reduce the difficulties.

2.

If one compares pollen diagrams from points comparatively close to each other, great similarities are often observed. This is sometimes regarded as a criterion of the correctness of the diagrams in question. That is not right, however. Deviation caused by fluctuations in the production and delivery factors is not »revealed» here. All reception points »similarly exposed to the general pollen cloud» naturally exhibit equally great deviations so conditioned. Correspondence therefore merely shows that the said points have had

similar PD-areas and that the diagrams exhibit the
composition of the pollen delivered to the sample
points.

There are also examples, however, of pollen diagrams from sample
points comparatively close to each other exhibiting distinct differences
(cf., e.g., Mrs. T. VON POST's analyses in MALMSTRÖM 1937, SELLING
1948, FÆGRI & IVERSEN 1950). If it is out of the question for the dif-
ferences to be due to something connected with the secondary or the
tertiary product factor, the causes will have to be sought in the PD-
area. This must have been heterogeneous in some
respect or other.

If the differences owe their occurrence to the very species which are
found at the sample points or in their immediate vicinity, they may be
due to the differences being entirely local. Thus the PD-area can, in
spite of the differences, have been homogeneous except for the homo-
geneity disturbances which the sample points themselves constitute. If
the differences owe their occurrence also to other species or only to
such, then it is a case of a truly heterogeneous PD-area. If it is out
of the question for the differences to be connected with the primary
product factor, they must instead be conditioned by the statistical
treatment of the material, by the manipulation work, by different
degrees of pollen conservation, by pollen being washed away, or by
something else included in the secondary and the tertiary product
factor. In most cases one cannot a priori determine
whether the differences are connected with the
primary, the secondary or the tertiary product fac-
tor. Naturally it is often possible for all of them
to have been influential.

3.

If several points in one and the same area show
corresponding pollen diagrams one must draw the
conclusion, in accordance with the above, that it
is a case of a homogeneous PD-area. It is clear from
the preceeding and the following that one can reconstruct, with varying
degrees of difficulty, the changes in the vegetation ratios if the
PD-area is homogeneous but that this reconstruction is extremely un-
certain or impossible if there is instead considerable heterogeneity.
When the purpose of a pollen-analytical investiga-

tion is to make studies of vegetation and climate, one should therefore first establish the character of the PD-area. If the effect of the heterogeneity is large or if it is established that the heterogeneity is such that it is not merely conditioned by the sample point itself and its immediate vicinity, then one should take into consideration whether it is sensible or not to continue the investigation.

III. Relation between the "diagram-", the "real-" and the "PFR-value".

1.

If a point on a pollen curve really indicates that the NUM-antagonist during the epoch represented was characterized by the real value R and its product factor was at the same time F_N, then at the analysis RF_N grains of NUM-pollen will be found. If the DENOM-antagonist had the product factor F_D, then $(100 - R)F_D$ grains of DENOM-pollen were found at the same time. The total sum of pollen found will thus be: $RF_N + (100 - R)F_D$.

If the NUM-pollen frequency found is expressed as $D\%$ (=the so-called diagram value), the following relation will be obtained:

$$D = \frac{100RF_N}{RF_N + (100 - R)F_D};$$

$$\therefore \frac{F_N}{F_D} = \frac{D(100 - R)}{R(100 - D)} \quad \ldots \ldots \text{ Equation No. 1.}$$

The equation obtained thus expresses the relation between the diagram value, the real value and the so-called PFR-value (i.e. NUM's product factor divided by DENOM's).

If $D = R$ is put in equation No. 1 we get:

$$F_N = F_D.$$

Hence the diagram value can only be accepted as the correct real value if the antagonists' product factors are the same.

If D (in equation No. 1) is larger than R we get instead:

$$F_N > F_D.$$

Conclusion: If the NUM-antagonist has a higher product factor than the DENOM-antagonist we get too high a value if the diagram value is accepted as the real value.

If D (in equation No. 1) is smaller than R we get instead:

$$F_X < F_D.$$

Conclusion: If the NUM-antagonist has a smaller product factor than the DENOM-antagonist the diagram value is too small.

The relations expressed above are diagrammatically illustrated in Fig. 1.

2.

The above circumstances are probably known to all those engaged in pollen analysis. If one discusses these circumstances and their resultant effects with pollen analysts one often hears it said that the pollen curves do not demonstrate the vegetation ratios which existed, but that they show the ratio changes that have taken place. In the following I shall show, however, that the said circumstances also cause deviation when it is a case of the latter.

3.

Different plant species exhibit product factors of varying magnitude. Their magnitude is influenced by a large number of different factors (cf. Chap. I and II). A very important factor in this connection is the extent of the pollen production and the pollen dispersal, i.e. what I have called in Chapter I the production and the delivery factor respectively. The literature contains information about the extent of the dispersal and the magnitude of the primary product factor in some cases. The survey of FÆGRI & IVERSEN (1950) shows that the primary product factor varies greatly in magnitude in different objects. In the comparisons published by the authors named the ratio in the extreme cases is as 1 : 10, 1 : 20 and 1 : 40 respectively. Nevertheless the comparisons only comprise trees producing an abundance of wind pollen. It is obvious that the product factor ratio (the PFR-value) will rise to very high figures (and fall to very low figures respectively) if the comparison comprises plants with wind pollen as well as insect pollen; especially

if in the latter case one keeps to the more extreme examples. e.g. to cases where the insect pollination is only effected by »specialists». Such figures as ∞ (and 0 respectively) can certainly be found.

If the PFR-value is known the diagram values obtained can naturally be adjusted to the real values with the aid of equation No. 1 and the diagram in Fig. 1 respectively. It is comparatively simple to estimate the magnitude of the said PFR-value if it is a case of a simple pollen curve (i.e. cases where the NUM- as well as the DENOM-antagonist represent a single species; cf. p. 189). It becomes more difficult, however. if it is a case of a complex curve or a summation curve. It is then much simpler to follow the method given below.

As an appropriate measure for partial elimination of the errors arising in consequence of the differences between the primary product factors IVERSEN (cf. FÆGRI & IVERSEN 1950 p. 87) suggests that for Scandinavian conditions the pollen figures from the components having a specially high primary product factor be divided by four before the diagrams are made. When the PFR-value is expressed by a very high figure one should naturally divide by a higher number than four. It is, however, very difficult to estimate the size of this correctly. By dividing by too small a number, the errors are naturally reduced. Here the correction is often relatively slight, however. Fig. 1 shows that if the PFR-value is, for example, 100 and if one by the »division method» »reduces» it to 25 or 10, then the remaining error is still so great that the values cannot very well be accepted. Adjustment is naturally impossible when the PFR-value approaches ∞. If the PFR-value is high an overvaluation of it when using the division method causes the error to »change front». The risk of this new error being greater than the primary error is extremely slight (cf. Fig. 1). On the other hand, the said risk is considerable when the PFR-value is expressed by low figures, e.g. 1:1, 2:1, 3:1, 4:1 or reciprocally. One should therefore have recourse to IVERSEN's method only when it is a case of large differences. Even if the method does not give total correction in such cases and even if it is not of much use in the above-mentioned extreme cases, yet it always results in a reduction of the existing errors. By achieving this reduction, a pollen diagram has, however, been produced in which the fluctuations have greater real signification than in the uncorrected diagram.

IV. Relation between the "diagram-", the "real-" and the "K-value".

1.

The change in the diagram ratio was written as C_d (cf. p. 190). The relation between this and the diagram values is expressed by the following equation (cf. p. 191):

$$C_d = \frac{D(100 - d)}{d(100 - D)}. \quad \ldots\ldots \text{Equation No. 2.}$$

The change in the real ratio was written C_r. Hence:

$$C_r = \frac{R(100 - r)}{r(100 - R)}. \quad \ldots\ldots \text{Equation No. 3.}$$

The relations given by equations Nos. 2 and 3 are graphically illustrated in Fig. 1.

If the symbols introduced in Chapter I are used, the mass of the NUM-pollen grains found will be rf_N at the »point of time fixed upon as a basis for comparison». The corresponding amount of DENOM-pollen is $(100-r)f_D$. If they are divided by each other the ratio of the amount of pollen at the said time will be obtained. This is accordingly: $rf_N : (100-r)f_D$. At the »point of time fixed upon as the subject for comparison» the amount of NUM-pollen was RF_N and of DENOM-pollen $(100-R)F_D$. If these are divided by each other we get the pollen amount ratio of $RF_N : (100-R)F_D$. If the latter ratio is divided by that at the »point of time fixed upon as a basis for comparison» we get:

$$C_d = \frac{RF_N(100 - r)f_D}{rf_N(100 - R)F_D};$$

$$\therefore \text{(cf. p. 190, 192)} \quad C_d = K\frac{R(100 - r)}{r(100 - R)}. \quad \ldots\ldots \text{Equation No. 4.}$$

From equations Nos. 3 and 4 we get the following relation between the change in the diagram ratio, the change in the real ratio and the K-value:

$$\frac{C_d}{C_r} = K. \quad \ldots\ldots \text{Equation No. 5.}$$

The following relation between the change in the real ratio, the K-value and the diagram values appears from equations Nos. 2 and 5:

$$C_r = \frac{1}{K} \cdot \frac{D(100 - d)}{d(100 - D)}. \quad \ldots\ldots \text{Equation No. 6.}$$
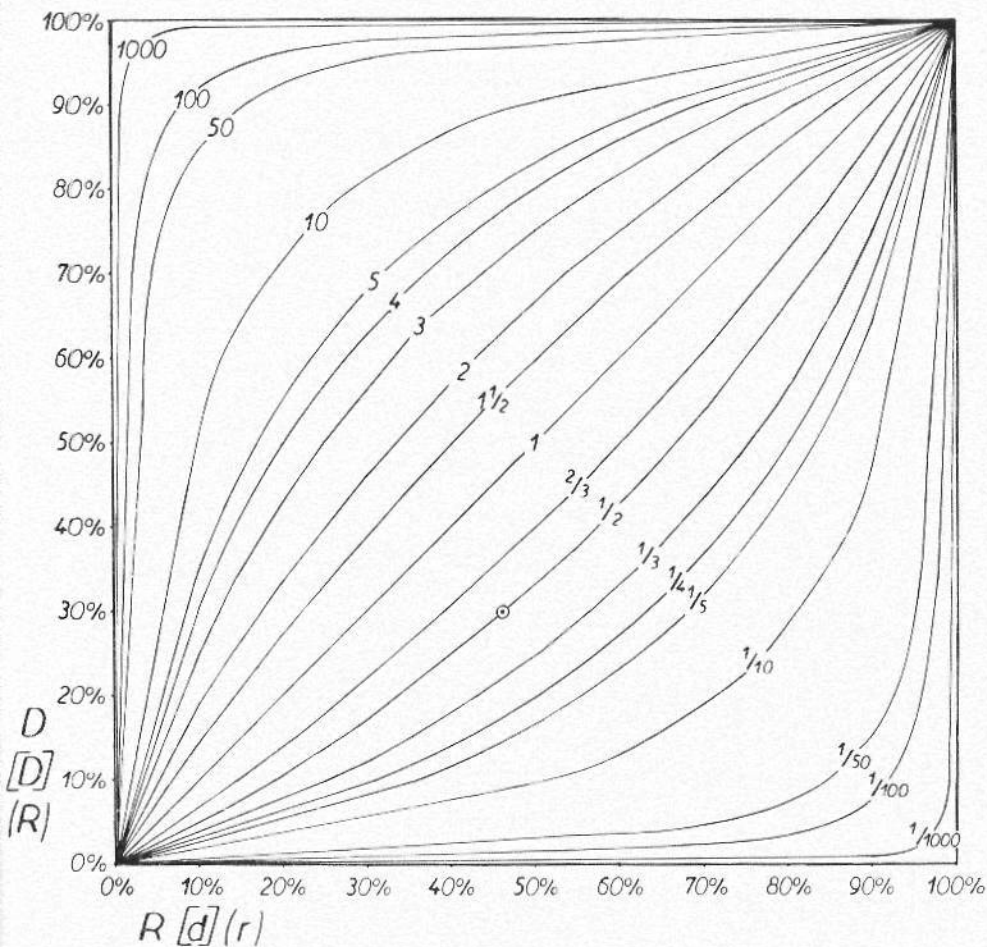
Fig. 1. The relation between:

a) the diagram-, the real- and the PFR-value. The diagram- and the real-value are laid down on the axis of the diagram — the symbols are placed without parenthesis or brackets —; the PFR-value appears from the figures on the curved diagram lines. ⊙ shows for example that the real value is 46 % if the diagram value 30 % is accompanied by the PFR-value 0.5.

b) two compared diagram values and the change in the diagram ratio. The diagram values are laid down on the axis of the diagram — symbols placed in brackets —; the change of the diagram ratio — the C-value — appears from the figures on the curved diagram lines.

c) two compared real values and the change in the real ratio. The real values are laid down on the axis of the diagram — symbols placed in parenthesis —; the change of the real ratio — the C_r-value — appears from the figures on the curved diagram lines.

