BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Contributions to the Knowledge of Dimorphotheca montana T. Norl.

New Varieties and a Discussion of the taxonomical Position of the Species

By TYCHO NORLINDH

(Meddelanden från Lunds Botaniska Museum Nr 116)

Dimorphotheca montana is one of the very few South African species of the tribe *Calenduleae,* the variation and distribution of which is not yet quite satisfactorily known. That is mainly due to the fact that the main part of the herbarium material of the species is incomplete. It is above all the lack of ripe achenes that makes the classification of the material difficult. Unfortunately I have not yet succeeded in obtaining any living material for making a more profound study of the species, but I hope in the near future to get germinable seed of *D. montana* for experimental cultivation, cytological and embryological investigations.

When in 1943 I described *D. montana* as a new species I had only one single complete specimen of it at my disposal. This had been collected at an altitude of 2300 metres on Seven Weeks Poort Mt. in the Laingsburg district of Cape Province.

However, during the last ten years I have on several occasions received as loan or gift material of *Dimorphotheca* which belongs to the form series of *D. montana.* Most valuable are those collections of the species which I have received from the Bolus Herbarium of the University of Cape Town. When studying this material, particularly Miss E. Esterhuysen's excellent collections, I have observed that *D. montana* varies considerably both in the shape of the leaves and in the colour of the flowers, and that it has a fairly wide distribution in the Cape region. Even the ray achenes vary in such a way that the wings are not always entire but may be more or less lobated or divided.

During the fourteen years which have elapsed since *D. montana* was described so many facts have been added concerning this interesting species, that I now consider the time is ripe to give an account of my investigations of it and to discuss its taxonomical position.

As regards the other species of *Dimorphotheca* sens. str., no material has been added more recently to cause any noteworthy modifications or additions to my monograph of 1943. The distribution statements have increased much, it is true, but these do not change in any essential respect the general impression given by the distribution maps already published.

I beg to tender my sincerest thanks to Dr. L. Bolus, formerly Curator of Bolus Herbarium, and Miss E. Esterhuysen who have sent me valuable material of *Dimorphotheca montana*. I also wish to thank Mrs. Elsa Nordström for drawings of achenes of the species. When quoting specimens, I have indicated in brackets the herbarium in which they are to be found. The following herbarium abbrevations are given: BOL=Bolus Herbarium, Cape Town, LD=Botanical Museum and Herbarium of Lund.

Morphology and Variation

Dimorphotheca montana has been characterized by me (Norlindh 1943, p. 74), int. alia as a perennial herb with entire leaves, golden-yellow ray florets and 3-winged ray achenes. The material of *D. montana* now to hand shows that the nomenclatural type is quite extreme as regards the shape of the leaves. Forms having only entire leaves seem in fact to be less common.

D. montana occurs always as a perennial herb with a well developed, ± strongly lignified rhizome which sometimes may be so exceedingly branched that the plant forms mats. At the apices of the rhizome branches and a few cm:s below it, the rhizome is provided with hard, tightly-packed remnants of leaf sheaths, from which the lower part of the tough midrib often stands out as a thick, irregularly curved bristle-shaped body. The rhizome sends out here and there, just above the old leaf scars, rootlets which are a decimetre long but only about one millimetre thick.

The stems are erect or ascendent, 1—3.5 dm high and unbranched, bearing a single head. Usually a rhizome sends out only a few fertile stems or sometimes only a single one. As the species is very beautiful in flowering stage it is easily explicable that most botanists have selected flowering stems and have neglected to take fruiting stems. It is mainly thanks to Miss Esterhuysen's care in collection I have succeeded

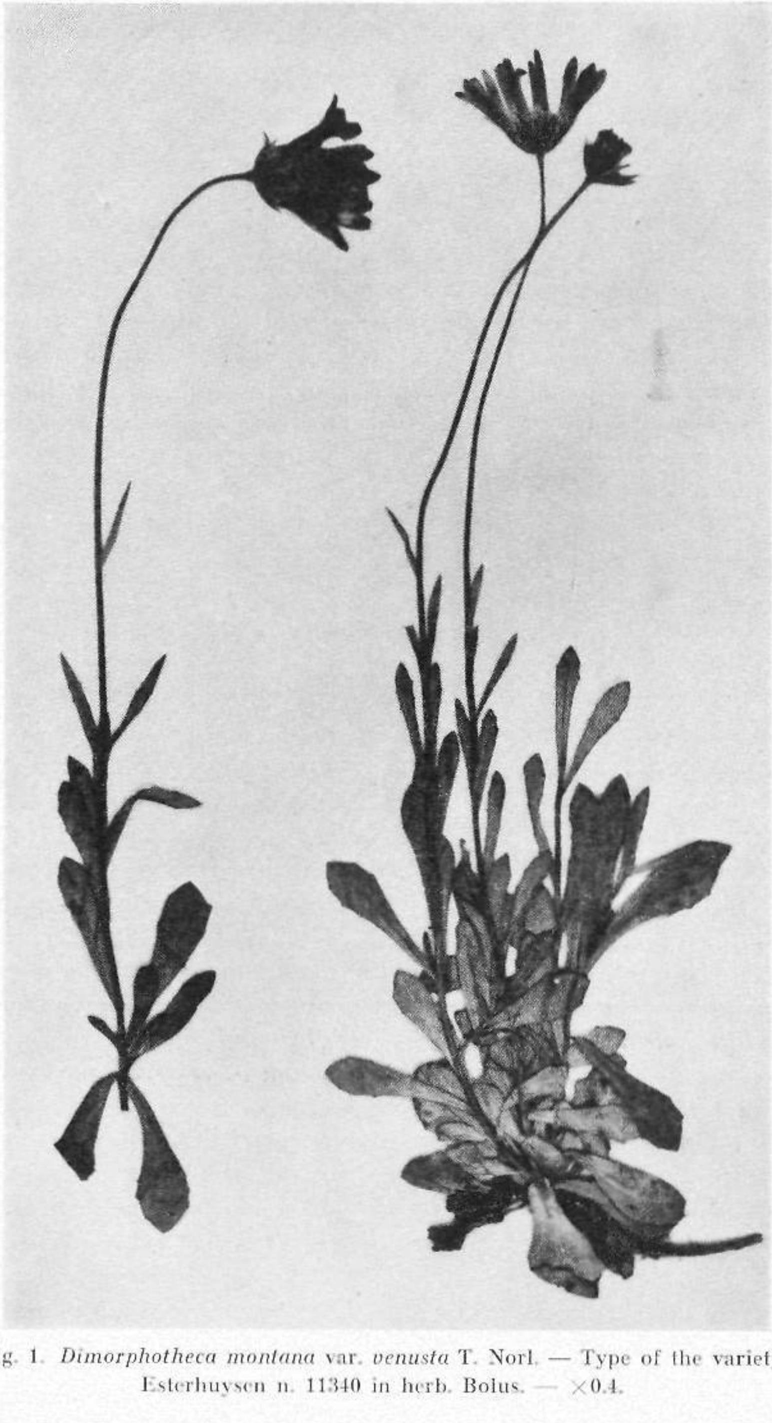


Fig. 1. *Dimorphotheca montana* var. *venusta* T. Norl. — Type of the variety: Esterhuysen n. 11340 in herb. Bolus. — ×0.4.

in obtaining a few perfectly complete specimens with well-developed fruits.

The shape of the leaves varies usually in one and the same specimen. The lower ones are obovate—spatulate—(linear-)oblanceolate, the upper ones linear or oblanceolate. In each specimen there are often both entire, sparsely dentate and sinuate-dentate leaves. More rarely, all the leaves are entire as in the type specimen.

The colour of the ray florets is often difficult to judge when it is a matter of herbarium specimens of *D. montana*. In more newly collected and carefully dried specimens the colour of the flowers may be well preserved, in others the original colour has faded entirely or partly. Fortunately there is a statement of the colour of the flower on the label of most collections of *D. montana*. Only in a few specimens is the original colour of the flowers quite unknown.

In the type specimen the colour of the ray florets is designated as golden-yellow. To *D. montana* sens. str. I assign that biotype group, the rays florets of which are predominantly yellow in colour, for instance pure yellow, bright yellow, orange-yellow.

Besides this *D. montana* comprises biotype groups, the rays of which are pink, purple, partly violet, partly white, etc. For further information about the colour of the flowers I refer the reader to the discussion under the main species and the varieties.

The ray achenes in the type specimen of *D. montana* are rather broadly 3-winged, the margins of the wings being entire (Norlindh 1943, p. 67, Fig. 4 j). In var. *amoena* which usually has pink flowers the achenes, see Fig. 2 a—b, agree excellently with those in the yellow-flowered main species. As an interesting comparison I may here point out, that 3-winged achenes of a similar type also occur in some *Osteospermum* species, int. alia in sect. *Trialata* (Norlindh 1943, p. 194). However, in this case it is only a matter of a parallel development of the achenes. Concerning most of the other characteristics I will not say that *Dimorphotheca montana* shows any closer connection with the species in that section of *Osteospermum*.

The wings of the ray achenes are not always entire as in the main species and in the above-mentioned variety but there are examples showing that the wings may be irregularly crenate or sinuate or divided into secondary wings (see var. *venusta*, p. 146, Fig. 2 c). This division of the three wings into lobes or winglets is not a secondary phenomenon but it appears in an early stage of development, viz. already in the ovaries during the flowering. Thus, this is not a case of a parallel with

Osteospermum spinescens Thunb., in which the wings of the achenes remain entire until the achenes are ripe. Then usually expansion takes place together with burstings in the cellular tissue of the wings, these being more or less deeply transversely lacerated in a varying number of laciniae (Norlindh 1943, p. 229, Fig. 22 d et p. 232).

When studying the material of *Dimorphotheca montana* now available I have come to the conclusion that the species comprises three more characteristic biotype groups, which I designate *D. montana* sens. str., *D. montana* var. *amoena* and *D. montana* var. *venusta*.

Dimorphotheca montana T. Norl. sens. str.

T. Norlindh, Studies in the Calenduleae I, 1943, p. 73.
Icon.: T. Norlindh, l.c. p. 67, Fig. 4 j. k.
Typus speciei: Andreae n. 1193 in Herb. Nat., Pretoria.

The main species is characterized by the wings of the ray achenes being entire and by the ray florets being yellow. As a rule the ray florets are on their under surfaces not solely yellow in varying shades but have a more or less strong admixture of some other colour, for instance purple, violet or brown.

As a complement to the original description, it ought to be specially emphasized that the main species also comprises forms with dentate and sinuate-dentate leaves, that it has a rhizome of the kind which has been exhaustively described at the beginning of this chapter and that the perfectly ripe disc achenes are considerably broader in proportion to their length than is seen from the figure cited above.

Dimorphotheca montana var. *amoena* T. Norl. — Var. nova

A typo differt: ligulis florum radii non flavis—aurantiacis sed supra roseis vel pallide roseis vel interdum albis, subtus roseis vel violaceo-roseis vel purpureis.

Icon.: Fig. nostrae 2 a—b, 3.

Typus varietatis: Esterhuysen n. 22210 in herb. Bolus.

Cape Prov.: Tulbagh: In clivis saxosis montis Winterhoeksberg Tulbaghensis, inter 4000 et 5000 ft, Bolus, 1879, flor. Nov., n. 5089 (BOL, probabiliter!). — Ridge on E. slopes of Gr. Winterhoek. In shade at foot of cliffs, 5500—6000 ft, Esterhuysen, 1951, flor. 31 Dec., n. 19796 (BOL, LD).

Worcester: Matroosberg, 7000 ft, Bolus, 1895, flor. Dec., n. 3956 (BOL). — Eod. loco, 7400 ft, Bolus, 1897, flor. 2 Jan., n. 4413 (BOL, probabiliter!). — Hex River Mts, Buffelshoek Twins, gully, 5500 ft, Esterhuysen, 1942, fruct. 25 Dec., n. 8388 (BOL). — Waaihoek Mt., amongst rocks, 5500 ft, Esterhuysen, 1942, flor. 15 Dec., n. 8329 (BOL). — Keeromsberg, cliff S. side, summit in shelter of rocks,

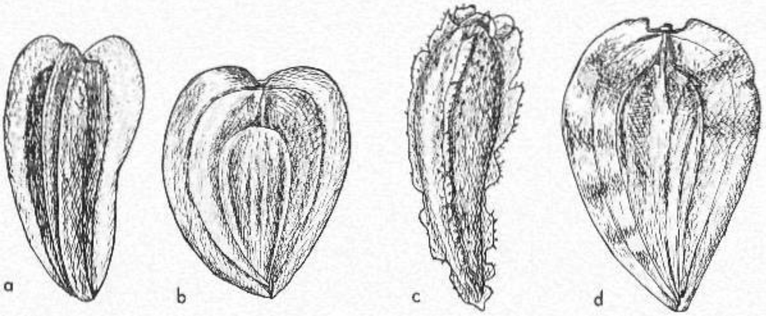


Fig. 2. *a—b Dimorphotheca montana* var. *amoena* T. Norl. *a* ray and *b* disc achene (Esterhuysen n. 22210 in herb. Lund.). — *c—d D. montana* var. *venusta* T. Norl. *c* ray and *d* disc achene (Esterhuysen n. 11340 in herb. Bolus.). — ×5. (Mrs. E. Nordström delin.)

5000—6600 ft, Esterhuysen, 1943, flor. 8 Nov., n. 9253 (BOL). — Waaihoek Pk. Amongst rocks near summit, 6400 ft, Esterhuysen, 1950, flor. 25 Dec., n. 18221 (BOL, LD). — Hex River Mts. Fonteintjiesberg—Sentinel. Ledges, usually on S. side, 5500 ft, Esterhuysen, flor. et fruct. 1 Nov. 1953, n. 22210 (BOL, LD).

Prince Albert: Swartberg Pass, Stokoe, 1942, flor. Dec., n. 8768 (BOL). — Swartberg Pass area, Stokoe, 1943, flor. Dec., n. 9086 (BOL, probabiliter!).

In this variety the wings of the ray achenes are entire as in the main species. It differs from *D. montana* sens. str. only in that the colour of the ray florets is not yellow or orange-yellow.