The relation between the diagram values, the real values and the **K**-value is from equations Nos. 2, 3 and 5 as follows:

$$K = \frac{D(100 - d)r(100 - R)}{d(100 - D)R(100 - r)}. \quad \ldots \text{Equation No. 7.}$$

2.

It is immediately clear from equation No. 5 that $C_d = C_r$ only if **K**=1. But **K**=1 only if the product factors of the antagonists are unchanged or if they have changed in a proportional manner. (The latter is really of no interest, since such a case is hardly likely to occur in practice.) If the product factors of the antagonists are unchanged the diagrams thus show the changes in the real ratios correctly. The significance of this fact should not be exaggerated, however.

It is clear from equations Nos. 2 and 3 and from Fig. 1, that a whole series of different real value changes and diagram value changes respectively lead to one and the same C_r- and C_d-value respectively. The consequence of this is that even if **K** is equal to 1 a more steeply inclined diagram line may correspond to a less steeply inclined line in the corresponding »real diagram» and vice versa. If nothing is known about the relative magnitude of the product factors, the pollen curves consequently only show the direction of the change even if **K** is equal to 1. They tell us nothing about the magnitude of the change.

If, on the other hand, something is known about the relative magnitude of the product factors, there is, however, a possibility of forming an approximately correct idea of the changes even from a quantitative point of view with the aid of Fig. 1. If the product factors are known to be almost the same, it is naturally permissible to accept the deflection of the curves straight away. If the section of the curve in question is known to lie too high or too low on account of the product factor ratios (cf. Fig. 1), the degree of inclination of the section of the curve in question should be »replaced» by one leading to the same ratio change but lying lower or higher respectively in the series exemplified in Fig. 1. If one has a rough idea of how much too high and too low respectively the curve section in question lies, there is a possibility of roughly estimating the magnitude of the necessary adjustment.

The above shows that certain readings can immediately be made

in sections of pollen curves characterized by the **K**-value 1. Such a **K**-value must, however, be described as extremely rare. Most pollen diagrams contain curves where at least one of the antagonists consists of a complex of different species. If these species have different product factors the variation in the composition of the complex must lead to **K**-fluctuations. This matter is further elucidated in Chapter VIII.

It is naturally much simpler to follow IVERSEN's recommendation (cf. p. 199) than to proceed in the usual way and then adjust the diagrams in accordance with the above. By dividing the figures which express the number of pollen grains of different kinds found by figures chosen with regard to the approximate magnitude of the existing product factors, the adjustments can already be made before the diagrams are plotted. The same drawbacks inherent in the method when it is a case of the circumstances discussed on p. 199 are, however, also inherent in it here.

V. How is "status quo" indicated in the diagrams? What is the signification of the rising and falling lines in the diagrams?

1.

For each **K**-value there is according to equation No. 5 a definite C_d-value which results in $C_r = 1$, and a definite C_r-value which results in $C_d = 1$.

If »status quo» exists in reality i.e. if $C_r = 1$, equation 6 gives the following:

$$K = \frac{D(100 - d)}{d(100 - D)}. \qquad \ldots \ldots \text{ Equation No. 8.}$$

If **K** is greater than 1 we then get:

$$D(100\text{-}d) > d(100\text{-}D);$$
$$\therefore \ D > d;$$
$$\therefore \ \Delta d > 0.$$

»Status quo» thus corresponds to a rising line in the diagrams if **K** is greater than 1. The lines which in these diagrams despite their rising course illustrate »status quo» are termed (cf. Chap. I) »eu status quo lines» (abbreviated to ESQ-lines).
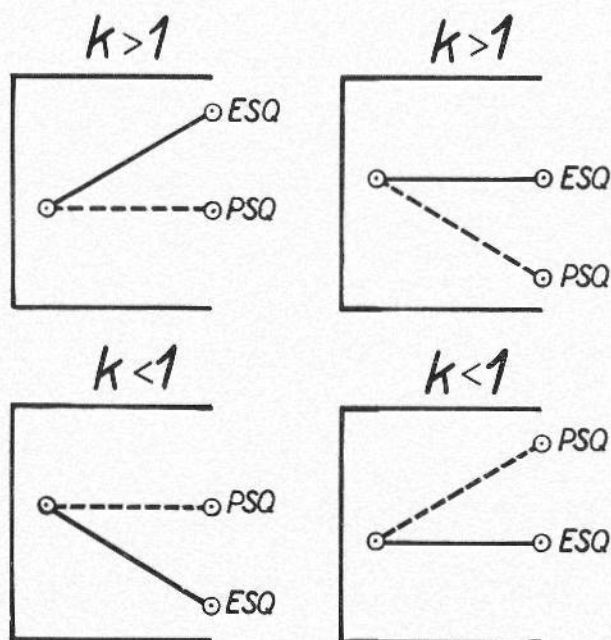
Fig. 2. The course of the ESQ- and the PSQ-line in the pollen diagram and in the »real diagram» when the K-value is greater than 1 and when it is less than 1.

If **K** is less than 1 we get in the same way $D<d$, i.e. $\Delta d<0$. T h e ESQ - l i n e s o f t h e d i a g r a m s w i l l t h i s b e f a l l i n g l i n e s w h e n **K** i s l e s s t h a n 1.

If **K** = 1 the ESQ-lines are naturally horizontal.

S e c t i o n s o f c u r v e s r u n n i n g h o r i z o n t a l l y i n t h e d i a g r a m s d o n o t c o n s e q u e n t l y i l l u s t r a t e »s t a t u s q u o» i n r e a l i t y i f **K** h a s a n o t h e r v a l u e t h a n 1. These »false» status quo lines are termed (cf. Chap. I) »pseudo status quo lines» (abbreviated to PSQ-lines).

The conditions here discussed are illustrated in Fig. 2.

In consequence of the ratios illustrated in Fig. 1 the ESQ-lines for each definite **K**-value will incline in different degrees when corresponding to different diagram levels. There is no difficulty in constructing them when the **K**-value is known. Fig. 3 shows how the construction is
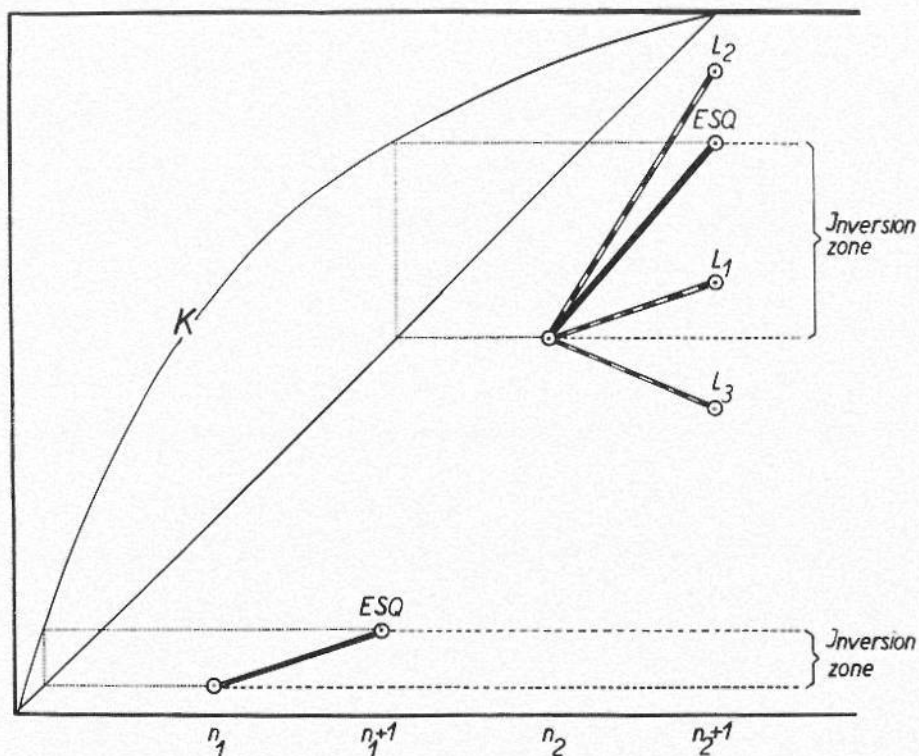
Fig. 3. Construction of the ESQ-line and the appertaining inversion zone. The curved line and the right line issuing from origo are drawn in accordance with Fig. 1. — Line L_1 represents a rising diagram line which corresponds to a falling one in the »real diagram»; L_2 and L_3 are qualitatively correct but quantitatively deviating lines.

done and how the ESQ lines corresponding to the same **K**-value run in the different zones of the diagram.

Each »horizontal» diagram area »spanned» by an ESQ line (cf. Fig. 3) is called in the following, for reasons explained below (p. 206), an inversion zone.

2.

With the aid of equation No. 4 one can determine the real ratios that correspond to the PSQ of the diagrams. If $C_d = 1$ we get:

$$\mathbf{K} = \frac{r(100 - R)}{R(100 - r)} \quad \ldots \ldots \text{ Equation No. 9.}$$

If **K** is greater than 1 we find that Δr is less than 0; if the former is less than 1 we find that Δr is greater than 0. If **K** = 1 Δr is naturally 0.

The PSQ-lines thus occur in the »real diagrams» as falling lines if **K** is greater than 1, as rising lines if **K** is less than 1 and as horizontal lines if **K** = 1.

The relation between the ESQ- and the PSQ-lines in pollen diagrams and in »real diagrams» is illustrated in fig. 2.

3.

It is clear from the above that the horizontal sections of the pollen curves only indicate status quo when **K** = 1. When **K** is greater than 1 they indicate a change in the negative direction, when **K** is less than 1 in the positive direction. It will immediately be realized (cf. Fig. 2 and 3) that the ratios illustrated in the pollen diagrams by means of rising lines when the ESQ line in question falls and those illustrated by falling lines when the ESQ line in question rises, are not subject to qualitative deviation. The same is also true when the diagram section inclines in the same direction as the ESQ line in question but to a higher degree than the latter. In all the said categories there is quantitative deviation, however. That is clear from Fig. 2 when it is positive and when it is negative. A line that inclines in the same direction as the ESQ line in question but to a lesser degree than the latter is, on the other hand, subject to qualitative deviation. When such a line creates the impression that a maximum exists, a minimum exists in reality, and vice versa.

If the magnitude of the **K**-values is known, there is of course the possibility of adjusting the diagrams by construction of the so-called inversion zones, i.e. the zones »spanned» by the ESQ lines in question (cf. Fig. 3). One then knows that the line (ESQ in Fig. 3) which may possibly run up (down) to the upper (lower) limit of the inversion zone, represents status quo, that the line (line L_1 in Fig. 3) that runs out into the zone but does not reach the said limit, should be »inverted» — hence the term »inversion zone» — i.e. if it is a rising line it should be exchanged for a falling and vice versa. The line (line L_2 in Fig. 3) that continues after having intersected the inversion zone and the line

(line L_3 in Fig. 3) that does not run into the zone in question at all, exhibit, on the other hand, the correct course (but not the correct degree) of inclination.

<div align="center">4.</div>

That which has been pointed out in the last part of the above paragraph 3 is of no particular interest, however. No one is likely to use the method. If one knows the product ratios from the various occasions, which is a pre-requisite condition for knowledge of the different K-values, one naturally makes the adjustments before plotting the diagrams; one uses in other words the method proposed by IVERSEN (cf. pp. 199 and 203). The so-called inversion zones are of great interest, however, in cases where the K-values are not known but when a general idea can be formed of the limits of the K-value variation.

A pollen curve is composed of the following consecutive points: D_1, D_2, D_3, D_4, etc., etc. If separate pairs of points are compared with each other, one naturally obtains different K-values. The variation in magnitude can be expressed by indicating the maximum K-value which occurs if the separate points of the diagram are compared in pairs with each other in every imaginable way. This K-value is called below K_{max}. If one draws through the diagram points vertical lines which are bounded at the top by the upper limit of the inversion zone corresponding to $K = \sqrt{K_{max}}$, and at the bottom by the lower limit of the inversion zone corresponding to $K = 1 : \sqrt{K_{max}}$, one gets the ranges of variation which the separate points in the diagram represent in consequence of the fluctuations in the K-values. The construction will be found in Fig. 4.