Concerning *Dimorphotheca* Harvey (1865, pp. 417, 418) attached a great importance to the colour of the flowers and used it as the primary character in his examination key. According to the colour he divided the genus in the following two groups of species: A. Rays white, or purple, or white above purple beneath, and B. Rays yellow or orange. I too made use of the colour of the flowers when I worked out my key to the species in *Dimorphotheca* (Norlindh 1943, pp. 43, 44). However, in several cases it has proved that the importance of the colour ought not to be exaggerated as a taxonomical character in the tribe *Calenduleae*.

When it is a question of *D. montana* the colour of the flowers, yellow and non-yellow, can only be used as a character distinguishing varieties. As far as I know the yellow-flowered main species and the non-yellow-flowered var. *amoena* agree with each other in all other characters. Only if it were to be shown by future investigations that they have different chromosome numbers could there be any question of elevating the above-mentioned variety to the rank of a species.

The colour of the ray florets in *D. montana* var. *amoena* is in some cases designated only as pink. However, the plant label gives sometimes more detailed information about the shade, e.g. rays pale pink above, deeper violet-pink beneath. As a rule the under surfaces of the ray florets may be somewhat darker than the upper ones by a more or less strong admixture of violet to their pink or red colour. Concerning the upper surfaces of the florets the colour-scale is pink—pale-pink—white. The extreme form, pure white above, is probably rare. It occurs int. alia in one specimen of Miss Esterhuysen's collection n. 22210 from Hex River Mts in Worcester District. The rays of one specimen from Matroosberg in the same district are designated as purple (violet-red).

Dimorphotheca montana var. ***venusta*** T. Norl. — Var. nova

A typo differt: acheniis radii 3-alatis, alis irregulariter lobatis vel in alis parvis secundariis divisis; ligulis purpureis vel roseis.

Icon.: Fig. nostrae 1, 2 c—d, 3.

Typus varietatis: Esterhuysen n. 11340 in herb. Bolus.

Cape Prov.: Paarl: Wemmershoek Pk., ledges in gully on W. side, 4000—5000 ft, Esterhuysen, 1944, flor. et fruct. 31 Dec., n. 11340 (BOL).

Ceres—Worcester: Roodeberg, Hex River Mts. Slopes below rocky summit, S.E. side, 6800 ft, Esterhuysen, 1952, flor. 27 Dec., n. 20888 (BOL, LD).

This variety differs from the main species both in respect of the shape of the ray achenes and in the colour of the ray florets. However, from var. *amoena* it differs only in respect of the characteristics first-mentioned.

The margins of the wings are irregularly crenate or sinuate and in extreme cases the primary wings are partly divided into a few small secondary wings. Because the wings are so irregular in their shape I do not consider that the wing-character in this case should be given any greater taxonomical value. In some achenes or ovaries the margins of the wings are only slightly crenate or inconspicuously incised. The boundary between this variety and the remaining population of the species, based on differences in the shape of the achenes, appears therefore less clearly defined and it is above all for this reason that I have desisted from establishing *venusta* as a separate species.

The ray achenes of the type collection from Wemmershoek Mt. are not perfectly ripe but still they give a good idea of the appearance of the achenes in a ripe state. As regards the collection from Roodeberg in Hex River Mts, I have only had the opportunity of studying the ray ovaries and a few ray achenes in a very early stage of development, and they have all proved to be clearly 3-winged. The margins of their wings are irregularly crenate or incised. Concerning the ray ovaries in a very early flowering stage it is almost impossible to judge the shape of the wings. When studying the ovaries and young achenes it is necessary to boil them up for microscopical investigations.

D. montana var. *venusta* has exceedingly beautiful flower heads, up to 7 cm in diam. The rays of the type are described as bright purple and in the specimens from Roodeberg as pink. As regards the colour of the flowers this variety thus resembles var. *amoena*.

A Discussion of the taxonomical Position of Dimorphotheca montana

This species occupies a rather isolated position in *Dimorphotheca* sensu stricto, i.e. that group of species in the tribe *Calenduleae*, which normally has fertile female ray florets and true hermaphroditic disc florets and which has ray and disc achenes of fundamentally different type, to which Vaillant alluded when naming it *Dimorphotheca*.

It does not fit particularly well in any of the sections of *Dimorphotheca* sens. str. hitherto established. *D. montana* differs from sect. *Meteorina* (Cass.) DC., to which the type of the genus *Dimorphotheca, D. pluvialis* (L.) Mnch, belongs, above all by being a perennial herb with a well developed, very characteristic rhizome and by having 3-winged achenes. *Dimorphotheca montana* differs least from the monotypical section *Arnoldia* (Cass.) DC., which originally was described as a genus. The pretty species in this section, *D. chrysanthemifolia* (Vent.) DC., differs from *D. montana,* int. alia in respect of the habit of growth and the shape of the leaves. It is a shrub or undershrub, up to 1 m high, and has mainly lobated and divided leaves which show the following series of variation: coarsely dentate—pinnatilobate—pinnatipartite.

In discussing the taxonomical position of *D. montana* I wish to emphasize that this species shows a great similarity to species of the genus *Castalis* in respect of the habit of growth, the leaf-shape, the rhizome and the general appearance. This fact was unknown to me at the time when I described *D. montana*. Then I had only seen one single complete specimen of it and did not know anything about its variation. Thanks to more recent collections *D. montana* has proved to be a species fairly rich in biotypes. However, this creates a problem difficult of solution when it comes to distinguishing the genus *Castalis* from *Dimorphotheca*. As regards the development of the organs of fructification this species agrees with *Dimorphotheca* but in other characters it is most

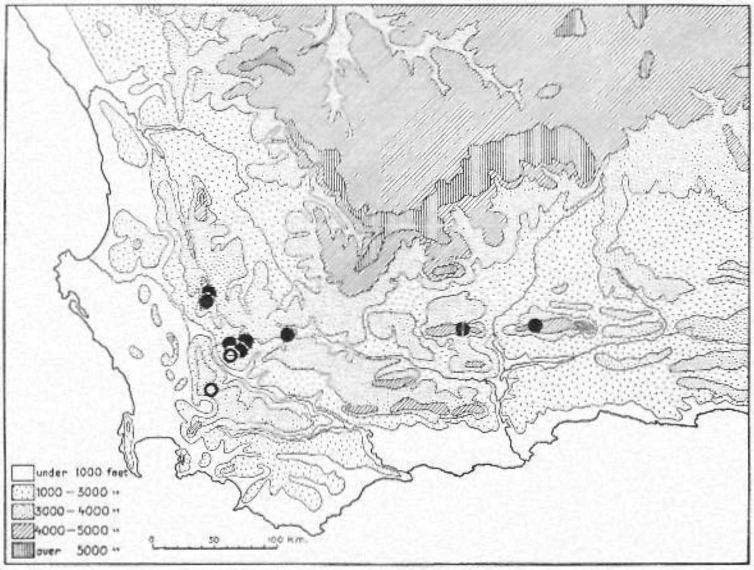


Fig. 3. Distribution of the varieties of *Dimorphotheca montana* T. Norl. and the type locality of this species. — *D. montana* var. *amoena* T. Norl., filled circles and half-moons. — *D. montana* var. *venusta* T. Norl., open circles. — Type locality of *D. montana*, filled circle cut by a white line.

closely connected to the following species of *Castalis*: *C. nudicaulis* (L.) T. Norl. and *C. Tragus* (Ait.) T. Norl.

As I have defined *Dimorphotheca* (Norlindh 1943, pp. 32, 38) it is logically correct to include *D. montana* in that genus, because it developes both ripe ray and disc achenes. However, this is not a natural arrangement, because this species shows much more affinity with the two *Castalis* species mentioned above than with any species in the true *Dimorphotheca*. The morphology of these three species suggests that they are very closely allied in their historical development. No doubt these two *Castalis* species and *Dimorphotheca montana* have evolved during a recent period from a common ancestor in the genus *Dimorphotheca*.

Concerning *Castalis* and its development from *Dimorphotheca* by a reduction of the pistils of the ray florets I refer the reader to my earlier works on this subject (Norlindh 1943, pp. 15, 24, 32 et 1946, p. 484). Here one need only repeat that the pistils are most strongly reduced in *Castalis Tragus* and that one biotype group in this species entirely lacks ray styles, but that in another short styles have developed, which in some cases are somewhat cleft, lacking stigmatic swellings.

In this connection the following question arises. Has the population of *Dimorphotheca montana* throughout fertile ray florets or does it also comprise biotypes with sterile ray florets? If it can be shown that there is a hereditarily determined sterility in the ray florets of certain biotypes of *D. montana* and thus that this species is a transitional one, then it ought to be transferred to *Castalis,* because it shows more affinity with species in that genus than with those in *Dimorphotheca.*

It is not always convenient to unite two genera if they should prove to be connected with each other by transitional species. There are hundreds of genera in the system which are not quite clearly delimited from each other, e.g. *Aster* and *Conyza, Gnaphalium* and *Helichrysum, Bromus* and *Festuca.* For various reasons they are kept as separate genera in spite of the occurrence of one or several species which form transition between them. The transitional species may conveniently be included in the examination keys of both genera, but be placed in that genus, the species of which they most resemble.

As *Castalis* represents a special line of development in the tribe *Calendulae* I consider it tenable to keep it as a separate genus even if it should prove to be connected with *Dimorphotheca* by a transitional species.

In a future paper I intend to give an account of my embryological investigations of *Castalis nudicaulis,* which I have had under cultivation for almost twenty years, and discuss more thoroughly the affinity of this species with *Dimorphotheca montana.*

The problem of the taxonomical position of *Dimorphotheca montana* can probably not be quite satisfactorily solved before different forms in the species-complex have been investigated from an embryological and cytogenetical point of view, including experiments of crossing it with *Castalis nudicaulis* and if possible also with *Castalis Tragus.*

Literature

De Candolle, A. P. 1837. Prodromus Systematis Naturalis Regni Vegetabilis VI. — Paris.

Harvey, W. H. in Harvey et Sonder, 1865. Flora Capensis III. — Dublin.

Norlindh, T., 1943. Studies in the Calenduleae I. — Monograph of the genera Dimorphotheca, Castalis, Osteospermum, Gibbaria and Chrysanthemoides. — Lund.

— 1946. Studies in the Calenduleae II. — Phytogeography and interrelation. — Bot. Notiser. Lund.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Tetraploid Rubus arcticus, framställd genom colchicinbehandling

AV GUNNY LARSSON

Vildväxande *Rubus arcticus* L., åkerbär, har gjorts till föremål för förädling på grund av sina osedvanligt aromatiska frukter. Dessa är emellertid små, 1.16 gram i medelvikt per frukt (3), och sitter mycket hårt fästade vid foderbladen. Det tar alltför lång tid med både plockning och rensning, vilket gör bären dyrbara i inköp. Då åkerbäret dessutom allt mer och mer visar tendens att försvinna, där kulturen går fram, är det av stor vikt att få fram bättre och odlingsvärda typer av detsamma.

I Finland har dr Antero Vaarama, nu professor i botanik vid Åbo universitet, under sin tidigare befattning vid Piikkiö försöksstation korsat *R. arcticus* med närbesläktade arter och fått fram nya värdefulla typer, dock inga med den så typiska åkerbärsaromen (7).

Även i Ryssland och Kanada har *R. arcticus* använts i förädlingssyfte. I det senare landet lär det emellertid ha rört sig om hybrider eller plantor av den närbesläktade arten *R. acaulis* (1). Man har där ej ansett sig ha någon större orsak att syssla med densamma, då frukterna saknat speciell arom, detta enligt uppgift från dr M. B. Davis i Central Experimental Farm, Ottawa.

Dr Vaarama var den förste, som konstaterade, att det diploida kromosomtalet hos åkerbär är 14 (6). Detta har även bekräftats av förf., som gjort många undersökningar dels av morfologiskt avvikande kloner, dels av egna uppdragna fröplantor. Endast vid ett enda tillfälle — i en tvillingplanta — hittades bredvid de diploida cellerna en klart tetraploid sådan.

Försök att fördubbla kromosomtalet hos åkerbäret med hjälp av colchicin har tidigare utförts på andra håll, men inga rapporter har utkommit om att dylika försök lyckats. Sålunda antages, att de tetraploida åkerbärsplantor, som kom till stånd i Öjebyn våren 1949, var de första i sitt slag. Ett par av dem har överlevt mycket väl och därtill blommat och satt frukt.

Material och metoder. — I slutet av juli 1948 insamlades frön bl.a. från storfruktiga åkerbärsplantor i Öjebyns närhet. De förvarades under vintern i en påse i ordinär rumstemperatur. Svårigheten var sedan att få dem att gro. Men med förbehandling i koncentrerad svavelsyra enligt Rose (4) gick det ganska bra. Av cirka 10.000 frön förstördes 2000 vid behandlingen. En del var tomma, andra möglade i petriskålarna, och ganska många tålde ej colchicinbehandlingen. Sammanlagt klarade sig ett hundratal plantor. Bland dessa fanns förutom kontrollerna fem säkra tetraploider samt en del chimärtyper.

Det första tetraploida åkerbäret, benämnt *49 — 1 a*, kom till på följande sätt. 100 frön från ovannämnda portion lades i koncentrerad svavelsyra med så mycket vätska, att fröna ej klumpade sig. Då och då skedde omrörning. Efter två timmar hälldes vätskan bort, och fröna utsattes en kvart för rinnande kallt vatten. Därefter fick de ligga i en 5 % lösning av natriumbikarbonat, tills bubblorna slutat att komma upp. Då tvättades de igen i rinnande vatten under en kvart. Därefter rullades de på tidningspapper, så att man kunde få bort endokarpet, och kunde sedan omedelbart läggas till groning i en petriskål. Detta skedde den 31 mars år 1949. Det fanns då endast 84 frön kvar efter behandlingen. 29 dygn senare utvaldes 25 av de bästa, vilkas rötter då börjat skymta fram, och överfördes i en 0.5 % colchicinlösning. Där fick de ligga i 18 dygn. Bland dem konstaterades samma år en tetraploid planta med 28 kromosomer i rotspetsarna (fig. 1 c). Flera andra i detta prov kunde antagas vara tetraploida, men de dog så småningom, innan de hunnit undersökas.

Den andra tetraploiden, *49 — 3 a*, fortfarande vid liv, härstammade från ett fröparti, taget från normalstora frukter, vilket stratifierats i kruka och stått frostfritt i källare under vintern. Efter svavelsyrebehandlingen inträffade groningen här efter fyra dagar, varefter överflyttning skedde till 0.5 % colchicinlösning. 5—6 dagars behandling tycktes denna gång vara nog för att ge effekt. Småplantorna överflyttades i sand+torvmull i en petriskål, vilken hela tiden i likhet med övriga prov stod i ett fönster, som vette mot norr. Rumstemperaturen höll sig mellan +15° och +20° C.