It will immediately be realized that it really is a case of correct ranges of variation. When passing from D_x to D_y K has a value which lies somewhere between K_{max} and $1 : K_{max}$ or which coincides with one of these extreme values. If R_x is represented by the highest point of the corresponding range of variation constructed and R_y by the corresponding one's lowest, it is obvious that $K = K_{max}$; if the ratios are reciprocal $K = 1 : K_{max}$. If R_x and R_y are represented by some other pairs of points in the appertaining ranges of variation, K lies between the said extreme values.

By constructing the ranges of variation which the points represent, it is possible to appraise the signification of the points of the diagram.
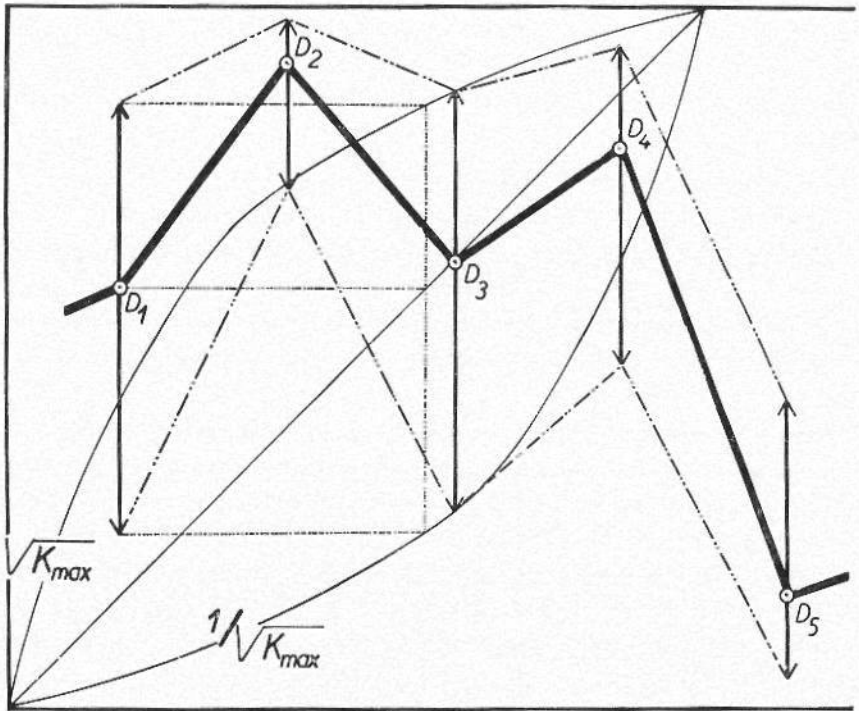
Fig. 4. Construction of the ranges of variation represented by the separate points
D_1, D_2, D_3, etc., of the pollen curve, when K_{max} is known. The arrow heads indicate
the upper and the lower limit of the ranges of variation. — The curved lines and the
right line issuing from origo are drawn in accordance with Fig. 1. — The fol-
lowing is obvious from the construction: The »real curve» lies somewhere in
the field that is limited by the lines running between the different arrow heads.
R_2 and R_4 are higher than R_5, but it is impossible to determine if R_2 is greater or
less than R_1, R_3 and R_4.

Value R_y is certainly higher (lower) than R_x if all
the points in the range of variation which D_y re-
presents lie higher (lower) than all the points in
the range of variation which D_x represents. If the
relation between two compared ranges of variation
is otherwise, it is impossible to determine a priori
whether the corresponding real values are equally
great or which is greater than the other.

VI. Which diagram fluctuations can be accepted?

Two diagram points indicate the real ratios qualitatively correctly only if the upper limit of the range of variation represented by the lower diagram point does not reach up to the lower limit of the range of variation represented by the higher diagram point (cf. Chapter V.). A great deal of time is needed, however, to construct the range of variation for each diagram point in accordance with what was stated in Chapter V. It is simpler to provide the diagrams with a system of lines showing how the limits of the range of variation appear in the different levels of the diagrams. These boundary lines are inserted in the following way:

The inversion zone which applies for the D-value 50 % is constructed, the K-value being put at $\sqrt{K_{max}}$ and $1 : \sqrt{K_{max}}$. The upper and lower boundary line of the double zone then coincide with D-values which can be written as $(50 + A)$% and $(50 - A)$%, where A is a quantity that depends on K_{max}. By constructing the inversion zone which applies for the D-value $(50 + A)$%, when the K-value is $\sqrt{K_{max}}$, and that which applies for the diagram points $(50 - A)$%, when the K-value is $1 : \sqrt{K_{max}}$, two additional zones are obtained which lie symmetrically round the double zone first constructed and which are bounded at the top and at the bottom respectively by the D-value lines $(50 + A + B)$% and $(50 - A - B)$% respectively. This process is repeated afterwards with the new lines thus obtained as a starting point and with those obtained through successive repetitions. The diagram will then become divided into a series of zones (Fig. 5 and 6) having special qualities and delimiting each other and lying symmetrically round the 50 % line. Each diagram point lying on one of these zone boundaries then represents a range of variation which extends from the zone boundary lying nearest below. If the point lies in the lower part (central part, upper part) of a zone it represents a range of variation which extends from the lower part (central part, upper part) of the zone lying above to the lower part (central part, upper part) of the zone lying below (cf. Fig. 6). For two diagram points to be »separate in reality» it is thus necessary for the vertical distance to exceed the distance between the upper and lower limit of the double zone in question. (The upper, central and lower part of the separate zones do
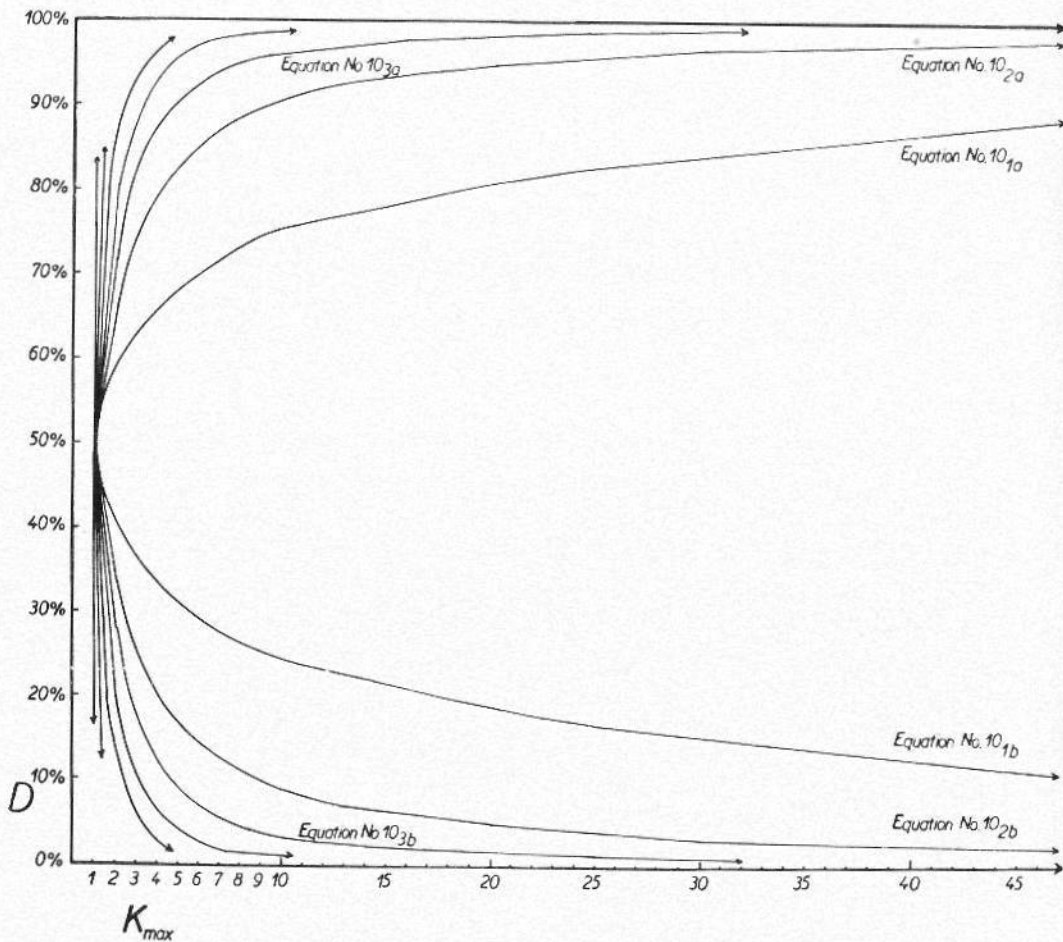
Fig. 5. The relation between the K_{max}-value and the upper and lower limit of the inversion zones. Cf. text on pp. 212—214.

not, however, correspond exactly with each other. Certain changes occur, which are connected with the depth of the zone.)

In the second part of Chapter IV it was stated that the pollen diagrams show directly the quality of the change when the K-value is 1, but that also under these circumstances they only exceptionally provide criteria for appraising the magnitude of the changes. For the same reasons as those then given, the ranges of variation which do not overlap also show the direction of the change, but only in exceptional cases do they
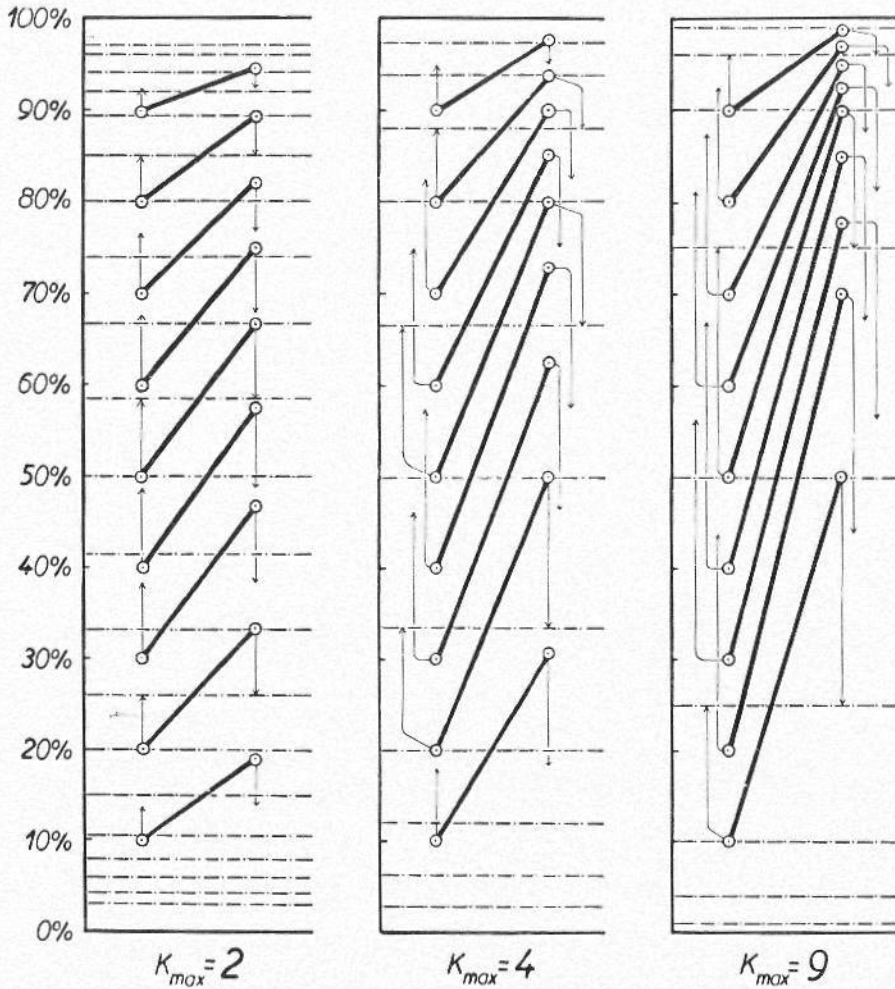
Fig. 6. The relation between the upper and lower limit of the inversion zones when K_{max} has the value of 2, 4 or 9. The dotted lines illustrate the boundaries between adjacent inversion zones. The endpoints of the different curve sections are examples of how far from each other diagram points in different zones of the diagram must lie for it to be certain that they illustrate separate real values. The arrow heads illustrate the upper and lower limit of the range of variation for the lower and upper curve point respectively. See also text on pp. 209, 212, 214.

provide any information about the magnitude of the changes.