För fixering av rotspetsar användes Navashin-Karpechenko, och dylik begagnades även för knoppar, sedan dessa först någon minut fixerats i

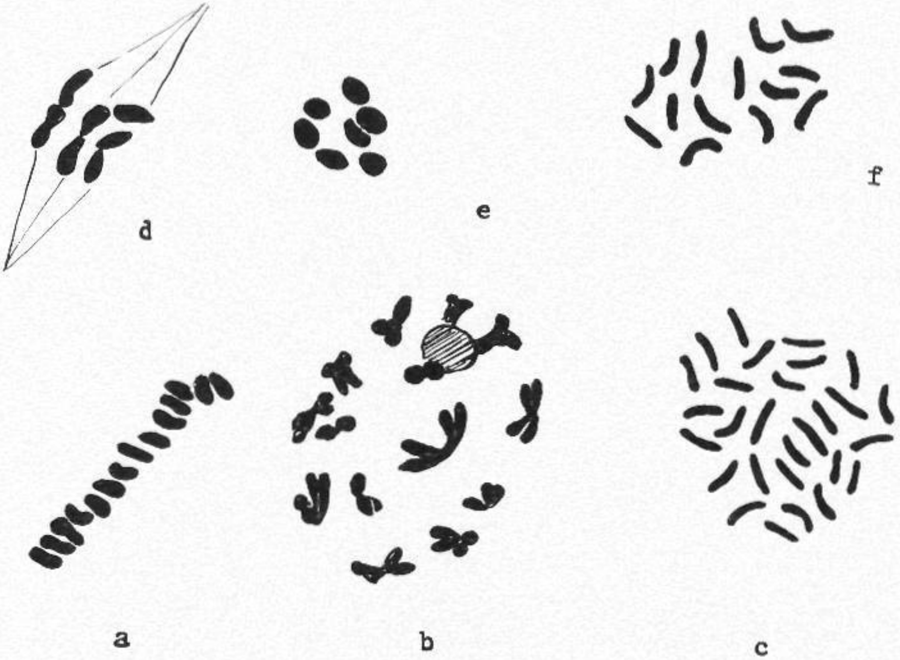


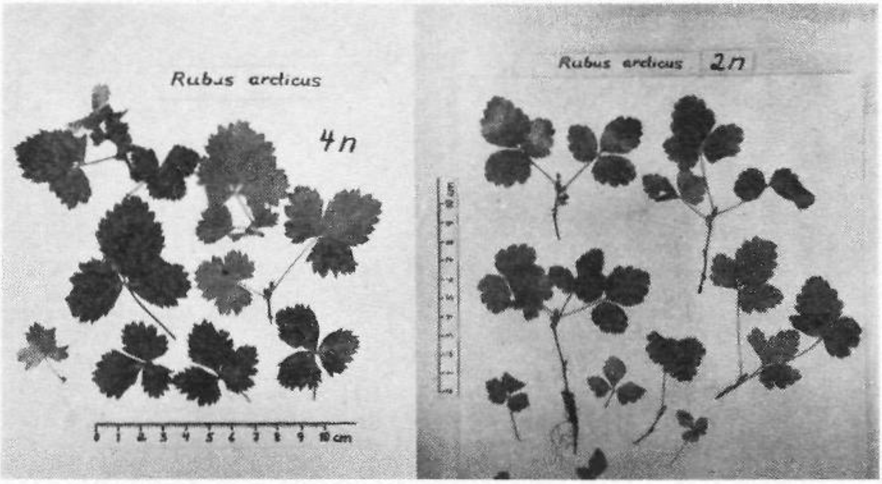
Fig. 1. a—b meios och c mitos (rotspets-) hos tetraploid *R. arcticus*. 2n=28. — d—e meios och f mitos från diploid *R. arcticus*, 2n=14. — ×3000.

Carnoy 3 : 1. För klyvöppningsmätningar fixerades jämförbara bladsnitt i Carnoy 3 : 1 under några minter och lades därefter i acetokarmin. Häri lades även pollenkorn för mätning av diametern (5).

Alla permanenta preparat ritades vid Statens trädgårdsförsök, Alnarp, med användandet av ett Zeiss-mikroskop och ritkamera vid 3000 gångers förstoring.

Resultat. — De cholchicinbehandlade plantorna växte oerhört långsamt och hade den första hösten i bästa fall blott 3—4 blad, cirka 1 cm breda. Kontrollerna hade betydligt flera blad.

Ett par vintrar överlevde samtliga fem tetraploider, emedan de då fick övervintra i frostfri jordkällare. Då förf. antog, att de sedan var tillräckligt härdiga, placerades de ute i kallbänk med påföljd, att tre av dem dog under den exceptionellt snöfattiga vintern 1951—52, då ett stadigvarande och därtill tunt snötäcke ej kom förrän fram i december.



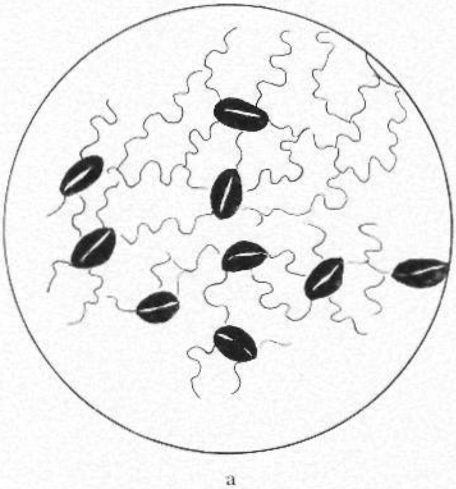
a b

Fig. 2. Bladtyper hos tetraploid och diploid *Rubus arcticus* L., åkerbär.

Morfologiskt skilde sig de behandlade plantorna tydligt från kontrollerna. Som väntat var bladen tjockare och kanterna mera skarpt sågade, vilket också framgår av fig. 2 a och b. Fig. 3 a och b visar, att tetraploiden hade större klyvöppningar än diploiden, och i tabell 1 uttryckes skillnaderna siffermässigt. 50 klyvöppningar hade mätts av varje exemplar. Mellan de rena tetraploiderna och diploiderna var skillnaderna statistiskt säkra, men inom hela det colchicinbehandlade materialet varierade klyvöppningslängden mera än inom de obehandlade plantorna. Detta hade tidigare konstaterats bl.a. av Lamm (2).

Ytligt sett skilde sig de tetraploida blommorna ej nämnvärt i storlek från de diploida (fig. 4), då dessa senare kunde variera kolossalt både till storlek och form. Jag lade dock märke till, att foderbladen var ovanligt rikt besatta med hår och körtlar hos den tetraploida blomman. Pollendiametern var hos denna också märkbart större såsom framgår av tabell 2 och fig. 5 a och b. De flesta pollenkornen var fyllda såväl hos tetra- som hos diploiden.

Vad slutligen frukten beträffar, utbildades färre men något större nötter hos tetraploiden (fig. 6), och de hade även en något skrovligare yta, vilket framgår av förstoringen på fig. 7. Antalet nötter räknades ej hos tetraploidens frukt, men hos diploiderna uppgick de i medeltal till 28 st. Medelvikten av 1000 frön var hos denna 2 1/2 gram, medan densamma hos tetraploiden ej understeg 3 gram.



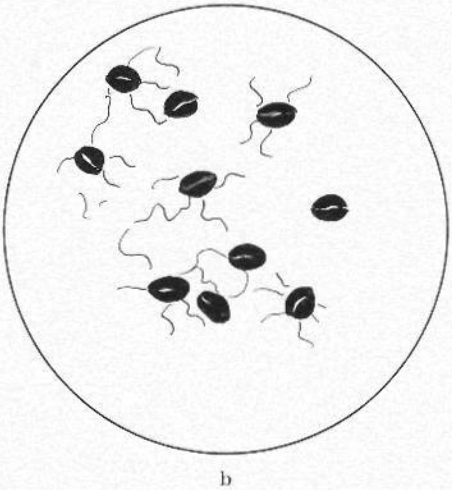
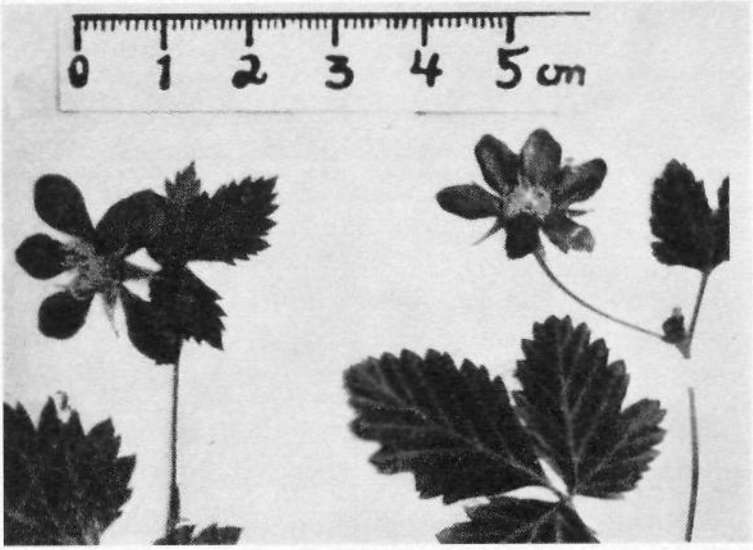


Fig. 3 a. Klyvöppningar hos tetraploid *Rubus arcticus* (49-3 a). — ×320.
Fig. 3 b. Klyvöppningar hos diploid *Rubus arcticus* (Umeå-klon). — ×320.

År efter år gjordes många rotspetspreparat av de förmodade tetraploiderna och alltid konstaterades det somatiska kromosomtalet vara 28. År 1952 blommade den ena tetraploiden för första gången med en enda blomma. 1953 var det några stycken, och då kunde även ett par knoppar



4n Fig. 4. *Rubus arcticus.* 2n

Tabell 1. Jämförelse mellan klyvöppningslängd och kromosomtal.

C-behandl. *R. arcticus*

	Skalenhet	2n		Skalenhet	2n
49—1 a	13.72 ± 0.15	28	49—6 a	14.42	14, 28
49—2 a	19.38 ± 0.21	28	49—7 a	12.78	14
49—3 a	18.30 ± 0.17	28	49—11 a	13.84	14, 28?
49—4 a	23.12 ± 0.47	28	49—12 a	16.98	14
49—5 a	18.70 ± 0.23	28	49—13 a	18.56	14, 28

Kontrollplantor, obehandl.			Kloner		
	Skalenhet	2n		Skalenhet	2n
49—16 a	13.50 ± 0.13	14	Gran 15	13.84 ± 0.14	14
49—17 a	14.16 ± 0.15	14	Laxbäcken 4	13.24 ± 0.03	14
49—18 a	13.42 ± 0.16	14	Laxbäcken 5	13.16 ± 0.16	14
49—19 a	13.06 ± 0.14	14	Laxbäcken 7	12.76 ± 0.16	14
49—20 a	12.10 ± 0.14	14	Sunderbyn	12.18 ± 0.16	14
49—21 a	13.28 ± 0.18	14	Umeå 8	13.60 ± 0.14	14
			Umeå 10	13.04 ± 0.17	14
			Umeå 13	13.34 ± 0.16	14

fixeras. De tre följande åren var det ganska mycket blommor på båda tetraploiderna, men av olika skäl kunde då inga undersökningar göras.

Diskussion av resultaten. — De två överlevande tetraploiderna har som förut nämnts beteckningarna 49 — 1 a och 49 — 3 a. Dessa båda finns nu jämte kontrollplantor utplanterade på ett fält vid Öjebyns försöksstation.

Hela plantan av 49 — 1 a medtogs till Alnarp och var där planterad i kruka åren 1951 och 1952, varefter den åter planterades ut på fält i Öjebyn. Denna tetraploid har alltid varit mycket svagväxande. Skulle man endast döma av klyvöppningsmätningarna kunde den vara di-

Tabell 2. Jämförelse mellan pollendiameter och kromosomtal.

	Pollendiam. i skalenhet	2n
R. arcticus, 49—1 a	9.25 ± 0.11	28
R. arcticus, 49—3 a	10.86 ± 0.09	28
R. arcticus, Laxbäcken 4	8.01 ± 0.06	14
R. arcticus, Laxbäcken 5	8.02 ± 0.08	14
R. idaeus, La France	11.86 ± 0.14	28
R. saxatilis	10.10 ± 0.08	28
R. stellatus	8.47 ± 0.06	14

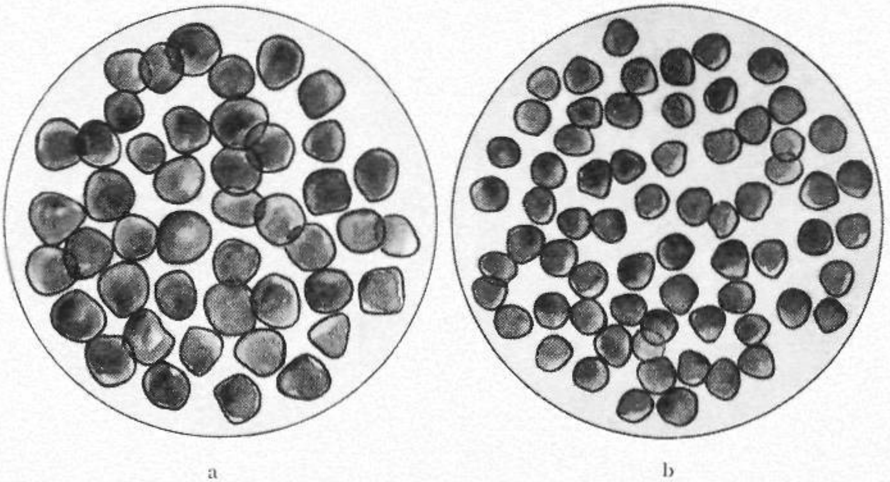


Fig. 5. a Pollen från tetraploid *Rubus arcticus* (49-3 a). — ×320. — b Pollen från diploid *Rubus arcticus* (49-16a, kontrollplanta). — ×320.

ploid, men undersökning av både mitos och meios (fig. 1 a—c) har klart visat, att den är tetraploid. Korsningar mellan denna tetraploid och *R. stellatus* (2n = 14) har också givit en triploid planta, 2n = 21.