It follows from the above that the possibilities of attaching import-ance to the fluctuations of a pollen curve decrease according as the

width of the zones inserted in the diagram increases. The width depends upon the magnitude of K_{max}, i.e. upon the magnitude of the existing K-value fluctuations. The width of the zones can easily, with the aid of equation No. 8 (in the first part of Chapter V), be illustrated graphically (Fig. 5) and with equations. The 50 %-line separated the two central zones from each other. The equations for their boundary lines, which are not shared in common, are then obtained (cf. equation No. 8) from the two systems:

$$\begin{cases} K_{max}^{0,5} = \dfrac{D(100-d)}{d(100-D)}; \\ d = 50; \end{cases} \qquad \begin{cases} K_{max}^{-0,5} = \dfrac{D(100-d)}{d(100-D)}; \\ d = 50; \end{cases}$$

$$\therefore D = \frac{100}{K_{max}^{-0,5}+1}. \qquad \therefore D = \frac{100}{K_{max}^{0,5}+1} \qquad \begin{array}{l}\text{Equations Nos.}\\ 10_1 \text{ a \& b.}\end{array}$$

The lines which delimit the following zones at the top and at the bottom respectively, are satisfied by the equations obtained from the two systems:

$$\begin{cases} K_{max}^{0,5} = \dfrac{D(100-d)}{d(100-D)}; \\ d = \dfrac{100}{K_{max}^{-0,5}+1}; \end{cases} \qquad \begin{cases} K_{max}^{-0,5} = \dfrac{D(100-d)}{d(100-D)}; \\ d = \dfrac{100}{K_{max}^{0,5}+1}; \end{cases}$$

$$\therefore D = \frac{100}{K_{max}^{-1}+1}. \qquad \therefore D = \frac{100}{K_{max}+1}. \qquad \begin{array}{l}\text{Equations Nos.}\\ 10_2 \text{ a \& b.}\end{array}$$

The equations for the following lines are obtained in a similar way. These are thus:

$D = 100 : (K_{max}^{-1,5}+1)$ and $D = 100 : (K_{max}^{1,5}+1)$. Equations Nos. 10_3 a & b

$D = 100 : (K_{max}^{-2}+1)$ and $D = 100 : (K_{max}^{2}+1)$. » » 10_4 a & b

$D = 100 : (K_{max}^{-2,5}+1)$ and $D = 100 : (K_{max}^{2,5}+1)$. » » 10_5 a & b

$D = 100 : (K_{max}^{-0,5n}+1)$ and $D = 100 : (K_{max}^{0,5n}+1)$. » » 10_n a & b

The positions of the separate boundary lines are illustrated graphically in Fig. 5. The diagram given here shows that the depth of the more central inversion zones increases quickly with an increasing K_{max}-value. With the exception of the 50 %-line the lines demonstrating the position of the boundary lines approach asymptotically the 0- and 100 %-lines of the diagram. This approach takes place comparatively slowly

for the first lines but at increasing speed for those following successively. The number of »practically usable» zones therefore diminishes rapidly with an increasing K_{max}-value. Fig. 6 also shows how the zone and boundary line grid appears in diagrams where K_{max} has values of 2, 4 and 9. It is immediately clear that even comparatively insignificant curve fluctuations — for example those which amount to or exceed the change from the percentage 10 to 29, from 20 to 35, from 30 to 48, from 40 to 58, from 50 to 68, from 60 to 76 or vice versa — should be accorded real signification when K_{max} is 2. When K_{max} is 4 the fluctuation must be greater — at least from 10 to 31, from 20 to 51, from 30 to 65, from 40 to 73, from 50 to 81, from 60 to 86, from 70 to 91, from 80 to 94, from 90 to 98, etc. — for significance to be accorded to them. If K_{max} is 9 they must be still greater, viz. from 10 to 51, from 20 to 71, from 30 to 78, from 40 to 00, from 50 to 91, from 60 to 93, from 70 to 96, from 80 to 97, from 90 to 99, etc. From this it is quite clear that pollen curves with not too small fluctuations are of value when K_{max} is 2 or less and if the fluctuations are wider also if K_{max} reaches 4. When K_{max} reaches 9 or a still higher figure the pollen curve is without value in most cases.

It is obvious from the above that attention must be paid to the K_{max}-value when judging the signification of a pollen curve. If one is convinced that this does not exceed 2, 4, etc., one must supply the diagrams with a corresponding zone- and boundary line system and »reject» the too low fluctuations. If the K_{max}-value is high owing to the species studied having too different product ratios (cf. Chap. VII), one should »bring these differences within reasonable limits» by using the division method recommended by IVERSEN. (For cases where that is not possible, see Chapters VII and VIII.) In cases where it is quite impossible to judge the magnitude of the K_{max}-value — for example when it is a question of a strongly heterogeneous delivery area (cf. pp. 194—196) — there is of course no possibility of constructing the zone- and boundary line system. Whether it is a question of small or large curve fluctuations one consequently lacks in these cases every possibility of determining whether these are

mainly due to a change in the percentage composi-
tion of the PD-area under consideration, whether
it is mainly due to a change in the **K**-values of the
components included or whether both of these phe-
nomena have played an important rôle simultane-
ously.

VII. Dependence of the K-value on the composition of the NUM- and DENOM-vegetation.

1.

In a complex curve the DENOM-components are called $DENOM_1$,
$DENOM_2$, $DENOM_3$, etc., By $d(=d_N)$, $D(=D_N)$, $r(=r_N)$, $R(=R_N)$,
$d_D(=[100-d])$, $D_D(=100-D)$. $r_D(=[100-r])$, $R_D(=[100-R])$, d_{D1},
D_{D1}, r_{D1}. R_{D1}, d_{D1}, D_{D2}, r_{D2}, R_{D2}, d_{D3}, D_{D3}, r_{D3}, R_{D3}, etc., are expressed in
the usual order the diagram- and the real values for the NUM-com-
ponent, for the DENOM-vegetation regarded as a unit and for the different
DENOM-components respectively. The d_D-value $(=$the $[100\text{-}d]$-value)
and the D_D-value $(=$the $[100\text{-}D]$-value) are conditioned to $a_{D1}\%$ and
to $A_{D1}\%$ respectively by $DENOM_1$, to $a_{D2}\%$ and to $A_{D2}\%$ respectively
by $DENOM_2$, to $a_{D3}\%$ and to $A_{D3}\%$ respectively by $DENOM_3$. etc. The
product factors which characterize NUM, $DENOM_1$, $DENOM_2$, $DENOM_3$,
etc., are assumed to be constant. Thus they are called, when it is a case
of conditions represented by d, r, etc., as well as when they are re-
presented by D, R, etc., F_N, F_{D1}, F_{D2}, F_{D3}, etc. The product factor
which characterizes the DENOM-vegetation if this is regarded as a unit
is, on the other hand, different in the two cases; they are called f_d and
F_D respectively. If the quantity $100 : (r_N F_N + r_D. F_{D1} + r_{D2} F_{D2} + r_{D3} F_{D3} +$,
etc.) is expressed by Q we get directly and from the definition for the
term product factor (cf. p. 189) the following system:

$$
\begin{cases}
d_{Dn} = \dfrac{a_{Dn} d_D}{100}; \\
d_{Dn} = r_{Dn} F_{Dn} Q;
\end{cases}
$$
$$n = 1, 2, 3, \text{etc.}$$

$$r_{Dn} = \frac{a_{Dn} d_D}{100 F_{Dn} Q}$$

r_{D1} surface units are characterized by the product factor F_{D1}, r_{D2}
by F_{D2}, r_{D3} by F_{D3}, etc. The product factor which characterizes the

DENOM-vegetation regarded as a unit, i.e. f_d, is then an average. Thus we get:

$$f_d = \frac{\Sigma\, r_{Dn} F_{Dn}}{\Sigma\, r_{Dn}}.$$

From that relation and those immediately preceding we get:

$$f_d = \frac{\displaystyle\sum \frac{a_{Dn} \cdot d_D}{100 F_{Dn} \cdot Q} F_{Dn}}{\displaystyle\sum \frac{a_{Dn} \cdot d_D}{100 F_{Dn} \cdot Q}};$$

$$\therefore f_d = \frac{\Sigma\, a_{Dn}}{\displaystyle\sum \frac{a_{Dn}}{F_{Dn}}}.$$

But: $\Sigma\, a_{Dn} = 100$;

$$\therefore f_d = \frac{100}{\displaystyle\sum \frac{a_{Dn}}{F_{Dn}}}.$$

In the same way we get:

$$F_D = \frac{100}{\displaystyle\sum \frac{A_{Dn}}{F_{Dn}}}.$$

The $\mathbf{K}$=value is the same as $F_N f_D : f_N F_D$ (cf. p. 192). The product factor of the NUM-vegetation is, however, assumed to be constant. F_N and f_N are thus of the same magnitude. By dividing the above assigned f_d-value by the above assigned F_D-value we therefore get:

$$\mathbf{K} = \frac{\displaystyle\sum \frac{A_{Dn}}{F_{Dn}}}{\displaystyle\sum \frac{a_{Dn}}{F_{Dn}}}. \qquad \dots\dots \text{ Equation No. 11.}$$

The conditions are of course much more complicated if not only the DENOM- but also the NUM-vegetation is composed of a complex; i.e. if it is a case of a socalled summation curve (cf. p. 189). Equation No. 11 b below is of general application. It is deduced in the same manner as equation No. 11.

$$\mathbf{K} = \frac{\displaystyle\sum \frac{A_{Dn}}{F_{Dn}}}{\displaystyle\sum \frac{a_{Dn}}{F_{Dn}}} \cdot \frac{\displaystyle\sum \frac{a_{Nn}}{F_{Nn}}}{\displaystyle\sum \frac{A_{Nn}}{F_{Nn}}}. \qquad \dots \text{ Equation No. 11 b.}$$

Equations Nos. 11 and 11 b will get a special simple shape if the NUM-vegetation is constituted of only one, and the DENOM-vegetation of only two components. Then we get:

$$K = \frac{\dfrac{A_{D1}}{F_{D1}} + \dfrac{100 - A_{D1}}{F_{D2}}}{\dfrac{a_{D1}}{F_{D1}} + \dfrac{100 - a_{D1}}{F_{D2}}} \; ;$$

$$\therefore K = \frac{A_{D1}F_{D2} + (100 - A_{D1})F_{D1}}{a_{D1}F_{D2} + (100 - a_{D1})F_{D1}} \, .$$

If F_{D2} is T times as great as F_{D1} we get from the last-mentioned equation:

$$K = \frac{100 + A_{D1}(T - 1)}{100 + a_{D1}(T - 1)} \, . \quad \ldots \text{ Equation No. 12.}$$

The relation between K, a_{N1} and A_{N1} in the special case now dealt with is illustrated graphically for some different T-values in Fig. 7.

It will immediately be realized even without access to formulae and graphs that the following applies in respect of each complex curve: If the variation in the composition of the complex is so strong that in one extreme case the complex only consists of the species with the lowest product factor and in the other extreme case of the species with the highest product factor the K-fluctuations will be violent; K_{max} will have the same value as the ratio which is obtained when the greater product factor is divided by the lesser.

Figs. 7 shows, in accordance with what has been stated above, that K_{max} can never exceed the actual T-value if this is greater than 1 and never its inverted value if the T-value is less than 1. When the T-value is 2 or $^1/_2$ K_{max} can thus never exceed 2 however the composition of the complex varies. The magnitude of the range of variation (cf. Fig. 7) which limits K_{max} to 2 or to still lower values, decreases when the T-value rises above 2 and falls below $^1/_2$ respectively.

Equation No. 12 can be written thus:

$$K = \frac{\dfrac{100}{T - 1} + A_{D1}}{\dfrac{100}{T - 1} + a_{D1}} \, .$$

If $T = \infty$, it will immediately be realized that the following relation exists:
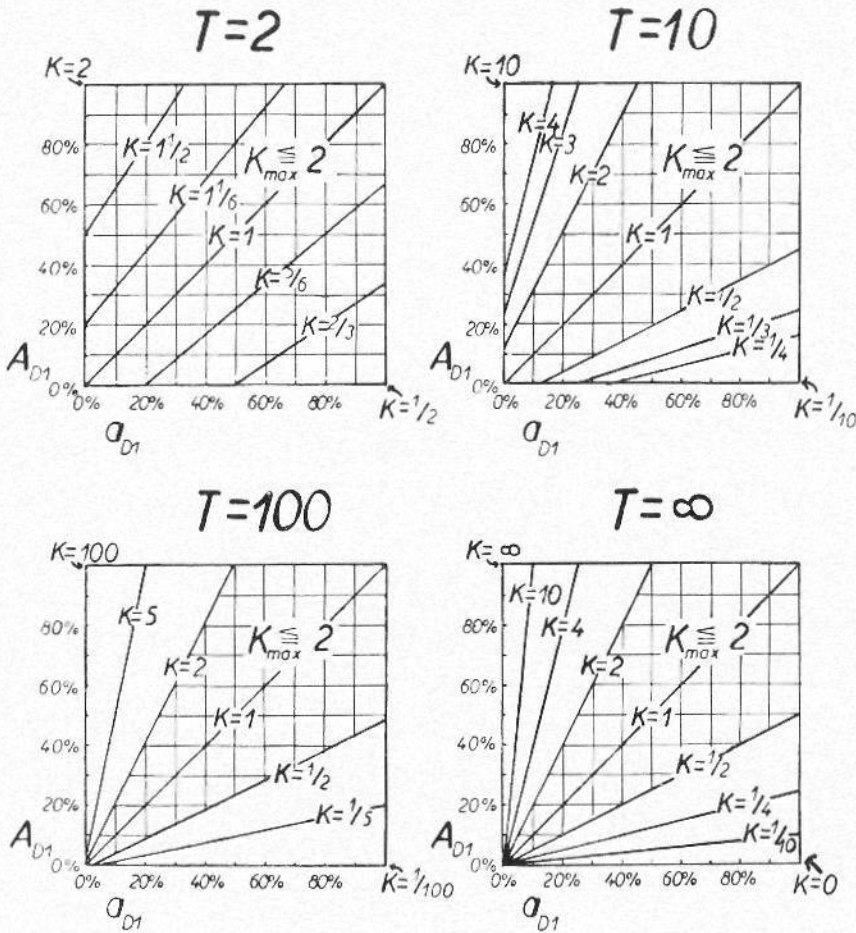
Fig. 7. The relation between the T-value, the **K**-value and the percentage composition of the DENOM-pollen mass. — Cf. text on p. 216.

$$K = \frac{A_{D1}}{a_{D1}}. \quad \ldots \ldots \quad \text{Equation No. 12 b.}$$

From this equation as also from the graphs in Fig. 7 it will be seen that K_{max} remains below 2 as long as the ratio between A_{D1} and a_{D2} lies between $1/2$ and 2 if $T = \infty$. If the said ratio lies just at the given values K_{max} will be exactly 2. The magnitude of the range of variation which limits K_{max} to 2 or to a lower value thus tends to a minimum that is

not less than 50 % of the total range of variation
when the value of T rises above 2 and when it falls
below $\frac{1}{2}$. The graphs and equations show that the
displacement towards this minimum value is rapid.
In the same way it will be realized that the magni-
tude of the range of variation which limits K_{max} to
4 or to a lower value tends at the same time to a
minimum that is not less than 75 % of the total
range of variation, etc.

<div align="center">2.</div>

The circumstances explained in the above sec-
tion are, in my opinion, exceedingly interesting. I
am of opinion that it is thanks to them that »un-
adjusted» pollen diagrams are often of some value
in spite of everything. Even if the pollen-delivering
components included have entirely different product
factors, K_{max} remains within reasonable values (here
all influences affecting the K_{max}-value that are not
connected with the percentage composition of the
DENOM-vegetation are naturally disregarded), except
in the case of curve sections exhibiting extreme
variations in composition. The reliability of the
diagrams can therefore be »regulated» by means of
relatively narrow inversion zones. It must not be
forgotten, however, that there can nonetheless be
separate points which require much deeper inver-
sion zones and that one seldom knows anything de-
finite about where these points are (see further sec-
tion 4 below).

<div align="center">3.</div>

The discussion at the end of paragraph 1 and in paragraph 2 is
based on the special case when the complex only consists of two com-
ponents. The principle is the same, however, when the number of com-
ponents increases. The components can then be divided into two groups
of components; the T-value will then lie between two extreme values.
The discussion seems to me therefore to have general application.

4.

If one works with a case in which the complex only consists of two components, one has access to certain clues when it is a question of judging whether a certain curve section has required a deeper inversion zone than others. If a rising (falling) section of a curve corresponds to a decreased (increased) or unchanged $a(A)$-value and the T-value is relatively high, then, according to equation No. 12, the change in the curve has undoubted real signification; if it corresponds instead to an obvious increase (decrease) in the said value, the deeper inversion zone is required. In such latter cases it is not possible to determine the depth of this zone without a knowledge of the true magnitude of the T-value and without having placed this in relation to the registered change in $a(A)$.

Appraisement is much more difficult if the components of the complex number are more than two. If circumstances permit these to be divided into groups of which one contains the components with the low product factors and the other those with the high, conclusions may perhaps still be drawn. The risk of false conclusions increases, however, according as the differences between the higher product factors of the first group and the lower ones of the second group decrease. These difficult questions of appraisement are diminished, however, if the figures obtained have been adjusted from the beginning by means of the IVERSEN method.

5.

The above observations in paragraphs 2 and 4 only apply if the PD-area exclusively contains plants that have delivered considerable amounts of pollen to the sample mass. If the area also comprises plants with a poor or non-existent delivery capacity, then the whole thing falls to the ground. The T value then approaches ∞. Both a_{DI} and A_{DI} are in these cases small quantities; they are hardly or not at all registrable. They approach in other words the value of $1 : \infty$. The ratio between them can accordingly be both 0 and ∞ or something intermediate. When T is ∞, the K-value in accordance with equation No. 12 b is the same as the ratio between A_{DI} and a_{DI}. K_{max} has therefore in the case in question extremely different and entirely uncontrollable values. Consequently there is no possibility, unless quite exceptional conditions exist, of interpreting pollen diagrams when the PD-area contains species

with an extremely low or non-existent delivery capacity. In these cases every curve fluctuation can have real signification, can be false owing to the fluctuation of the **K**-value in connection with vegetational changes not registered in the diagrams or can have any kind of intermediate signification whatever. This critical case cannot be »forced» with the aid of the IVERSEN method either. Here the adjustments would require the unadjusted pollen grain figures of the pollen-delivering components to be divided by ∞, which naturally does not lead to the desired result.

If one excludes from the analysis a plant represented by its pollen in the sample mass, then this plant has been treated as though it had the product factor 0. In other words one has made a mistake. Even if this is of no importance in itself, a system has thereby been created which cannot be appraised, owing to the fact that it is no longer possible to check the fluctuations of **K**. This case is further dealt with in Chapter VIII.

<div align="center">6.</div>

Even if both the NUM- and DENOM-vegetation consist of one single species, fluctuations undoubtedly exist owing to the composition. The two types of vegetation may comprise plant specimens, biotypes, ecotypes, etc. with varying pollen production capacity; the types of vegetation may be composed of different proportions of these during different periods. There is, however, reason to regard the T-values as being relatively low in these cases. This means that one merely needs to use narrow inversion zones.

The dependence of the **K**-fluctuations on the composition of the NUM- and DENOM-vegetation comprising different species, the above indications and the statement that the IVERSEN method never effects complete correction (cf. p. 199), make it necessary always to »use» inversion zones when reading pollen diagrams.

VIII. Can elements whose pollen has been found in the sample mass be excluded when constructing the diagrams?

FÆGRI & IVERSEN (1950) write: »One very important point is the pollen sum that forms the basis for the calculation of percentages. The

pollen sum should comprise all species forming the topmost layer of the vegetation under investigation.» SELLING (1951) states: »The idea that the diagrams cannot be decisive unless they comprise everything, may a p r i o r i be deemed wrong.» Who is correct? SELLING illustrates his statement by comparing the rhythmics of the diagrams when a larger or smaller number of the components have been excluded. The train of thought seems to me to be that the curves are reliable if the inclusion (or exclusion) of a further one or two components has no very fundamental effect on the rhythmics of the curves. Is that correct?

Two points on a pollen curve represent the %-value d and (d + Δd). A kind of pollen that has not been included in the diagram is represented in the sample mass which corresponds to the first diagram point of h grains of pollen per 100 grains of the total number given in the diagram for the occasion in question. The corresponding figure which corresponds to the second diagram point is (h+Δh). If this kind of pollen is now also included in the diagram, the first point will represent the percentage figure of 100 d : (100+h) and the second point 100 (d+Δd) : (100+h+Δh). The new curve-line will then exhibit the same inclination as the original one if 100 (d+Δd) : (100+h+Δh) − − 100 d : (100+h) = Δd; the same direction of inclination but too steep an inclination if the said difference is greater than Δd, and the same direction of inclination but too low an inclination if it is less than Δd but greater than 0. If the said difference is less than 0, the new curve-line inclines in a different direction from its original one. The change in inclination thus takes place when the said difference is 0. At the »equalization limit» we thus have the relation:

$$\frac{100\,d}{100+h} = \frac{100\,(d+\Delta d)}{100+h+\Delta h};$$

$$\therefore \frac{\Delta h}{\Delta d} = \frac{100+h}{d}. \quad \ldots \ldots \text{Equation No. 13.}$$

The highest possible value of d is 100; the lowest possible value of h is 0. It follows from this that (100+h) is equal to d only if d has its maximum value at the same time as h has its minimum value, and that (100+h) is greater than d in all other circumstances. Equation No. 13 shows then that Δh and Δd are equal only if d has its minimum value at the same time as h has its minimum value, and that h is greater than d in all other circumstances.
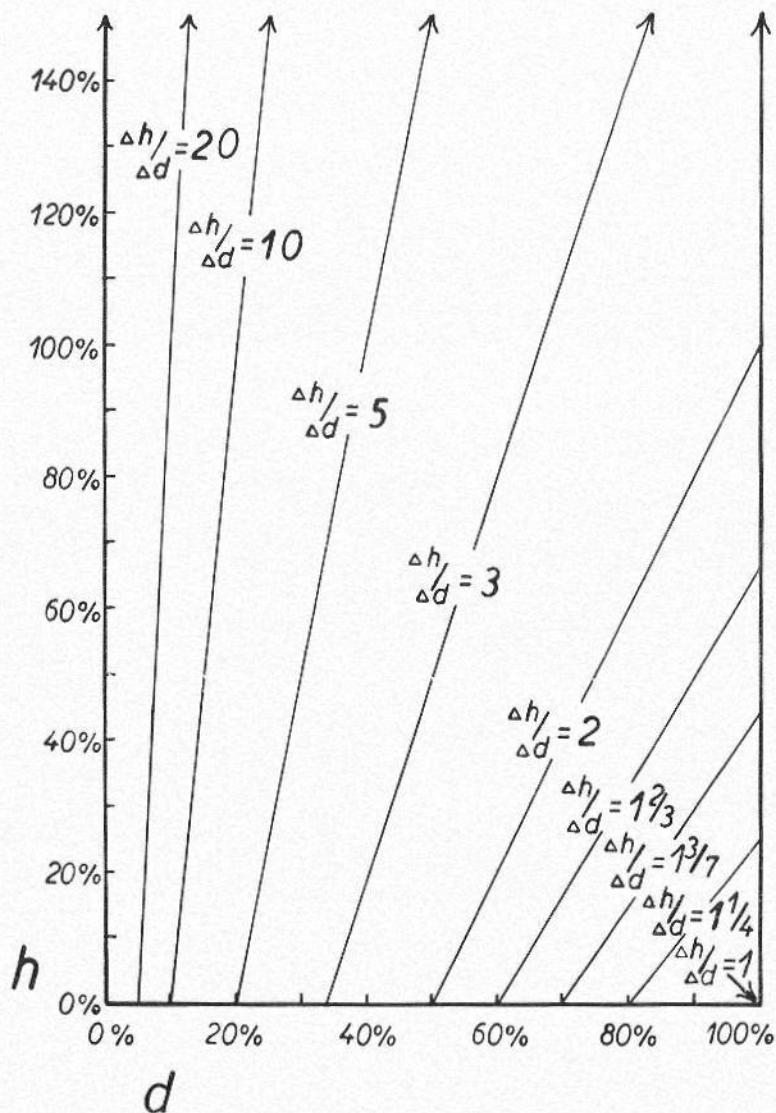
Fig. 8. The pre-requisite conditions for »equalization and change». — Cf. text on pp. 222—223.

At the »equalization limit» Δh is thus greater than Δd except in the said extreme combination, which is of no interest, however. Thus two things are required for the section of a curve to change its direction: 1) that the »frequency curve» of the »newly included» element inclines

in the same direction as the said section, 2) that the former exhibits a steeper inclination than the latter.

Equation No. 13 and these observations are illustrated graphically in Fig. 8. The graph shows that the excess of inclination required is often considerable. At first it increases slowly and then more and more rapidly, when the d-value runs from 100 % to 0 %. When the d-value is quite small, considerable excess is consequently required. The requisite excess of inclination also increases with an increasing h-value. The demand for an excess of inclination thus becomes extremely great, when it is simultaneously a question of a low d- and a high h-value.