49 — 3 a är mycket kraftigväxande och i det avseendet lik kontrollplantorna. Den har emellertid stora klyvöppningar och pollenkorn, fåfröiga frukter samt somatiskt kromosomtal 28. Meiosen har ej undersökts här. Men plantor efter fri avblomning har i rotspetsarna visat

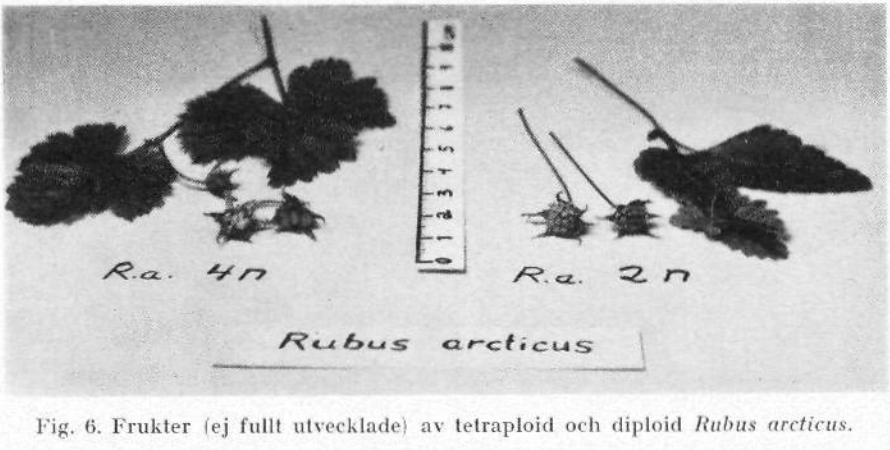


Fig. 6. Frukter (ej fullt utvecklade) av tetraploid och diploid *Rubus arcticus*.

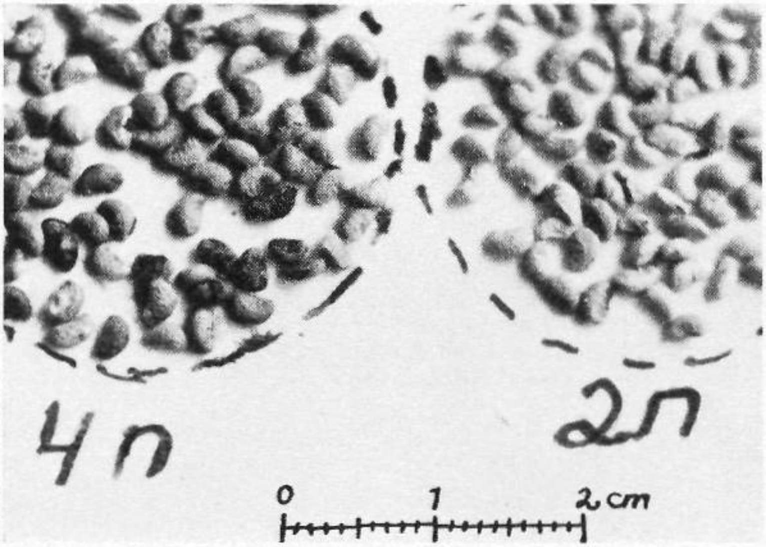


Fig. 7. Frön av tetraploid och diploid *R. arcticus*.

samma kromosomtal, d.v.s. 28, vilket tyder på att korsning kan ha skett med den intill planterade 49 — 1 a. Därmed har även 49 — 3 a bevisats vara tetraploid.

Dessa båda konstgjorda tetraploider av *Rubus arcticus* är de första i sitt slag, och några spontana sådana har ej heller tidigare rapporterats. Tack vare framställningen av dem har man nu större möjligheter till kombinationsförädling med andra nordliga *Rubus*-arter, t.ex. *R. chamaemorus* och *R. stellatus* och även med odlade former av *R. idaeus*, då särskilt tetraploida typer av densamma. Därför kan de båda tetraploida åkerbärsplantorna få inte endast teoretiskt utan även praktiskt värde.

Undersökningarna har utförts vid Statens trädgårdsförsök i Öjebyn och Alnarp, där material ställts till förfogande. För detta vill jag framföra mitt tack till professor Fredrik Nilsson, såsom även för inspiration under arbetets gång.

Summary

The title of the paper is "Colchicine-induced tetraploidy in *Rubus arcticus* L. (the Arctic rasberry)". The diploid *Rubus arcticus* ($2n=14$) is wild-growing, but on account of its unusually aromatic berries it has also been cultivated (3) and used for hybridization with other *Rubus*-species (7). In the second case the typical aroma, so far, has been known to disappear more or less. Because of the smallness of the

fruit this is also very hard to pick. It was thought that, if polyploidy were introduced, one could possibly obtain bigger fruit, whilst retaining the rich aroma.

Thus in the spring of 1949 seeds were soaked in 0.5 % colchicine-solution until showing effect, this after first having been treated with concentrated sulphuric acid for two hours (4). From all treatments only five tetraploids were obtained, of which two are still alive. They have also had blossoms and fruits. Everything indicates tetraploidy: serrated thick leaves, big pollen grains, fruits with bigger but fewer seeds and 14 respectively 28 chromosomes in root tips and pollen grains. A cross between one of the tetraploids (49—1 a) and *R. stellatus* ($2n=14$) gave also a triploid plant ($2n=21$) and an other open-pollinated tetraploid (49—3 a) produced plants with 28 chromosomes in the root tips.

These two tetraploids are the first of their kind and will probably be of value for further breeding-work with northern *Rubus*-species.

Litteratur

1. HULTÉN, E. Flora of Alaska and Yukon. — Lunds Univ. Årsskrift. N.F. avd. 2, sid. 993. Bd 42. Nr. 1. 1946.
2. LAMM, R. Cytogenetic studies in Solanum, sect. Tuberarium. — Hereditas XXXI: 1—128, 1945.
3. LARSSON, G. Odlingsförsök med åkerbär, Rubus arcticus. (A cultivation trial with Rubus arcticus L.). — Sv. Pomol. För. Årsskr. 1955.
4. ROSE, R. C. After-ripening and germination of seeds of Tilia, Sambucus and Rubus. — Bot. Gaz. 67: 281—308, 1919.
5. STRAUB, J. Die Feststellung der Polyploidiestufe. — Ur »Wege zur polyploidie», — Berlin. 1941.
6. VAARAMA, A. Cytological studies on some Finnish Species and Hybrids of the Genus Rubus L. — Journ. Sci. Agr. Soc. Finland, Vol. 11. 1., 1939.
7. — Cytogenetic studies on two Rubus arcticus - hybrids. — Journ. Sci. Agr. Soc. 20. 1948.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Contribution to the floral morphology and embryology of Leea sambucina Wild

By N. C. NAIR & P. N. N. NAMBISAN

(Department of Botany, Birla College, Pilani, India)

Introduction. — The family *Vitaceae* comprises 11 genera of which a few species of *Vitis* alone have been worked out and practically nothing is known about the other genera.

The earliest work on the embryology of the family includes the contributions of Elfving (1879), Berlese (1892), Tischler (1913), Dorosey (1914), and Baranov (1927). Their works have been summarized by Schürhoff (1926), and Schnarf (1931). Biolette (1921)[1], Ivanova (1928)[1], Pearson (1932)[1], Syndes (1935)[1] and Stout (1936) have worked on the seedlessness of grapes. Other recent publications include those of Adatia, Mulay, and Hingorani (1950, 1953) on *Vitis trifolia,* Mulay, Nair, and Sastry (1953) on *Vitis pedata* and Nair and Parasuramen (1954) on *Vitis pallida.* The present paper deals with the floral morphology and embrylogy of *Leea sambucina.*

Material and methods. — *Leea sambucina* is a shrub with straight branches and large pinnate leaves. The material for the present investigation was collected from plants growing under natural conditions in Ernakulam (S. India) during the month of June and later in September 1954. It was fixed on the spot in F.A.A. and dehydrated and embedded according to Johansons' tertiary butyl alcohol method. Serial sections were cut at 8 μ for young stages and 10—12 μ for older stages. Considerable difficulty was encountered in getting good ribbons as they were often badly torn due to the presence of raphides and sphaerocrystals. Staining was done in safranin and fast green as well as in iron alum

---

[1] Quoted from Stout (1936).

haematoxylin. Whole mounts of pollen grains were prepared by aniline oil gention violet method as suggested by Wodehouse (1935).

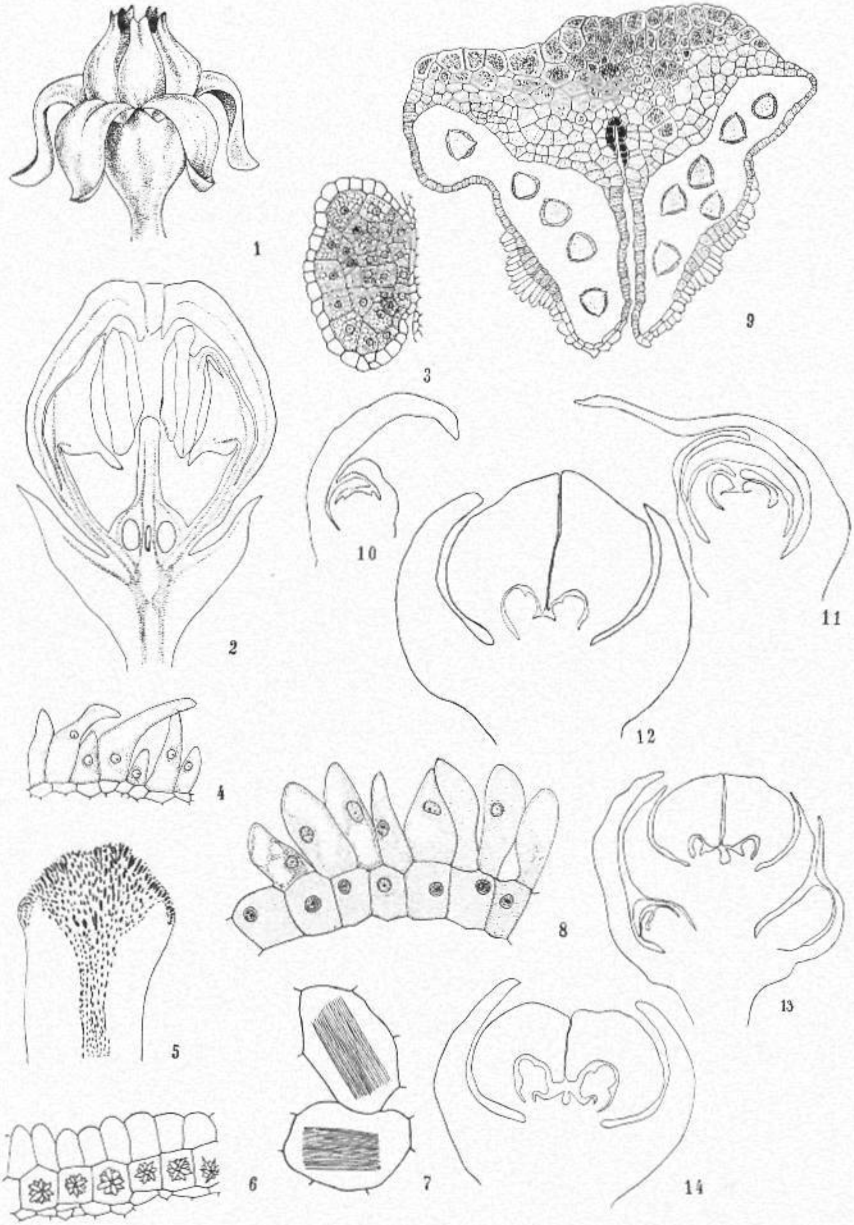
Morphology of the flower. — The flowers occur in corymbose cymose clusters. They are bisexual, hypogynous, and pentamerous with a tricarpellary gynoecium. The outer surface of the calyx is provided with glands (Fig. 3) and unicellular hairs (Fig. 4) which develop from the epidermal cells. The basal region of the corolla is united with the staminal tube to form a pentagonal structure in transverse section (Fig. 22). This tube is partly united with the ovary at the base. The tip of the staminal tube is provided with 5 crescent shaped appendages (Fig. 2) alternating with the five crenate and included anthers (Fig. 28). The prominent intrastaminal disc characteristic of other *Vitaceae* members is not found in *Leea sambucina*. The ovary is 6 celled at the base and apex (Figs. 19—23). In the middle the septa recedes slightly to the periphery (Figs. 20, 21). Each cell contains a single anatropous ovule with an inferior micropyle. The ovary is continued above into a style and ends in a glandular stigma (Fig. 5). The flowers are markedly protandrous.

The anthers bear unicellular hairs (Figs. 8, 9) except in the region of dehiscence. Raphides (Fig. 7) and sphaerocrystals are found in all parts of the flower as in other members of the family. The subepidermal cells of the petal contain one sphaerocrystal each almost filling the cell and this layer appears as a hypodermal pad studded with jewels (Fig. 6).

Organogeny. — The first set of organs to appear is a bract followed by two bracteoles one on either side. The sepals, petals, stamens, and carpels develop in acropetal succession (Figs. 10—13). As the primordia of the carpels arch inwards and fuse by their margins to form the ovary, style, and stigma another set of organs arise in between the stamens and the carpels (Fig. 14) alternating with the former. These later fuse with the filaments of the stamens and the basal part of the corolla to form the petal stamen tube.

Floral anatomy. — The pedicel has a circular outline and contains four large vascular bundles (Fig. 15) each of which below the receptacle divides into two and a ring of eight vascular bundles is formed (Fig. 16). In the region of the receptacle the stele gives off five traces to the gamosepalous calyx (Fig. 17). Each of these traces divides into one median and two laterals while still in the receptacular cortex. The supply of the calyx shows good number of variations. Out of the 25 flowers examined two had six traces, one showed seven and another nine. After the departure of the sepal traces some of the stelar bundles fuse with the adjacent ones to form a ring of five bundles from each of which is given off a trace alternating with the sepal traces (Fig. 17). These traces are the common traces for the petals and the five antipetalous stamens. At first there is no indication of their dual nature but as they move to the periphery of the five-angled receptacle, they separate and continue into the petal stamen tube (Figs. 18—26). Just before the petals separate from the petal stamen tube, the outer part divides into three (Fig. 26) one median and two laterals. The laterals may again divide in the higher regions of the petal. The inner continues as such. Simultaneous with the formation of the petal stamen traces the vascular tissue left behind divides to form twelve to fifteen bundles (Figs. 18, 19). Six of these bundles swing inwards and fuse in pairs to form the inversely oriented placental bundles (Figs. 19—22) which give supply to the two ovules on each placenta. The vascular bundles left behind move to the periphery and divide to form a large number of bundles. They again divide tangentially into two rings of bundles of which the outer enters the petal stamen tube (Figs. 20—23). Some of the bundles of this ring divide irregularly in the higher regions. From the inner ring three carpellary dorsals are distinguished (Fig. 20). The other bundles traverse the ovary wall. Alternating with the placenta the ovary wall projects inwards, making the ovary six celled in the base and the apex. The corresponding dorsal bundles move into these projections (Figs. 21, 22). The middle part of the ovary is unilocular where the placentas appear peltate in transverse sections with ovules on their margins (Figs. 21, 22). At the top of the ovary each of the inversely oriented placental bundles divides into two ventrals. The ventral bundles of each carpel unite with the corresponding dorsal bundles. Some of the bundles that traverse the ovary wall fuse with them and form three strands (Fig. 26) that supply the style and fade out before the stigmatic region is reached.

Microsporangium. — A group of hypodermal archesporial cells (Fig. 29) gets differentiated in each of the four lobes of the anther primordium along the entire length. It is 3—4 cells across and 18—20 cells deep. The peripheral layer of archesporial cells undergoes a periclinal division to form a primary parietal layer separating the sporogenous tissue from the epidermis. Older stages show four layers of cells between the epidermis and the mother cells (Fig. 30). The cells of the innermost layer are



Figs. 1—14. — 1. Entire flower. × 5. — 2. L. S. flower to show the vascular supply (semidiagramatic). × 8. — 3. A gland from the calyx. × 90. — 4. Unicellular hairs from calyx. × 300. — 5. Glandular stigma. × 25. — 6. Part of petal in T. S. showing a hypodermal pad of sphaerocrystals. × 300. — 7. Raphides from ovary wall. × 300. — 8. Part of a mature anther wall in T. S. × 300. — 9. A mature anther in T. S. Note the fibrillar thickenings in the cells near the connective. × 150. — 10—14. Organogeny of the flower. × 25.

more or less isodiametric and function as the tapetum. The sub epidermal layer develops into the endothecium and the inner two layers into the middle layers.

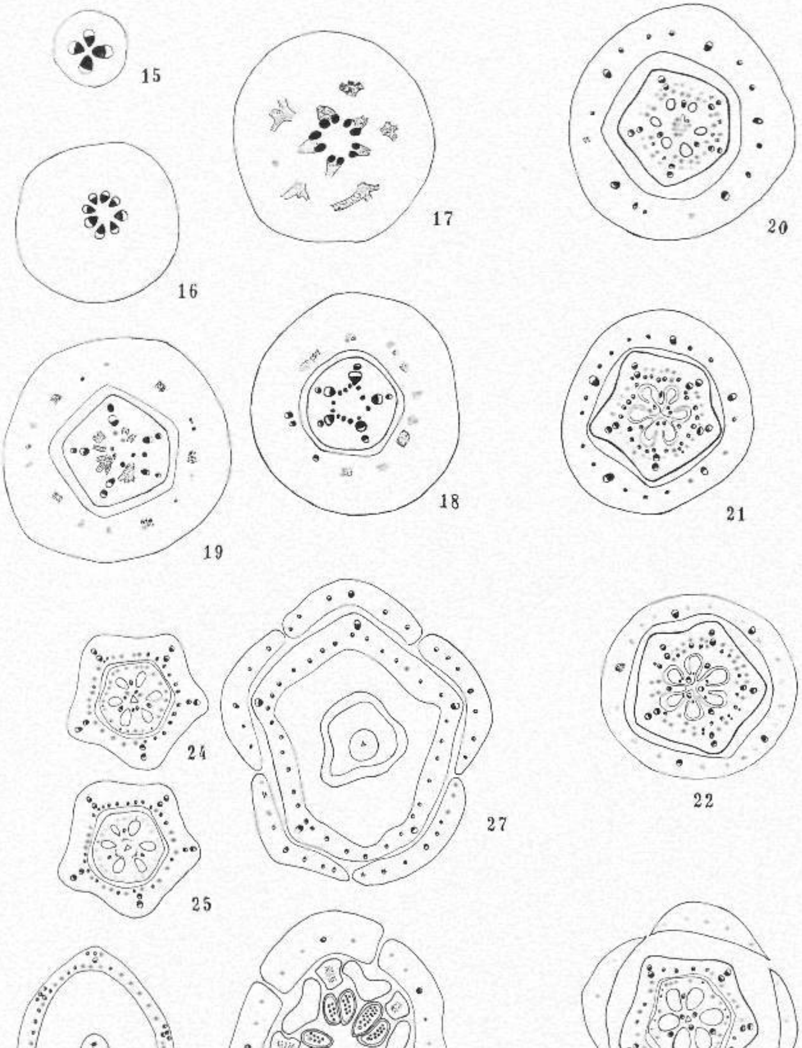
The meiotic division is normal. In polar view of a typical equatorial plate (Fig. 31) ten bivalents were counted. The first meiotic division (Fig. 32) is not followed by a wall and after a short interkinesis (Fig. 33) the daughter nuclei enter a second meiotic division (Figs. 34, 35, 36). The spindles may be parellel or at right angles to each other (Figs. 34, 36). Secondary spindles connect the daughter nuclei to each other (Fig. 37). Cytokinesis is simultaneous and takes place by centripetal furrowing (Fig. 38). The microspores aquire their own walls. The walls of the microspore mother cells remain intact through out the whole process of meiosis. The tetrads are tetrahedral (Fig. 39). The microspores are liberated by the disintegration of the wall of the microspore mother cells.

The tapetum is glandular. Before the meiotic divisions in the microspore mother cells the nuclei of the tapetal cells divide mitotically to form two to three nuclei (Fig. 30). The size of the tapetal nuclei vary considerably. The tapetum shows signs of degeneration at the time of tetrad formation. At the uninucleate stage of the pollen grain the tapetal cells are completely disorganised.

The endothecial cells enlarge considerably and develop fibrillar thickenings (Fig. 42). But the endothecial cells at the region of the staminal hairs do not develop these thickenings. They take a deep stain and their nuclei persist even in the mature anther. Some of the cells lying towards the connective also develop fibrillar thickenings (Fig. 9).

The middle layers are crushed and no trace of them can be seen in the mature anther. The epidermis also disintegrates but persists at certain places. At maturity the two pollen sacs of each lobe of an anther become confluent by the disintegration of the cells in between them (Fig. 9). The anther wall at this stage consists of only the fibrous endothecium and the epidermis at places. Along the line of dehiscence the epidermal cells are extremely small.

Male gametophyte. — The young microscope has a dense cytoplasm with a large nucleus. Its wall consists of thick smooth exine and a thin intine (Fig. 40). They are provided with three germ pores (Fig. 42, 43). As the pollen grains enlarge a large vacuole appears in the cytoplasm which pushes the nucleus to one side (Fig. 40) where it divides to form a small generative cell and a large tube cell. The generative cell moves up to-



Figs. 15—28. Serial T. S. from the pedicel onwards showing the structure and the vascular supply of the floral parts. × 8.

wards the tube nucleus (Fig. 41). The mature pollen is subpyrolate (Erdtman, 1952).

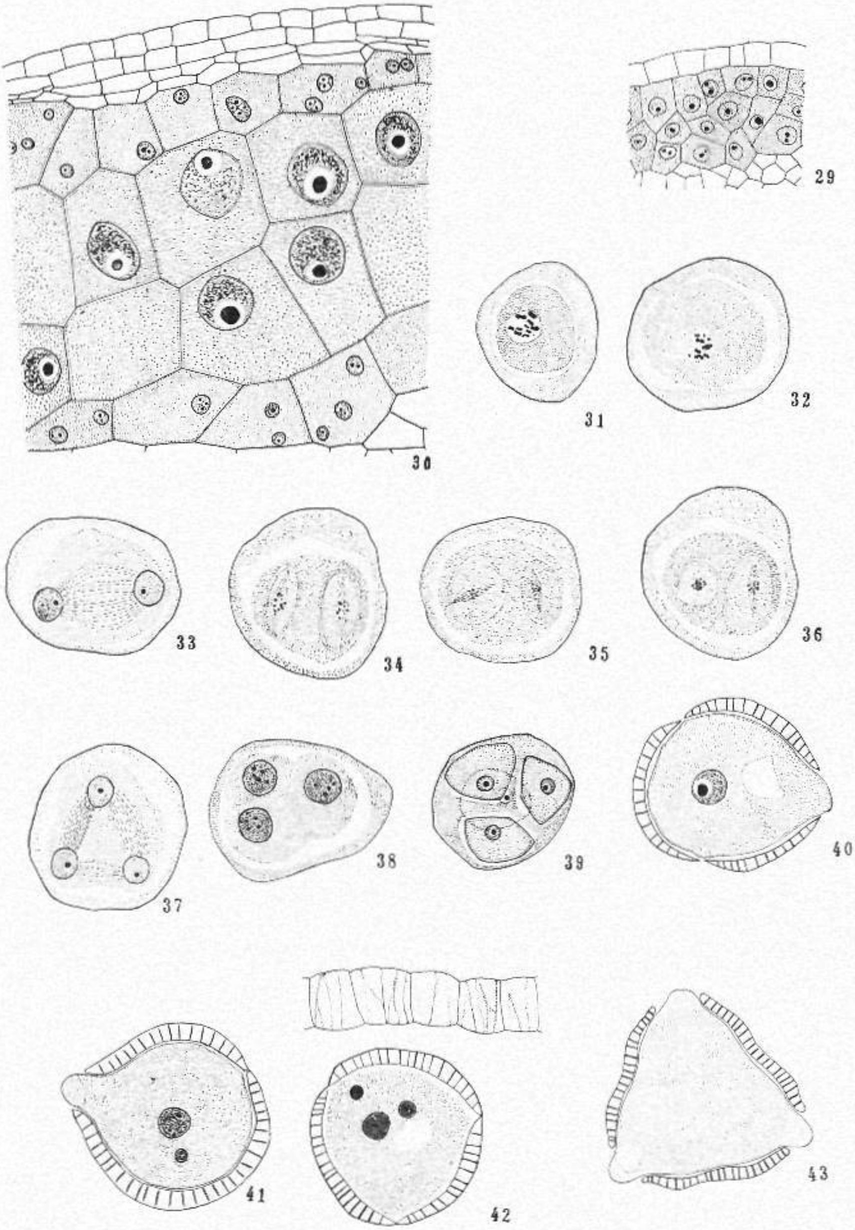
The pollen grain is shed at the three celled stage (Fig. 42). The two male cells are spherical. The tube nucleus disintigrates and stains deeply. Degeneration of the pollen grains is very frequent.

Megasporangium. — There are two ovules for each carpel one in each cell. The ovules are crassinucellate, bitegmic, and anatropous. The micropyle is directed downwards. The ovule arises as a small erect protuberance, but soon becomes inverted (Fig. 44). The micropyle is formed by both the integuments (Figs. 45, 55). The inner integument is three layered at the apex and two layered at the base. The outer integument is four to five layered (Fig. 55). The cells of the outer epidermis of the outer integument and the inner epidermis of the inner integument stain deep with safranin (Fig. 55) probably due to the presence of tanin. A hypostase like structure is present at the chalazal region of the mature ovule (Fig. 54). The cells of this can be clearly distinguished from the surrounding cells by their thickened cell walls. The vascular strand supplying the ovule extends up to the chalaza (Fig. 45).

Megasporogenesis. — A hypodermal archesporial cell differentiates in the nucellus (Fig. 46) at the time when microspores are distinguished in the microsporangium. It cuts off a parietal cell towards the outside which undergoes repeated periclinal divisions as a result of which the mother cell becomes very deep seated. At the mature embryosac stage there are about 8—9 layers of parietal tissue formed by the nucellus and by the division of the nucellar epidermis (Fig. 55).

The first meiotic division results in a dyad (48) which gives rise to a linear tetrad of four megaspores (Fig. 49). Degeneration begins from the micropylar megaspore.

Embryo sac. — The functioning megaspore enlarges considerably. The two daughter nuclei formed after the first division of the centrally placed nucleus of the uninucleate embryosac are separated by a large central vacuole (Fig. 50). Each of the daughter nuclei divides repeatedly twice to produce a monosporic eight nucleate embryo sac. Thus its development conforms to the *Polygonum* type (Maheshwari, 1950). The embryosac is elongated with a tapering chalazal end (Fig. 51). The antipodals organize into triangular cells (Fig. 52). In one case two nuclei were observed in the lowermost antipodal cell (Fig. 53). The antipodals are ephemeral and no trace of them can be seen in a sac ready for fertilization (Fig. 51). The synergids are hooked and have apical



Figs. 29—43. — 29. Part of young anther in L. S. showing hypodermal archesporium. × 500. — 30. Part of anther in L. S. showing wall layers and microspore mother cells. × 500. — 31—38. Meiosis I and II of pollen mother cells. × 500. — 39. Pollen tetrad. × 500. — 40—41. Uninucleate and two celled pollen grains. × 500. — 42. Part of the mature anther showing fibrous endothecium and a mature pollen grain. × 500. — 43. Whole mount of pollen to show the nature of the germspores. × 500.

vacuoles (Figs. 55, 56). The polar nuclei meet each other and fuse in the chalazal region of the embryosac (Figs. 53, 54).

Discussion. — The family *Vitaceae* includes an assemblage of plants having several common features. The flowers occur in cymose inflorescences and they are actinomorphic, pentamerous or tetramerous with 4 or 5 antipetalous stamens and 2 or 3 fused carpels.

The vascular supply to the calyx in *Leea sambucina* shows a good deal of variation. Normally there are 5 traces but in some cases it varies from 6—9. This shows that it is in a process of change undergoing considerable reduction in the number of vascular supply to the calyx.

The supply to the petals and the stamens arise conjointly. This feature is remarkably constant in all the members of the family so far studied (Saunders, 1938; Nair & Mani, M. S.).