It is clear from what has been said that the inclusion of a new element into a pollen diagram cannot very well change the course of the diagram's curves except in very few points and that there is often no fundamental change at all. The inclusion of a new element (or the exclusion of one previously included) will therefore only in exceptional cases change the course of the original curves in any fundamental way. Every new incorporation results in changes, however; changes in the degree of inclination of the various sections and in exceptional cases in the direction of the inclination of a section or of a few sections. The inclusion (or exclusion) of a further element causes similar effects. The said changes are then uninfluenced, wholly or partially eliminated or augmented. It is therefore by no means out of the question that the pollen diagram will exhibit an entirely different rhythm when it is complete from that exhibited when it only contains a small number of elements. The demonstration that the inclusion (or exclusion) of one or more components does not change the rhythmics of the curve shows therefore nothing at all; it constitutes no criterion of a »stabilization point» having been reached. No such point exists until the whole is complete. Consequently one must regard pollen diagrams from which one or more of the elements forming the topmost layer of the vegetation under investigation are absent (have been excluded) with great suspicion.

IX. Concluding remarks.

As a final result of the discussion carried on in the various paragraphs and chapters it may be said:

I f t h e IVERSEN m e t h o d h a s b e e n u s e d, i f t h e PD - a r e a is practically homogeneous, if species are lacking with slight or non-existent delivery capacity, and if all the kinds of pollen delivered from the topmost layer of the PD-area to the sample mass have been included, then importance should be attached to the diagram fluctuations; also to those which oscillate slightly outside comparatively narrow inversion zones (such as correspond to $K_{max}=4$, 2 and perhaps in certain cases still lower).

If any of the said pre-requisites are lacking, it is very hazardous to draw conclusions from the diagrams.

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Smärre uppsatser och meddelanden.

Chamaedaphne calyculata (L.) Moench, Dianthus suberbus L. och Euphorbia esula L. funna i Lappland.

Under sommaren 1950 och 1951 hade jag förmånen att i min tjänst vistas några månader i olika byar i Gällivare socken. I denna ur botanisk synpunkt ytterligt dåligt undersökta socken gjorde jag många intressanta växtfynd, av vilka de allra intressantaste här meddelas. Samtliga äro helt nya för Lappland.

Chamaedaphne calyculata. Det första fyndet av denna art, finnmyrten, gjorde jag hösten 1950, 2—3 km öster om bebyggelsen i Hakkas by, Gällivare socken. Förekomsten omfattar ett område av myr och försumpad skogsmark om c:a 50 hektar, där denna växt förekom ymnigt, fläckvis dominant inom risvegetationen.

Sommaren 1951 fann jag åter finnmyrten på en annan lokal inom samma trakt. Denna gång c:a 5 km SSV om bebyggelsen. Förekomsten är här riklig på c:a en hektars yta.

Finnmyrten är tidigare endast känd från Norrbotten. Mina fyndlokaler ligga 7—8 mil väster om närmast kända lokal, Ohtanajärvi by i Korpilombolo socken. De äro de hittills västligast kända i Norden.

Dianthus superbus. Sommaren 1950 fann jag på anvisning av en bybo, f.d. småskollärare NUTTI, praktnejlikan växande på en torr gräsmark intill en gård i Hakkas by. Den förekom här i ett hundratal exemplar på en yta av c:a en fjärdedels hektar. Markägaren uppgav, att han iakttagit den vackra blomman sedan åtminstone 20—30 år tillbaka.

Praktnejlikan har förutom en sydlig förekomst i Skåne och södra Halland, en nordlig i Norrbotten, som nu med detta fynd utökats med en lokal i Lappland.

Min härmed rapporterade fyndort är den nordligaste i Sverige.

Euphorbia esula. Sommaren 1950 fann jag vargtöreln vid fäboden c:a 4 km söder om bebyggelsen i Hakkas by, Gällivare socken. Den förekommer här i ett mycket livskraftigt bestånd på c:a ett ar å en sedan 30—40 år tillbaka nedlagd åkerlapp. En gammal bybo uppgav, att han iakttagit växten så länge han kan minnas. Förmodligen har vargtöreln kommit hit med hö söderifrån. Ett numera igenrasat skogsstall finns strax intill. Inom själva bebyggelsen i byn har jag förgäves efterspanat vargtöreln.

Enligt HULTÉN: »Atlas över växternas utbredning i Norden» är vargtöreln mycket sällsynt i norra Sverige. Ingen prick finnes för hela Lappland. I

Norrbotten finns däremot en dylik vid kusten strax söder om Kalix älvs mynning. Den av framlidne lektor HERMAN SVENONIUS meddelade fyndplatsen, Oscarsvarv i Luleå, (Svensk Bot. tidskr. 1925 s. 470) är ej markerad. Antingen har denna lokal förbisetts eller har en felmarkering skett.

Min fyndort är den nordligaste i Norden.

Luleå den 7 mars 1952.   INGMAR PILSTRÖM.

Några Hieraciumfynd i Skåne.

Hieracium subterdentatum K. JOH. & G. SAM. i Bot. Not. 1924 sid. 155. Ny för landskapet. Förut känd från Halmstad och Knäred i Halland samt Femsjö och Lidhult i Småland. Funnen 1947—49 i Brunnby sn. i bokskogen Bränneslyckan vid Krapperup, i vägskärningen vid Brunnby kyrka samt bland enbuskar vid stigen uppåt Håkull på Kullaberg. De skånska exemplaren avvika något från typen genom starkare hårighet på holkarna.

H. colliniforme N. & P. funnen 1951 på skuggig gräsmatta på gamla begravningsplatsen inne i Malmö stad. Arten, som torde vara införd med gräsfrö, är i Skåne tidigare insamlad på följande lokaler:

Lund	utan datum	Herbarium ELIAS FRIES (U).
»	1836	» HARTMAN (U).
»	1867	»A. F.» (RM).
»	1875	S. A. TULLBERG (U).
Skarhult	1886	GUNNAR ANDERSSON (RM, U, L, Gbg).
»	1894	CÖSTER (RM, L, Gbg).

H. cruentifolium DAHLST. & LÜB. Gladsax sn, sandbacke S om Brösarps stn. 1949.

H. pinnatifidum LÖNNR. Degeberga sn. Brenge, vägkant 1949, Gladsax sn. Tjörnedala, ängsmark innanför strandvallen 1949, Ivetofta sn. Håkanryd, glänta i bokskog 1949.

Samtliga arter äro bestämda av lektor ERIK ALMQUIST i Eskilstuna. För godhetsfullt lämnade herbarieuppgifter har jag att tacka docenterna SMITH i Uppsala och NORLINDH i Lund samt fil. doktor CARL BLOM i Göteborg.

Saltsjöbaden den 12 mars 1952.   CARL-AXEL TORÉN.

Något om floran på grönstensbergen i Glimåkra socken.

Glimåkra socken ligger helt inom nordöstra Skånes urbergsområde. De lösa jordlager, som täcka berggrunden, utgöras huvudsakligen av en näringsfattig morän, bildad av gnejs och ljus granit. I socknen förekommer det emellertid också basiska gångbergarter, hyperit och diabas, som givit upphov till en näringsrik morän. De äro mörka till färgen och kallas med ett gemensamt namn »grönsten» eller »svart granit». Dessa grönstensberg äro oftast långsträckta och gå huvudsakligen i nord-sydlig riktning. Endast ett fåtal av grönstensbergen gå upp i dagen, de flesta äro täckta av ett mer eller mindre tjockt

lager av morängrus. Största intresset ur botanisk synpunkt tilldrager sig de lättvittrande grönstensberg, som ligga ytligt och som äro delvis blottade, t.ex. bergen vid Rumperöd och Biskopsgården. De förra ligga 2—3 km N och de senare 15—17 km NNO Glimåkra samhälle.

I anslutning till dessa grönstensberg uppträda lundar och lövängar, som ha en bördig brunjord och en undervegetation, rik på näringsfordrande arter. Dessa grönstensbergs rika och intressanta flora står i bjärt kontrast till socknens i övrigt relativt fattiga urbergsflora. Bortsett från grönstensbergen är det endast i det lilla området nedanför marina gränsen, d.v.s. i församlingens sydvästra del, och i trakten av Källstorp och Sporrakulla, som lundar och lövängar med en någorlunda bördig brunjord utvecklat sig. Av florans sammansättning att döma har man anledning misstänka, att det på dessa ställen finns smärre kalklager kvar under moräntäcket. I grannförsamlingen Broby, vid Denningarum, som ligger ungefär lika nordligt, ha nämligen kalkavlagringar påträffats under moränen.

På grönstensberget vid Rumperöd och på grönstensmoränen söder och sydost därom har lundvegetationen i församlingen nått sin optimala utveckling. Träd- och buskskiktet är välbevarat och har, bortsett från några smärre partier, skonats från starkare ingrepp genom skogsavverkning och stenbrytning. Över stora delar av berget uppträder *Carpinus* som dominant. *Fagus* däremot förekommer endast sparsamt. Bland de ädla lövträden märkes vidare *Tilia cordata, Quercus Robur, Acer platanoides, Ulmus glabra* ssp. *scabra* och *Fraxinus*. I buskskiktet dominerar *Corylus*, mera sparsamt uppträder där *Lonicera Xylosteum* och *Crataegus Oxyacantha*.

Örtfloran i dessa lundar kan i fråga om yppighet och artrikedom tävla med den i södra och mellersta Skåne. Den är till stor del sammansatt av kalkgynnade arter. Fältspaten i denna grovkorniga grönsten innehåller en icke föraktlig mängd kalcium och kalium och det är framför allt dessa ämnen, som gynnat uppkomsten av en ovanligt bördig brunjord. I dessa lundar förekomma åtskilliga arter, som saknas i andra delar av socknen, t.ex. *Anemone ranunculoides, Pulmonaria officinalis* ssp. *obscura, Vicia silvatica, Lathraea, Neottia, Melica uniflora* och *Agropyron caninum*. Gulsippan växer såväl på Rumperödbergets östsluttning som på grönstensmoränen sydöst om detta berg inne på Bosarpgårdens ägor. Så är också fallet med *Lathraea. Vicia silvatica* och *Agropyron caninum* förekomma sparsamt i den blockrika avenbokskogen på bergets västsida. *Pulmonaria* och *Melica uniflora* däremot uppträda i rikliga och livskraftiga bestånd. Under en följd av år har jag påträffat några få exemplar av *Neottia* i hasselbuskage på bergets norra del nära stenbrottet. Sedan hasselbuskagen för ett par år sedan delvis nedhöggos har jag emellertid ej iakttagit något blommande exemplar av denna intressanta växt. Det är möjligt att den ej tålt detta ingrepp på hasseln, varigenom ljus- och näringsförhållanden ändrats, och att den nu håller på att försvinna på denna sin enda lokal i socknen. Åtskilliga andra, mer eller mindre näringsfordrande arter förtjäna att omnämnas från dessa lundar, bl.a. *Campanula Trachelium, Stachys silvatica, Lathyrus vernus* och *L. silvestris, Vicia sepium, Astragalus glycyphyllus, Cardamine bulbifera, Paris, Carex digitata, Milium* och *Equisetum pratense*. Dessa växter äro endast kända från ett fåtal lokaler i socknen. I området ovan marina gränsen påträffas de nästan utan undantag i anslutning

till grönstensförekomst. I åtskilliga fall är inget fast anstående grönstensberg känt intill fyndorten för ovannämnda, näringsfordrande arter men efter något sökande i den omgivande terrängen brukar man åtminstone finna enstaka grönstensblock, som bevisa att krossmaterial av grönsten är inblandat i moränen.

På rasbranter och i klippsprickor på Rumperödberget, särskilt på lokaler överskuggade av träd, trivas *Geranium lucidum, Actaea spicata, Melica uniflora, Asplenium Trichomanes* och *Cystopteris fragilis* utomordentligt väl. Förstnämnda art uppträder rikligt på bergets sydostbrant, där vatten sipprar fram ur klippsprickorna, men endast sparsamt i det norra stenbrottet. *Geranium lucidum* har ej påträffats på någon annan lokal i socknen.

Nordligast i Glimåkra församling, endast c. 4 km från Smålandsgränsen ligger Biskopsgårdens grönstensberg. En gång i tiden torde detta ha haft en nästan lika rik lundvegetation som berget vid Rumperöd. På grund av en alltför stark skogsavverkning ha emellertid de gamla lundarna där delvis förstörts och i samband därmed har också de gynnsamma betingelserna för bevarandet av en rik örtflora upphört att existera, annat än på några få otillgängliga lokaler. Talrika stubbar av nedhuggna lövträd vittna om en tidigare tät lundvegetation, åtminstone på norra delen av Biskopsgårdens långsträckta grönstensberg. En hård betning har också bidragit till att örtfloran till stor del förstörts. På östsluttningen av berget mellan de båda nordliga gårdarna växa spridda exemplar av ädla lövträd, bl.a. *Carpinus, Tilia cordata, Quercus Robur, Acer platanoides* och *Fraxinus*. Buskvegetationen i dessa lundfragment utgöras huvudsakligen av *Corylus*. Sparsamt förekomma dessutom *Crataegus Oxyacantha, Viburnum Opulus* och *Lonicera Xylosteum*, jämte några andra buskarter.

Vid en grundlig undersökning av den blockrika terrängen i Biskopsgårdens fragmentariska lundar visar det sig, att många intressanta lundväxter fortfarande finnas kvar där, särskilt mellan grönstensblock överskuggade av lind, avenbok och hassel. Bland dem må i första hand nämnas *Campanula Trachelium, Lathyrus vernus, Cardamine bulbifera, Actaea spicata, Paris* och *Carex digitata*. Såväl *Lathyrus vernus* som *Paris* tyckas vara stadda i utdöende där, ty jag har endast lyckats finna några få exemplar, väl skyddade mellan stora grönstensblock. Där kunna de betande djuren knappast nå dem. *Cardamine bulbifera* förekommer på liknande ståndort under lind och avenbok men i stort individantal. *Anemone Hepatica* och *Primula veris* höra till karaktärsväxterna för Biskopsgårdens grönstensområde. Ovanpå stenblocken och i klippsprickorna är *Cystopteris fragilis* synnerligen vanlig. *Asplenium Trichomanes* däremot förekommer ytterst sparsamt vid Biskopsgården.

På lövängarna invid åkrarna uppträda där åtskilliga för socknen mindre vanliga arter, t.ex. *Polygonatum multiflorum, Clinopodium vulgare, Helianthemum ovatum, Thalictrum simplex* och *T. aquilegifolium*.

Den sydligaste delen av Biskopsgårdens över två km långa grönstensberg är nästan helt i avsaknad av lundfragment. Där är en blandskog av gran, tall och björk dominerande. I undervegetationen trivs blåsippan utmärkt, vilket visar att jordmånen är god. Biskopsgårdens bördiga och artrika grönstensområde ligger som en långsträckt oas i en trakt, som i övrigt utmärker sig för en synnerligen mager moränmark, stora myrar och en artfattig flora.

Det är ingalunda alla grönstensberg i socknen, som haft en särskilt gynnsam inverkan på floran. Stora Björkeröds berg, beläget c. 4 km ONO Glimåkra samhälle, består av en hård, svårvittrande sten av utomordentligt hög kvalitet, vilken varit föremål för brytning under mer än femtio år. Ur botanisk synpunkt är det tämligen ointressant. Där förekomma inga speciellt näringsfordrande arter. Endast en mindre del av detta berg ligger ytligt och de lösa jordlager, som täcka det, torde endast innehålla en ringa mängd krossmaterial av svårvittrande grönsten och äro följaktligen föga bördiga.

Lund den 24 maj 1952. TYCHO NORLINDH.

Litteratur.

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In Memoriam.

Johan Mauritzon.

1/8 1902—16/11 1950.
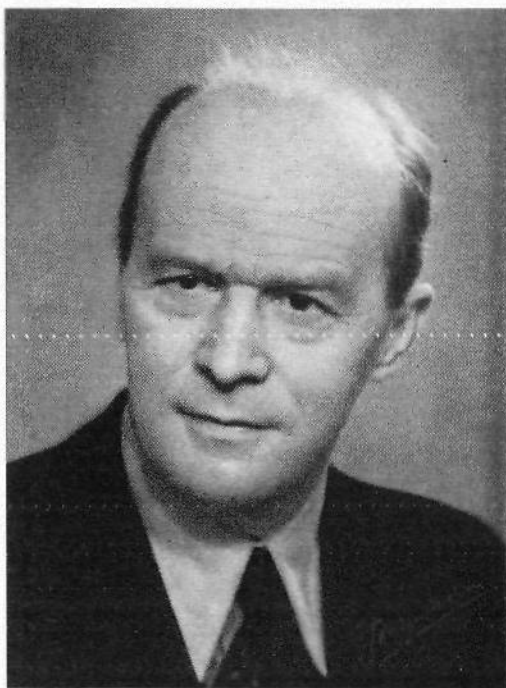
JOHAN MAURITZON var född i Höganäs, hans far var sjökapten. Han gick i Lunds privata elementarskola och avlade där studentexamen 1922. Vid universitetet studerade han de biologiska ämnena, kemi och geografi. De första åren hade geografin hans största intresse och hans första tryckta skrift var en studie över Höganäs. M. var mycket fästad vid sin hemort och tillbringade nästan alla sina ferier där. På de botaniska kurserna syntes M. som en tämligen kortvuxen, mager och blek ung man med rörligt ansikte och bred panna som ofta var rynkad. De första examina dröjde något, fil. kand.-examen avlade han 1927, fil. mag. 1929, men sedan gick det fortare, 1931 blev han fil. lic. och 1933 disputerade han för fil. doktorsgraden.

M. blev 1927 fast knuten till botaniska laboratoriet som professor Kylins amanuens, och två år senare blev han assistent i växtfysiologi. Den senare befattningen innehade han tills han blivit docent och fått docentstipendium strax efter disputationen. När stipendietiden var slut sökte och erhöll han 1940 lektorat i Motala, och två år före sin död blev han lektor vid högre allmänna läroverket i Hälsingborg.

MAURITZONS botaniska forskning gällde uteslutande angiospermernas embryologi. Till sin läggning var han en logisk och i viss (bättre) mening ekonomisk natur och troligen ville han i eget och vetenskapens intresse utnyttja sin docentstipendietid så effektivt som möjligt genom en samlad insats inom sin specialitet. Detsamma gällde även hans läsning av vetenskaplig litteratur. Den föreföll vara helt koncentrerad till växtembryologi. I företalet till sin gradualavhandling meddelar M., att det var professor Kylin som ledde hans intresse till växtembryologin, Kylin hade under sin Uppsalatid planerat en undersökning av crassulacéernas embryologi och föreslog M. en sådan som ämne för licentiat- och gradualavhandling; M. tackar även för fixeringar av *Sedum album*. M. förvaltade det anförtrodda pundet synnerligen väl, *Crassulaceae* blev en av de bäst undersökta familjerna, embryologin blev känd hos 28 av de 33 släktena, 125 arter undersöktes. I gradualavhandlingen ingår också fam. *Saxifragaceae*, vilken förklarligt nog icke kunde bli föremål för en lika ingående undersökning, bl.a. blev i ganska stor utsträckning herbariematerial använt.

I gradualavhandlingen framträder med stor tydlighet de för M:s forskning utmärkande dragen. Han strävade att skaffa undersökningsmaterial av ett så stort antal släkten som möjligt, ofta undersökte han flera arter av samma släkte. Detta extensiva drag berodde även på hans strävan att giva sina undersökningar en embryologisk-systematisk karaktär. I avhandlingen »Die Bedeutung der embryologischen Forschung für das natürliche System der Pflanzen», som delvis är en sammanfattning av hans forskningsresultat och med sitt personliga framställningssätt för tanken på ett vetenskapligt testamente, heter det ». . . selbst habe ich in allen Fällen, wo ich dies für möglich gehalten habe, bewusst versucht soviele systematische Resultate wie möglich aus den embryologischen Tatsachen zu erhalten». De flesta av hans större avhandlingar innehåller en embryologisk-systematisk del med en ingående diskussion. Ett tredje drag är de många och goda figurerna, de äro synnerligen distinkta men visa i de senare avhandlingarna en tendens till schematisering, det är kanske en smaksak om man skall anse detta som ett fel.

Under åren 1933—1936 publicerade M. ett tjugotal avhandlingar; vilka växtgrupper som undersökts framgår av förteckningen över hans tryckta skrifter. M. arbetade energiskt på att skaffa undersökningsmaterial från olika botaniska trädgårdar, bland annat företog han resor i Mellaneuropa och till Sicilien. I viss utsträckning kom herbariematerial till användning. M. förkortade i hög grad det vanliga tidsschemat vid inbäddning i paraffin och vid färgning med hematoxylin. Väldiga processioner fixeringar passerade i snabb takt genom alkohol-cederträolje-serien och termostaten. M. tålde märkvärdigt nog ej doften av cederträolja och hans maka måste hjälpa honom vid materialets inbäddning i paraffin.

För att erhålla mera material reste M. i juli 1936 till Australien där han under sex månader samlade i naturen och olika botaniska trädgårdar. Sedan begav han sig till de botaniska trädgårdarna i Buitenzorg på Java där han gjorde stora insamlingar och på hemvägen som togs över USA gjorde han fixeringar i Japan och på Honolulu. Resan varade mera än ett år och M. var mycket belåten med sin färd, men det insamlade materialet tycks endast i ringa utsträckning ha blivit föremål för bearbetning. Efter sin hemkomst utgav han, utom det förut nämnda sammanfattande arbetet, endast ett stort arbete behandlande vissa *Rosales-* och *Myrtales*-familjer och en liten uppsats om *Marcgravia*. Efter sin avresa från Lund tycks M. helt ha avbrutit sin tidigare så intensiva vetenskapliga verksamhet.

I Lunds botaniska förening höll M. flera föredrag, och han invaldes i dess styrelse. Detta uppdrag intresserade honom mycket, han var närvarande vid alla styrelsemöten och upptog de flesta frågor till ingående diskussion.

Sedan han blivit lektor gick M. helt upp i sin lärargärning. En av hans f.d. elever har berättat för mig, att M. ofta talade om sitt arbete, han tyckte att lärarkallet var trevligt och fann det intressant att studera nya delar av biologin. Han var en mycket ambitiös lärare ehuru måhända ingen lysande pedagog. Enligt min sagesman funderade han mycket över betygsättningen. Att utdela rättvisa betyg ansåg han vara mycket viktigt, och han tycks ha haft verkliga samvetskval över omöjligheten eller svårigheten att skipa verklig rättvisa. Motala läroverk erhöll en nybyggnad, och M. fick då mycket att göra, han bar ständigt en portfölj med ritningar, kämpade för att biologin skulle få bästa utrymmet, ordnade biologiska museet. Mycket beröm fick han för ordnandet av den nya skolträdgården. Den har blivit föremål för en artikel i tidskriften »Lustgården».

Det var utmärkande för M. att han intensivt gick upp i den uppgift han tog itu med och ej skydde ansträngningar att lösa den på ett utmärkt sätt. Som människa föreföll han mig vara en smula isolerad, hade kanske svårt att finna hjärtlig kontakt med kolleger och medarbetare, vilket måhända delvis berodde på hans starka koncentration till sitt arbete. Han var nämligen gästfri och tyckte om att se gäster i sitt trevliga hem. Han gifte sig 1931 men hade inga barn. M:s liv fördystrades redan under slutet av hans Lundatid av en ohälsa, som tilltog med åren. När han kommit till Hälsingborg, var han periodvis tjänstledig. Han dog av en magåkomma endast 48 år gammal.

M. har gjort en god insats genom sin kartläggning av embryologiska förhållanden inom stora delar av systemet. Vid dylikt extensivt arbetssätt kan naturligtvis ej allt material bli lika grundligt undersökt och vissa förbiseenden och feltolkningar ha varit oundvikliga men undersökningarna stå kvalitativt högt. Ett mycket vackert arbete utgör t.ex. analysen av den egendomliga endospermbildningen hos acanthacéerna, och i M:s avhandlingar finner man många intressanta iakttagelser och upptäckter. Som förut antytt ansåg M. sina embryologisk-systematiska utredningar mycket viktiga och har sammanfattat deras resultat i en särskild skrift. Denna har en rätt personlig prägel och är ganska polemisk. Han uppehåller sig ej blott vid riktiga embryologiska »Arbeits- und Schlussfolgerungsmethoden» utan med långa citat från vissa författares arbeten visar han hur de enligt hans mening använder felaktiga sådana metoder, i ett fall talar han t.o.m. om att avhandlingen är ett av-

skräckande exempel. Kanske voro hans omdömen ibland onödigt hårda, men i många fall var hans kritik utan tvivel berättigad, och de bidrag han från embryologiska utgångspunkter lämnade till systematiken äro ofta av stort värde. Otvivelaktigt var M. en av 30-talets mest prominenta växtembryologer. Ett tecken på detta är, att DONALD JOHANSEN i en uppsats »A critical review of the present status of plant embryology» (Bot. Review 1945) talar om »the SOUÈGES school» och »the MAURITZON school» på embryologiens område. Den förra menar med embryologi endast embryots utveckling, den senare även hela fröämnets, den honliga gametofytens och endospermets. Den senare uppfattningen är ju den vanligaste — särskilt bland europeiska forskare är den dominerande —, och att den uppkallats efter MAURITZON visar vilken ledande ställning han ansetts intaga på embryologins område.