Hooker's (1875) statement that the staminal tube in *Leea* is formed by the fusion of 5 antipetalous stamens does not seem to be correct. The preceding description of the vascular anatomy and the organogeny of the flower clarifies the exact nature of staminal tube in *Leea sambucina*. It is made up of an outer antipetalous whorl of 5 fertile stamens and an inner whorl of staminodes. The traces to the inner whorl of staminodes arise conjointly with the carpellary supply and become separated in the higher regions. Therefore the flowers of *Vitaceae* show an obdiplostemonous condition which might have been resulted by the adnation of the traces of petals and antipetalous stamens.

A feature which deserves attention in the nature of the gynoecium is its multilocular condition at its base and near the top of the ovary. This feature is easily explainable in the light of the classical interpretation of the gynoecium but is not easily understandable if we follow rigidly Troll's (1928) distinction into paracarpous and coenocarpous gynoecium. *Leea* according to his classification is paracarpous but the multilocular base is coenocarpous. It is incomprehensible how a paracarpous gynoecium can become multilocular in the upper region as in *Leea*. Attention has also been drawn to such features by Arber (1942), Puri (1950), and Murthy (1954). Therefore it seems that the strict distinction between paracarpous and coenocarpous gynoecium can not be maintained.

The placentation in *Leea* has been described as axile in all the taxonomic systems. In his review "Placentation in Angiosperms", Puri (1952) described and redefined the various types of placentation and has pointed out that the position and composition of the placental

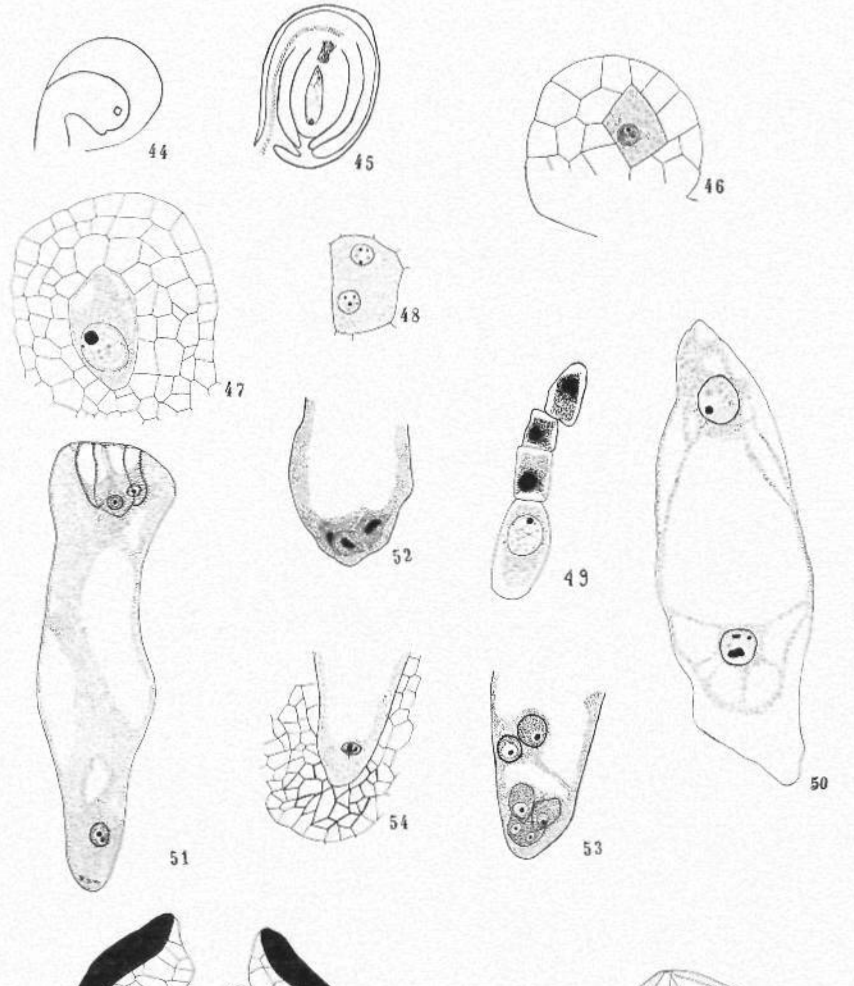


Fig. 44—56. — 44. Young ovular primordium. × 67. — 45. A mature ovule (semi-diagramatic). × 67. — 46. L. S. of young ovule showing hypodermal archesporium. × 500. — 47. L. S. of young ovule showing megaspore mother cell with two parietal layers. × 500. — 48. Megaspore mother cell towards the close of the first meiotic division. × 500. — 49. A linear tetrad of megaspores. × 500. — 50. Binucleate embryo sac. × 500. — 51. Mature embryo sac. × 360. — 52—54. Chalazal region of embryo sac. × 500. — 55. Micropylar region of a mature ovule. × 360. — 56. Micropylar part of the embryo sac. × 500.

strands are features of great significance in the determination of placentation. In typical axile placentation according to him the placental strands occur on the same radii as the carpellary dorsals and are formed by the fusion of two ventrals of the same carpel. But in parietal placentation they occur on radii alternating with those of the dorsals and are formed by the fusion of the ventrals of two different carpels. In *Leea sambucina* it has been pointed out that the placental strands are on the septal radii and are formed by the fusion of ventrals belonging to two different carpels. It becomes clear, therefore, that anatomically the placentation is parietal.

It has been shown that the gynoecium is supplied by a large number of vascular bundles from which are distinguished 3 dorsals. The presence of large number of bundles other than the usual dorsals and ventrals may be interpreted as an indication that the present tricarpellary gynoecium is derived from a multicarpellary condition.

In the young anther lobes the archesporium in *Vitaceae* is 2—4 cells across and 15—20 cells in longitudinal section. There are two ephemeral middle layers. The endothecium is fibrous except in *Vitis trifolia* (Adatia, Mulay, & Hingorani, 1950). Multinucleate tapetal cells are characteristic of all members of the family so far studied (Schnarf, 1931; Adatia *et al.* 1950; Mulay *et al.* 1953; Nair & Parasuraman, 1954). Adatia *et al.* (1950) reported a periplasmodial tapetum in *V. trifolia*. In all the other members of the family so far studied the tapetum is of the glandular type. The division of the microspore mother cells is according to the simultaneous type.

The mature pollen grains are binucleate in *V. trifolia* (Adatia *et al.* 1950). Three celled condition is known in *V. pedata* and *V. pallida* (Mulay *et al.* 1953; Nair & Parasuraman 1954). In *Leea sambucina* they are 3 celled. The pollen grains are triporate.

The ovule is crassinucellate and bitegmic. It is orthotropous to begin with but soon becomes anatropous. The inner integument forms the micropyle in *Vitis* species but in *Leea* it is formed by both the integuments.

A nucellar cap is reported in *V. vinifera.* This cap is not present in *V. pedata,* and *V. pallida.* In *Leea* the nucellar cap formed by the division of the nucellar epidermis consists of 2—3 layers of cells.

The nucellus is massive in almost all members. In *V. pallida* the apical end of the embryosac disorganises the nucellus, comes out through the micropyle and performs a haustorial function. There is a well marked deep staining hypostase consisting of compactly arranged cells in all the members.

The ovular archesporium is unicellular in most of the cases. Two megaspore mother cells lying side by side sometimes exist in *V. trifolia* and *V. pallida* (Adatia etal, 1953; Nair & Parasuraman, 1954).

The development of the embryo sac is of the *Polygonum* type in all the members. In the organisation of the mature embryo sac in *Leea* an important feature is the egg like synergids. With in the family it has been reported in *V. trifolia, V, pedata* and *V. pallida.* The antipodals in the family are three in number and they are usually uninucleate. A characteristic feature of the antipodals is their quick degeneration.

Summary

The flowers of *Leea sambucina* are pentamerous, bisexual and hypogynous. The intrastaminal disc characteristic of other *Vitaceae* members is absent.

The development of the floral organs is in the sequence sepals, petals, outer whorl of antipetalous stamens, the carpels and finally the inner whorl of staminodes. The basal part of the petals, stamens and staminodes fuse to form the petal stamen tube. The organogeny and the vascular pathways in the flower lend support for an obdiplostemonous condition.

The presence of multilocular condition in the base and apex of the ovary has been interpreted as an evidence against Troll's classification of gynoecium.

The nature of placentation has been discussed in some detail and it has been concluded that it is parietal.

The anther wall consists of epidermis, fibrous endothecium, two middle layers, and glandular multinucleate tapetum.

The flowers are markedly protandrous. Reduction divisions are simultaneous. Cytokinesis is by furrowing and tetrads are tetrahedral. Pollen grains are psilate, triporate and three celled.

The ovules are bitegmic crassinucellate and anatropous. The micropyle is formed by both the integuments.

The development of the embryo sac is of the *Polygonum* type. The synergids simulate eggs. The antipodals are ephemeral.

We are thankful to Dr. B. N. Mulay for his interest encouragement and facilities.

Literature cited

* Originals not seen.

ADATIA, R. D., MULAY, B. N., and HINGORANI, G. R. 1950. A contribution to the embryology of *Vitis trifolia* L. — J. Univ. Bomb. 19: 1—10.

— 1953. A contribution to the embryology of *Vitis trifolia* L. II. — J. Univ. Bomb. 21: 51—60.

ARBER, A. 1942. Studies in the floral structure VII. On the gynoecium of *Reseda* with a consideration of paracarpy. — Ann. Bot. 6: 43—48.

*BARANOV, P. 1927. Zur Morphologie und Embryologie der Weinrebe. — Ber. Deutsch. Bot. Ges. 97—114.

*BERLESE, A. N. 1882. Studi sulla forma, struttura esviluppo del semenelle Ampelideae. — Malpighia. 6: 293—324; 442—536.

*DOROSEY, M. J. 1914. Pollen development in the grape with special reference to sterility. — Univ. Minnesota Agr. Exp. Bull. 144: 1—60.

*ELFVING, F. 1879. Studien über die Pollenkörner der Angiospermen. — Jenaische Zeitschr. Mid. Nat. 13: 1—28.

ERDTMAN, G. 1952. "Pollen morphology and plant taxonomy". — Waltham Mass.

HOOKER, J. D. 1875. "Flora of British India". I. — London.

JOHANSEN, D. A. 1940. "Plant microtechnique". — New York.

MAHESHWARI, P. 1950. "An introduction to plant embryology". — New York.

MULAY, B. N., NAIR, N. C. and SASTRY, M. S. R. 1953. Contribution to the embryology of Vitaceae. — Proc. Raj. Acad. Sc. 4: 16—28.

MURTHY, Y. S. 1954. Studies in the order Parietales IV. Vascular anatomy of the flower of Tamaricaceae. — Journ. Indian Bot. Soc. 33: 226—238.

NAIR, N. C. and PARASURAMAN, V. 1954. Gametophytes of *V. Pallida.* — Curr. Sc. 23: 163—164.

PURI, V. 1950. Studies in the floral anatomy VII. Vascular anatomy of the flower of *Crateva religiosa* with special reference to the nature of carpels in the Capparidaceae. — Amer. J. Bot. 37: 363—370.

— 1952. Placentation in angiosperms. — Bot. Rev. 18: 603—651.

SAUNDERS, E. R. 1937. "Floral morphology". — Cambridge.

*SCHÜRHOFF, P. N. 1926. "Die Zytologie der Blütenpflanzen". — Stuttgart.

SCHNARF, K. 1931. "Vergleichende Embryologie der Angiospermen". — Berlin.

STOUT, A. B. 1936. Breeding for hardy seedless grapes. — Proc. Amer. Soc. Hort. Sc. 34: 416—420.

*TISCHLER, G. 1913. Über die Entwicklung der Samenanlagen in parthenokarpen Angiospermenfrüchten. — Jahrb. Wiss. Bot. 52: 1—84.

*TROLL, W. 1928. Zur Auffassung des Parakarpen Gynaeceums und des coenocarpen Gynaeceums überhaupt. — Planta 6: 255—276.

WODEHOUSE, R. P. 1935. "Pollen grains". — New York.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Some Notes on the Endosperm and Embryo Development in Fagales and Related Orders

By H. HJELMQVIST

In a previous paper (Hjelmqvist, 1953) the present writer described the embryo sac development of *Quercus robur* until the first endosperm formation. As the further endosperm development in *Fagales* and related orders affords much of interest and also has been made the basis of phylogenetical theories, an investigation has been made of the endosperm formation in *Quercus* and some related genera, as a contribution to their embryology and to the phylogenetical discussion.

1. Quercus robur L.

The material of *Quercus robur* investigated was collected in South Sweden July—August 1955, with some complementary collections in August 1956. As fixative the solution of Navashin-Karpechenko was used in this as in other cases and staining was made with haematoxylin according to Heidenhain.

As was already stated by Conrad (1900), the endosperm formation follows the nuclear type and a large number of free nuclei are formed, before cell formation takes place. Fig. 1 *a*, which is made through combination of several sections, shows an embryo sac from July 26 1955 with hundreds of free nuclei, lying mainly in narrow strings of cytoplasm (in reality the nuclear number is probably somewhat greater than is shown in the figure). In the micropylar part the wall formation has just begun and a small group of cells surrounds the embryo, which now consists of 9 cells. In some cases secondary spindles could be observed which had been formed between the endosperm nuclei and were divided through the middle by a wall; such spindles could emanate from one nucleus in two directions. The wall development thus took place by way of cell plate formation, as usual in the endosperm.

The nucellus in this stage of development is almost completely destroyed through the growth of the embryo sac; only at the base a remnant is left. That part of the embryo sac that penetrates down along the side of this and doubtless corresponds to an original *caecum*-formation is not only made up of narrow cytoplasm bands, but forms a greater mass of cytoplasm. In this several fusions were observed between nuclei that united in twos or in threes. In one group two nuclei had partly fused and a third one lay immediately close to them, in two other cases two nuclei were close together, obviously just going to fuse. In another embryo sac, which was in the same stage of endosperm development, a big nucleus was observed (Fig. 1 *b*) in this basal part of the embryo sac, considerably greater than the other nuclei near by and containing several (8) nucleoli; evidently it had arisen through fusion of several nuclei.

The stages just mentioned belonged to fixations made in the end of July. In material from the beginning of August (3/8 1955) a later stage was observed (Fig. 1 *c*). The embryo had now increased and showed the first primordia of the cotyledons. In the endosperm the wall formation had proceeded, especially in the micropylar part, which was completely filled by cell tissue, but also along the walls cellular tissue had been formed as far as to the base of the embryo sac, surrounding a large vacuole. The thickness of the cell tissue around the vacuole varies to some extent; in the case figured the tissue at the bottom of the vacuole is as a rule made up of one cell layer only, in another case in the same stage of development it was somewhat thicker, made up of 2—3 cell layers. All cells are surrounded by thin walls. In the periphery of the cavity free nuclei occur; evidently the cell formation is going on here.