ARTUR HÅKANSSON.

Tryckta skrifter.

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Über die Embryologie von *Marcgravia*. Bot. not. 1939, p. 249—255.

Litteratur.

VIRGIL G. LILLY and HORACE L. BARNETT: Physiology of the Fungi. McGraw-Hill Book Company, Inc., New York, Toronto, London. 1951. — XII+464 s., 81 ill. — Pris $ 7.50.

Intresset för svamparnas fysiologi har under de två senaste årtiondena varit i oavbruten och snabb tillväxt. Till en del kan nog detta betraktas som en återverkan av den ökade industriella betydelse svamparna fått, i synnerhet såsom producenter av antibiotika. Därtill kommer emellertid också, att både biokemister och genetiker alltmera insett användbarheten av lämpligt valda svampobjekt för lösandet av skilda problem inom resp. forskningsfält. Det har härigenom blivit allt vanligare att personer med obetydliga botaniska förkunskaper ställas inför besvärliga frågor rörande svamparnas tillväxt-betingelser, näringsfysiologi och, icke minst, tekniken för renodlandet av dessa heterotrofa organismer. Goda skäl föreligga sålunda för att utgiva en sam-manfattande översikt av vårt nuvarande svampfysiologiska vetande, och det är ej förvånande, att flera känt sig kallade att åstadkomma ett dylikt arbete.

Den bok, som här i korthet skall anmälas, »Physiology of the Fungi», är författad av två amerikanska mykologer, VIRGIL G. LILLY och HORACE L. BARNETT, bägge professorer vid West Virginia University i Morgantown. Den förstnämnde är känd genom sina redan under 30-talet inledda undersökningar över svamparnas tillväxtämnen; hans medförfattare, H. L. BARNETT, har under de senaste åren medverkat vid dessa arbeten och även studerat sexuali-tetsproblem hos svampar.

»Physiology of the Fungi» är en mycket innehållsrik bok och i dess 18 kapitel behandlas det mesta rörande svamparnas livsföreteelser. Den är närmast avsedd som kursbok för mera avancerade studenter (i ett avslutande appendix äro tolv kurslaborationer beskrivna), men innehåller även mycket av intresse för den på området aktive specialisten. Framställningen är rik på praktiska råd — ofta av nästan väl elementär natur — och överflödar av litteraturhänvisningar, där t.o.m. enstaka arbeten från 1951 hunnit komma med. Av stort intresse ur metodik-synpunkt är bl.a. diskussionen av glas-sortens och autoklaveringens inverkan på närlösningars sammansättning, och vidare användbarheten av olika adsorbens och komplexbildare vid framställan-det av närlösningar. I synnerhet de näringsfysiologiska kapitlen äro väl disponerade och innehålla rätt mycket originaluppgifter, mest i form av tabeller och diagram. Enligt recensentens mening skulle dock framställningen (och priset) hava vunnit på en viss beskärning av texten här och var. Väte-jonkoncentrationens betydelse för tillväxt och metabolism behandlas sålunda på 20 sidor, av vilka jämnt hälften ägnas åt en redogörelse för innebörden

av begreppen dissociation, pH, buffert, indikator, etc., vilket ju allt kan återfinnas i varje elementär lärobok i fysikalisk kemi. Liknande onödiga utredningar återkomma i andra kapitel. Å andra sidan äro vissa frågor alltför flyktigt eller ej alls behandlade ur rent fysiologisk synpunkt, såsom symbiosfenomen (lavar, mykorrhiza) och den praktiskt så betydelsefulla nedbrytningen av cellulosa och lignin. För vissa praktiska problem redogöres annars utförligt och på ett intressant sätt, t.ex. verkningsmekanismen för »fungicider» och det industriella utnyttjandet av olika ämnesomsättningsprodukter.

Recensenten har ej funnit mer än ett fåtal direkta oriktigheter, bl.a. är riboflavinets formel (s. 202) felaktig.

I förlagsreklamen på omslaget betecknas boken som den första i sitt slag. Detta är nu inte riktigt: arbetet utkom under senare hälften av år 1951, och då hade LILIAN HAWKER's »Physiology of Fungi» redan i närmare ett år varit tillgänglig i bokhandeln. De bägge framställningarna kunna emellertid sägas delvis komplettera varandra: under det att HAWKER ägnar större utrymme åt fruktkroppsbildning och olika slag av »interactions» mellan svampar och andra organismer — överhuvudtaget åt frågor med ekologisk anknytning —, är de bägge amerikanarnas behandling av näringsfysiologiska och biokemiska frågor säkrare och mera djupgående.

NILS FRIES.

ARTHUR P. KELLEY: Mycotrophy in plants. Waltham, Mass. 1950. Chronica Botanica Co. $ 4.50.

A. P. KELLEY's föreliggande arbete behandlar de mykotrofa växterna ur morfologisk och biologisk synpunkt. Huvudvikten lägges visserligen vid mykorrhizan i inskränkt bemärkelse, men även andra symbiotiska förhållanden mellan svampar och högre växter behandlas. Boken ger en översikt över denna forsknings utveckling och nuvarande ställning. I en serie kapitel tas de mykorrhiza-bildande svamparna, deras förekomstsätt och förekomstvillkor upp till behandling. I ett litet kapitel framlägges också kännedomen om den fossila mykorrhizan. I slutet av boken ges en sammanställning av de olika teorierna om mykorrhizans natur och betydelse. Boken avslutas med en fyllig litteraturförteckning. På grund av den enkla framställningen torde boken lämpa sig som inledning till studier inom detta område. Kvalitén på illustrationerna lämnar mycket övrigt att önska.

OLOF ANDERSSON.

Notiser.

K. Vetenskapsakademiens Wahlbergsmedalj. Vid Vetenskapsakademiens högtids-
sammankomst den 31 mars 1952 utdelades dess Wahlbergsmedalj i guld till professor
RUDOLF FLORIN för hans betydande botaniska forskargärning, särskilt rörande de
fossila och nutida gymnospermerna.

Doktorsdisputationer. För vinnande av filosofie doktorsgrad vid Uppsala uni-
versitet försvarade fil. lic. BENGT KIHLMAN den 24 maj 1952 en avhandling med titeln:
»A Survey of Purine Derivatives as Inducers of Chromosome Changes» och fil. lic.
MATS WÆRN den 27 maj en avhandling över ämnet: »Rocky-Shore Algae in the
Öregrund Archipelago».

Forskningsanslag. K. Vetenskapsakademien har utdelat två Krokska
stipendier å 500 kr. vardera, det ena till lektor R. STERNER för växtgeografiska
undersökningar vid sjön Allgunnen och det andra till fil. lic. O. RUNE för under-
sökning av kärlväxtfloran i Sorsele socken. — Akademien har vidare från Hierta-
Retzius' fond för vetenskaplig forskning tilldelat fil. kand.
INGRID KRISTIANSSON 1.000 kr. för undersökning av cellulosanedbrytande enzym hos
vissa svampar, lektor S. RÖNNERSTRAND 600 kr. för undersökning av oxidassystemet
hos *Furcellaria*, fil. kand. T. INGESTAD 2.000 kr. för undersökning av vissa auxin-
homologers tillväxtverkningar på skott, docent IRMA ANDERSSON-KOTTÖ 7.000 kr.
för genetisk-kemisk undersökning av aminosyrornas bildning hos *Neurospora*,
agr. dr G. JULÉN 1.200 kr. för cytologiska undersökningar av röntgenbehandlad
Poa pratensis, professor Å. GUSTAFSSON 2.500 kr. för utarbetande av en monografi
över släkt- och arthybridisering i växtriket, dr ASTA LUNDH-ALMESTRAND 400 kr. för
diatomé-studier i Plön, Holstein, fil. lic. H. RUNEMARK 3.000 kr. för studier av släktet
Rhizocarpon i mellersta och sydvästra Europa, docent O. ALMBORN 1.300 kr. för
undersökning av släktena *Pertusaria* och *Lepraria*, docent G. HARLING 1.200 kr. för
embryologisk-cytologiska materialinsamlingar och studier i Frankrike och Spanien,
fil. lic. S. BJÖRKMAN 1.000 kr. för insamling av cytologiskt material på pyrenéiska
halvön för undersökning av släktet *Agrostis* m.m., fil. mag. S. KILANDER 600 kr.
för undersökning av kärlväxternas höjdgränser i Skandinaviens fjälltrakter, professor
F. FAGERLIND 3.000 kr. för en botanisk forskningsresa till Ecuador. — Ur Hierta-
Retzius' stipendiefond har fil. kand. BERTA SANTESSON erhållit 700 kr.
för fortsatta undersökningar över polyploidi inom släktet *Prunus*, fil. lic. R.
SANTESSON 800 kr. för färdigställande av en världsmonografi över de bladbeboende
licheniserade svamparna, fru ELSA NYHOLM 2.000 kr. för utarbetande av en illustre-
rad skandinavisk bladmossflora och fil. dr H. PERSSON 2.000 kr. för en bryologisk
forskningsresa till Madeira.

Ur stiftelsen Lars Hiertas Minne ha bl.a. följande forskare erhållit anslag: fil. lic. O. RUNE 300 kr. för undersökning av sällsynta fjällväxters ekologi i Junkerdalen och på Saulo och Järvas i Pite lappmark, docent G. DEGELIUS 2.000 kr. för fältstudier av släktet *Collema* i Spanien, lektor B. HALDEN 600 kr. för växtekologiska undersökningar i Kopparbergs och Västernorrlands län. Fonden för skogsvetenskaplig forskning har utdelat bl.a. 1.500 kr. till professor N. SYLVÉN för studier av ärftligheten av olika förgreningstyper hos gran och 1.500 kr. till jägmästare V. SÖDERSTRÖM för en undersökning av föryngringsförhållandena på bondeskogar i Jämtland.

Större akademiska konsistoriet i Uppsala har ur Lennanderska fonden utdelat bl.a. ett stipendium å 1.000 kr. till fil. kand. BERTA SANTESSON för hennes ovan nämnda undersökning.

Fysiografiska sällskapet i Lund har utdelat bl.a. följande anslag: till fil. lic. F. LUNDBERG 1.400 kr. för en limnologisk undersökning i Dalarna, till professor HERIBERT NILSSON 200 kr. för komplettering av korsningsarbeten med släktet *Salix*, till fil. lic. H. RUNEMARK 800 kr. för studier av släktet *Rhizocarpon* i utländska museer, till lektor S. RÖNNERSTRAND 400 kr. för ovan nämnda undersökning, till fil. kand. B. ULF 500 kr. för vegetationsundersökningar i Kungsmarken, till docent O. ALMBORN 500 kr. för undersökning av lavvegetationen på Kullaberg.

Från Nordstedtska fonden vid Lunds universitet ha två stipendier om vardera 375 kr. utdelats, det ena till dr ASTA LUNDH-ALMESTRAND för diatomé-undersökningar i norra Skåne och det andra till fil. mag. H. RUFELT för växt-fysiologiska studier i Tübingen. Vid Lunds universitet ha vidare ett Aeryleanskt resestipendium å 1.500 kr. tilldelats fil. kand. CAMILLA WILSKE för växtfysiologiska undersökningar i Pretoria och ett stipendium för blekingsk hembygdsforskning å 350 kr. dr ASTA LUNDH-ALMESTRAND för diatoméundersökningar i blekingska sjöar.

Lunds Botaniska Förenings stipendier. Lunds Botaniska Förening har ur Svante Murbecks fond utdelat ett stipendium å 400 kr. till amanuens LEIF ANDERSSON för insamling av material för cytologisk undersökning av vissa *Carex*-arter och ur Jubileumsfonden ett stipendium å 200 kr. till fil. kand. B. ULF för vegetationsundersökningar i Skåne.

Till salu.

S. B. T. årg. 1907—35 (27 band) jämte Bot. Not. 1889—35 (27 band) samtliga inbundna i eleganta klotband säljes båda serierna tills. eller var för sig till högst-bjudande. Hänvändelse till Lennart Arvidsson, Mellösa.