A later stage of development is shown by Figs. 2 *a*—*c*, which represent the conditions in the later part of August (fixation of 20/8 1956). The embryo now has two distinct cotyledons and forces its way down in the endosperm, the adjacent tissue being dissolved. The cellular tissue has increased considerably in thickness and fills up the greater part of the embryo sac. A vacuole is left, however, somewhat varying in size and position. The vacuole reproduced in Fig. 2 *a* is rather large and extends high up in the upper part of the embryo sac. It has an irregular limit, and there are some cytoplasm strings and free nuclei in the periphery, obviously the cell formation is still in progress. In Fig. 2 *b* a vacuole is visible which is somewhat smaller in relation to the cellular tissue and situated more closely to the base of the embryo sac. Its limit is for the main part even and no free nuclei were observed;

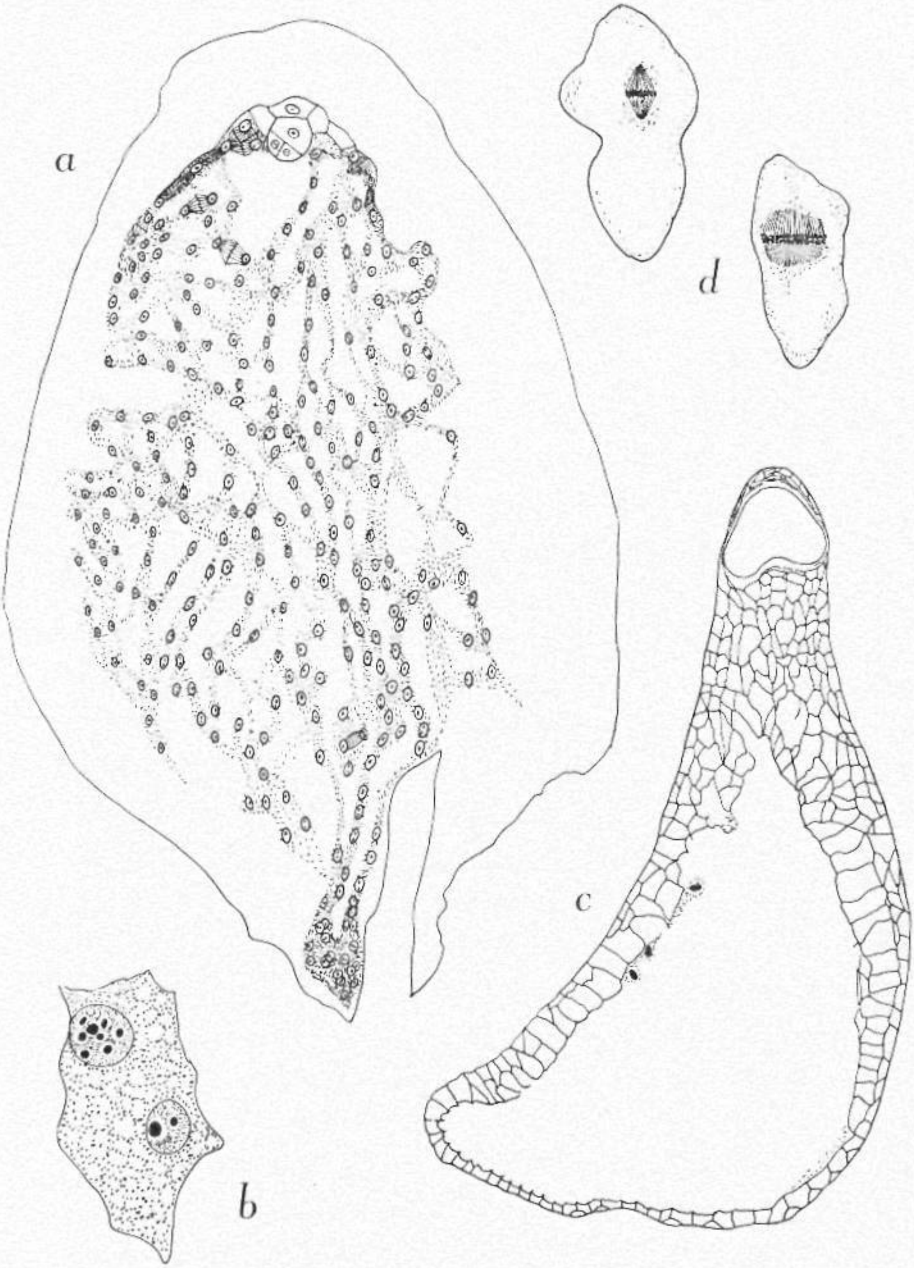


Fig. 1. Endosperm development of *Quercus robur*. *a* Endosperm (26/7) with free nuclei and beginning cell formation in the micropylar part, around the embryo (combination of several sections). *b* Two nuclei from the basal part of an endosperm, one of them larger and with several nucleoli. *c* Endosperm (3/8) with cellular tissue in the micropylar part and along the walls in the other part. Some free nuclei visible. *d* Two nuclear divisions of different size from cells in the same endosperm (the endosperm reproduced in Fig. 2 *c*). — Enlargement *a* c. × 170, *b* c. × 400, *c* c. × 55, *d* c. × 530.

thus the cell formation apparently is more or less finished. The basal part of the cellular tissue, situated below the vacuole, has a somewhat different appearance and is largely made up of small cells rich in cytoplasm and with large nuclei. Fig. 2 *c*, finally, shows an instance of a comparatively small vacuole, irregularly situated; the cell formation here is probably not quite completed.

A later stage is shown in Fig. 2 *d* (fixation 27/8 1956). The embryo now has increased so much that the cotyledons penetrate about to the middle of the embryo sac. In the lower part of the endosperm there is still a vacuole left, though rather small. Only a small further increase of the embryo is needed for uniting the cavity around the embryo with the vacuole. Another slide (the same fixation) shows how the embryo fills up almost the whole embryo sac (Fig. 2 *e*). At the base there are still some remnants of the endosperm tissue which also extend in a lobe between the cotyledons; at the sides they have been destroyed with exception for some inconsiderable rests outside the base of the cotyledons.

Curiously enough several nuclear divisions were in this late stage observed in the remaining endosperm. This may be compared with the statements of Håkansson (1954) of a secondary nuclear activity ("seconda primavera") in the endosperm of *Salix* during the development of the embryo and perhaps also with the increased division activity in *Casuarina* in the endosperm surrounding the growing embryo (Swamy, 1948, p. 10). In *Quercus* the chromosome plates and spindles were found to be of very different size (Fig. 1 *d*), obviously a consequence of nuclear fusions in some cases.

2. Fagus sylvatica L.

The material investigated of *Fagus sylvatica* was collected in the summers 1952 and 1956. The fixations of 1952 were made somewhat earlier in the summer (June 27, July 7 and July 17), the material was taken from spontaneous trees in South Sweden (Småland: Nydala). In the year 1956 complementary fixations were made of young fruits from the middle of July to the end of August; the material was of the same origin with exception of the latest fixations, of almost full-developed fruits, from the latter half of August; in this case the material was collected from cultivated trees in Lund.

As regards the general structure of the ovule, it should first be pointed out that the integuments here are somewhat different from those of *Quercus*. Whereas in this genus both integuments are about equally

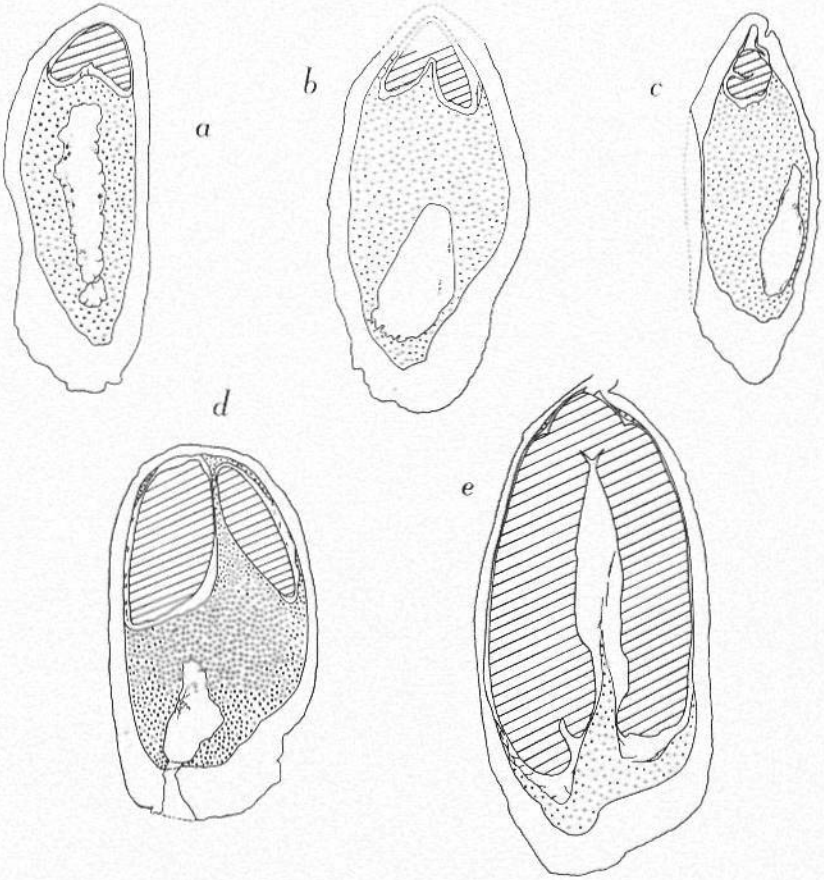


Fig. 2. *Quercus robur*, later endosperm and embryo development. *a*—*c* Ovules from 20/8 with large cellular tissue (dotted) and vacuoles of different size and position. *d* Later stage, still with a cavity. *e* The embryo (striated) fills almost the whole seed. — Enlargement c.×12.

developed, in *Fagus* the inner one is considerably shorter and thinner, irregularly folded and with papillate elevations on the surface (Fig. 3 *a*). The development may vary to some extent; the reduction is not always so strong as in the case figured, but obviously the inner integument is more or less reduced.

The earlier development of the embryo sac, until the formation of the mature embryo sac, was described by Benson (1894). As already stated by this author, there are in the mature embryo sac well-developed *caecum*-structures, as is also the case in *Quercus* (Benson, l.c.; Hjelmqvist, 1953). Such a *caecum* may already be observed in the early stage reproduced in Fig. 3 *a*—*b*. Here the antipodals may still be found in the embryo sac, and the polar nuclei have not yet fused. A vigorous prolongation, however, has already been formed and forces its way down in the nucellus at the side of the antipodals, which remain *in situ*. The polar nuclei, which obviously are on the point of fusing, are just migrating down in the *caecum*.

Later on this *caecum*-structure increases vigorously and the secondary nucleus, formed through the fusion of the polar nuclei, is often situated in its lower apex, where there usually is a dense mass of cytoplasm. After the division of the secondary nucleus gradually — as in *Quercus* — a large number of free endosperm nuclei arise in the embryo sac, whereas the egg-cell is still undivided. An earlier stage of this development is shown in Fig. 3 *c*, where there are at least about 20 endosperm nuclei. In the chalazal part of the embryo sac there is here a dense cytoplasm containing some nuclei that are closely clustered together (Fig. 3 *d*). These nuclei are very close to each other and two of them are much greater than normal size. Obviously it is a case of nuclear fusion: the two larger nuclei must have arisen through fusion and are now going to fuse with each other and with a third one. Such fusions are evidently — as in *Quercus* — not infrequent in the endosperm. In several cases, thus, cell nuclei of abnormal size with many nucleoli were observed, which obviously had arisen through fusion; they occurred especially in the basal part of the endosperm.

When the number of free nuclei has considerably increased, the wall formation in the endosperm gradually begins. It starts here somewhat earlier than in *Quercus*, in the middle of July in the investigated cases. In material from 16/7 1956, as well as from 17/7 1952, it was in several cases observed that cell formation had begun in the micropylar part of the endosperm, in some cases a small embryo was also seen here. One fixation (17/7 1952) showed a young embryo, built up of 6 cells; this embryo was surrounded by a few endosperm cells, the cell formation, thus, having recently begun in the embryo as well as in the endosperm, probably at about the same time.

The cell formation in the endosperm proceeds in *Fagus* after the same model as in *Quercus*, that is to say a calotte of thin-walled cells is at first formed in the micropylar part, which gradually increases downwards, and then cells are formed along the walls and at the base of the embryo sac. Fig. 4 *a*—a^1 shows an early stage: in the micropylar part a calotte of large cells has been formed, in the basal part no cell

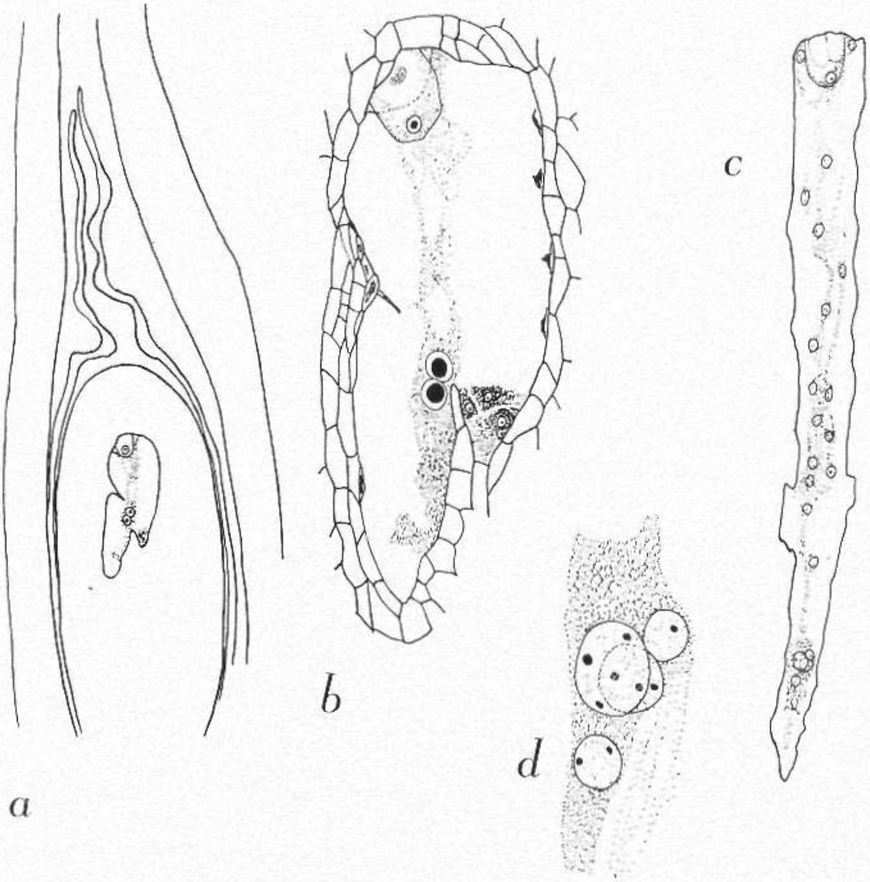


Fig. 3. *Fagus sylvatica. a* Ovule (7/7) with integuments and *caecum*-formation from the embryo sac. *b* Embryo sac from the same ovule in greater magnification, the polar nuclei just migrating down into the *caecum. c* Embryo sac with free endosperm nuclei and undivided egg-cell. At the base of the embryo sac nuclei in fusion, visible in greater magnification in Fig. 3 *d*. — *a* and *c* about×100, *b* and *d* more enlarged.

formation has yet taken place, but radially outgrowing cytoplasm rays have been formed from the nuclei, which sometimes meet between two nuclei that are close to each other; obviously this is a first development towards secondary spindles and cell wall formation.

The further development of the endosperm is evident from Fig. 4 *b*—*b*^{1}, which shows a later stage (from 6/8 1956), when the embryo has begun differentiating and primordia of the cotyledons appear. The cellular tissue in the upper part of the embryo sac now has enlarged so much that it fills up about the upper third; below it there is a large vacuole extending over more than half the embryo sac. This cavity is surrounded by a thin cell tissue along the walls, consisting of only 1—2 cell layers, and at the limit between this and the vacuole there are some free nuclei. In the base of the embryo sac cell formation has also taken place, but it is not yet completed and does not proceed regularly inwards but has a course that is somewhat irregular.

The further development of endosperm and embryo is shown in Fig. 4 *c*. In the ovule represented in the figure the embryo, now with two distinct cotyledons, has begun to increase vigorously dissolving the surrounding endosperm. The cell formation in the endosperm is now probably more or less completed; as visible there is a large vacuole in the lower part, considerably larger in relation to the endosperm than in *Quercus robur*. This vacuole is at the sides surrounded by a thin cell layer which in the basal part expands into a larger tissue. Fig. 4 *d* shows a later stage (6/8 1956) where the cotyledons of the embryo have begun to assume the folded condition characteristic of *Fagus*. The embryo now is so large that it almost reaches the large vacuole. The endosperm that surrounds the embryo is partly in dissolution and shows cavities and destroyed cell walls. After only a small further increase of the embryo the cavity surrounding it will be united with the large vacuole and the embryo will grow down into this.

In material that was fixed in the latter half of August the latest development was observed: the embryo now has increased so much that it fills practically the whole seed. In several slides from the fixation of August 20 it was observed that only inconsiderable rests of the endosperm were left at the base and apex and these were obviously in disintegration. Apparently the endosperm is comparatively better retained at the base. Fig. 4 *e* shows this part in a seed that otherwise is almost entirely filled by the embryo so that only a thin compressed endosperm layer remains in the periphery, which at the apex expands into a thicker layer. However in the basal part the cell structure is, as visible from the figure, still retained. Some cell nuclei in these cells, which, as frequently in this part, contained a larger number of nucleoli, had an irregular outline and were flattened or lobate (Fig. 4 *f*).

The endosperm formation of *Fagus sylvatica* thus agrees principally with that of *Quercus robur*. There is the difference that the cell formation as a rule does not proceed as far as in the latter species; the

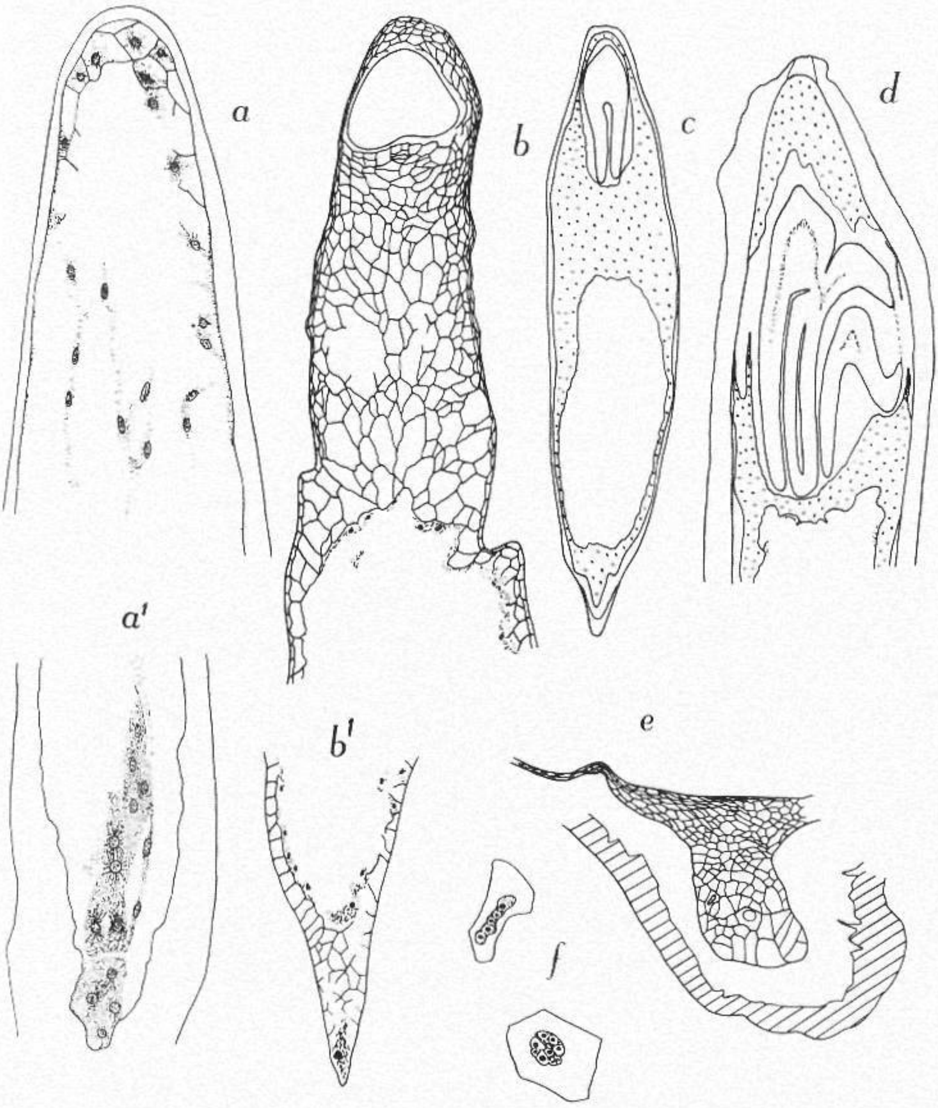


Fig. 4. *Fagus sylvatica.* Later endosperm and embryo development. *a*—a^1 Endosperm (17/7) with cell formation in the micropylar part and beginning of secondary spindle formation in the base of the same embryo sac. *b*—b^1 Later stage of endosperm formation (6/8), the micropylar part filled with cellular tissue, at the base (same embryo sac) incomplete wall formation and in the centre a large vacuole (more than one half of the embryo sac) with a thin cellular tissue along the walls. *c* Later endosperm with cellular tissue (dotted) and a large cavity. *d* The embryo has almost reached the large cavity. *e* Remnants of endosperm and nucellus (striated) at the base of an ovule, almost completely filled up by the embryo (20/8). In 4 *f* two cells from the same endosperm in greater enlargement. *a* c.×80, *b* and *e* c.×50 *c* and *d* c.×15.

remaining vacuole is generally considerably greater. There is, however, a certain variation in *Fagus sylvatica* in this respect; the vacuole is not always of the same great size. In an exceptional case it was particularly observed that almost the whole embryo sac was filled with cellular tissue, there were only a few comparatively small vacuoles; this probably, however, was an abnormal case, where the embryo was going to abort.

The genus *Nothofagus,* closely related to *Fagus*, has recently been investigated embryologically by Poole (1952), who gives some information also of the endosperm formation, whereas the investigations of Langdon (1947) are more purely morphological-anatomical. As regards the general structure of the ovule it is stated by Poole that in *Nothofagus* there is only one integument; the reduction of the inner integument that may be observed in *Fagus* thus has gone a step farther here, so that this integument has quite disappeared. The enlargement of the embryo sac by way of *caecum*-structures toward the chalaza is also mentioned, though the terminology is another: the remaining nucellar column below the antipodals is called a »postament». The endosperm is apparently formed in the same way as in *Fagus*: after a stage with free nuclei a large-celled tissue is formed in the periphery, which never completely fills the embryo sac, but leaves a big central vacuole. A difference compared with *Fagus* is that the embryo is said to develop before the endosperm.

3. Castanea sativa Mill.

The earlier embryo sac development of *Castanea sativa* was described by Benson (1894). In order to elucidate the later stages, fixations were made in the summer and autumn of 1956 of material from cultivated trees in the Botanical Garden of Lund. The species here in favourable conditions produces some ripe fruits, and also this year, in spite of the cold summer, some at least nearly ripe nuts were developed; embryos were also observed in several developing seeds.

In comparison with the conditions in *Quercus robur* and *Fagus sylvatica* the embryo- and endosperm-development of *Castanea sativa* is very late. In fixations from August 20 several embryo sacs with undivided secondary nucleus were observed; only exceptionally had the development proceeded farther. At this time the embryo sac had developed a vigorous *caecum*-prolongation and the secondary nucleus had migrated down in this. In one case (Fig. 5 *a*) the development had advanced a little farther: the secondary nucleus had divided into two nuclei and it was also observed that a male nucleus had reached the nucleus of the egg-cell.

The further development of the endosperm has not been followed so in detail as in the above-mentioned genera (partly because in earlier stages it was impossible at the fixation to separate the developing ovules from the numerous aborting ones), but sufficient material has been observed to elucidate the general development. In some slides from material of October 17 there occurred in the ovule, which now had increased vigorously in size, a large vacuole in the centre of the endosperm, which was surrounded by cellular tissue, somewhat thicker in the micropylar part. In one case it was observed that cells had been formed in well-delimited groups of a rounded or irregular shape; this may be a correspondence to the embryo-like structures that have been recorded for the endosperm of *Salix* and *Gale* (Håkansson, 1954, p. 330, 1955, p. 9).

The cell nuclei in the endosperm cells showed different sizes; some of them were considerably larger and had several nucleoli. This obviously depended on the fact that nuclear fusions also in this stage occurred between two or more nuclei in the same cell; aggregations of up to 10 nuclei might lie in a cell, partly in fusion (Fig. 5 *c*). In an endosperm nucleus a nuclear division was observed with a very great number of chromosomes, more than 100 in number. The chromosome number of *Castanea sativa* is n=12 (Tischler, 1950), and the nucleus observed was perhaps enneaploid (through a fusion of three triploid endosperm nuclei), perhaps the chromosome number was still greater; it could not be exactly determined.

In material from the middle of October (17/10) there were also, in some cases, large embryos. Fig. 5 *b* shows a such embryo, with well-developed cotyledons, which forces its way down almost to the middle of the embryo sac. The endosperm around the embryo has been dissolved, and also the remaining endosperm tissue has been pressed together; lacunes have arisen there as well as dense stripes of compressed tissue. However the original cavity in the centre can still be observed, having partly a rather regular wall. In *Castanea sativa* too the cell formation is thus incomplete in the endosperm.

Some observations were also made on the earlier stages of the embryo development of the investigated genera. An embryo of *Quercus robur* in an early stage is shown in Fig. 6 *a*—*b*. Here a suspensor cell has been detached and the embryo proper has divided into 8 cells. In one plane there are 4 crosswise arranged cells with smaller nuclei, which are delimited by an oblique wall from the rest of the embryo. In another plane there are 2 similar cells, also separated by an oblique wall from the remaining part of the embryo, which contains two large nuclei. If it is imagined that the embryo is turned 90 degrees, it must get the appearance shown in Fig. 6 *c*: the embryo proper has first been divided by an oblique wall and then by a second oblique wall more or less perpendicular to the former; the three cells which have arisen in this way are then further divided by walls in different planes. In Fig. 6 *d*, which shows a somewhat later stage, the primary oblique walls are directly visible. Besides the first two walls a third oblique wall has also been formed here, which has separated a cell at the side of the embryo; in addition further divisions of the original cells have also taken place here.

Fig. 6 *e*, showing one of the two sections in which an older embryo is divided, still exhibits the oblique wall system in the embryo. However it is evident that the development does not follow any strict scheme but may vary to a great extent.

The suspensor in these young embryos is still 1-celled, whereas in *Quercus velutina* (Conrad, 1900) and *Q. prinus* (Vecchierello, 1928) it is said to be 2-celled. In a later stage (material of 3/8 1955), when the embryo is multicellular, oblong and flattened above, though no cotyledons are yet visible, the suspensor has however a changed appearance. It now is made up of several cells and forms a small tap protruding from the rounded embryo (Fig. 6 *f*—*h*). This suspensor scarcely can have arisen from the original suspensor cell, the nucleus of which early shows signs of degeneration, but has certainly developed from the embryo proper, as a »secondary suspensor».

The meristems of the radicle in *Quercus prinus* were investigated by Vecchierello (1928), who found that they on the whole are of the same type as in the Gymnosperms (p. 57: »the root of *Quercus prinus* at this stage of full development has all or practically all the characteristics which typify the apical root-development of the Gymnosperms»). Especially it may be mentioned that the periblem originates from an apical meristem of several cell layers, which downwards also gives rise to the root cap.

The earlier development of the *Fagus* embryo is reminiscent of the conditions in *Quercus*. Fig. 6 *i* shows a 6-celled embryo, where a suspensor cell has been detached and the embryo proper has been

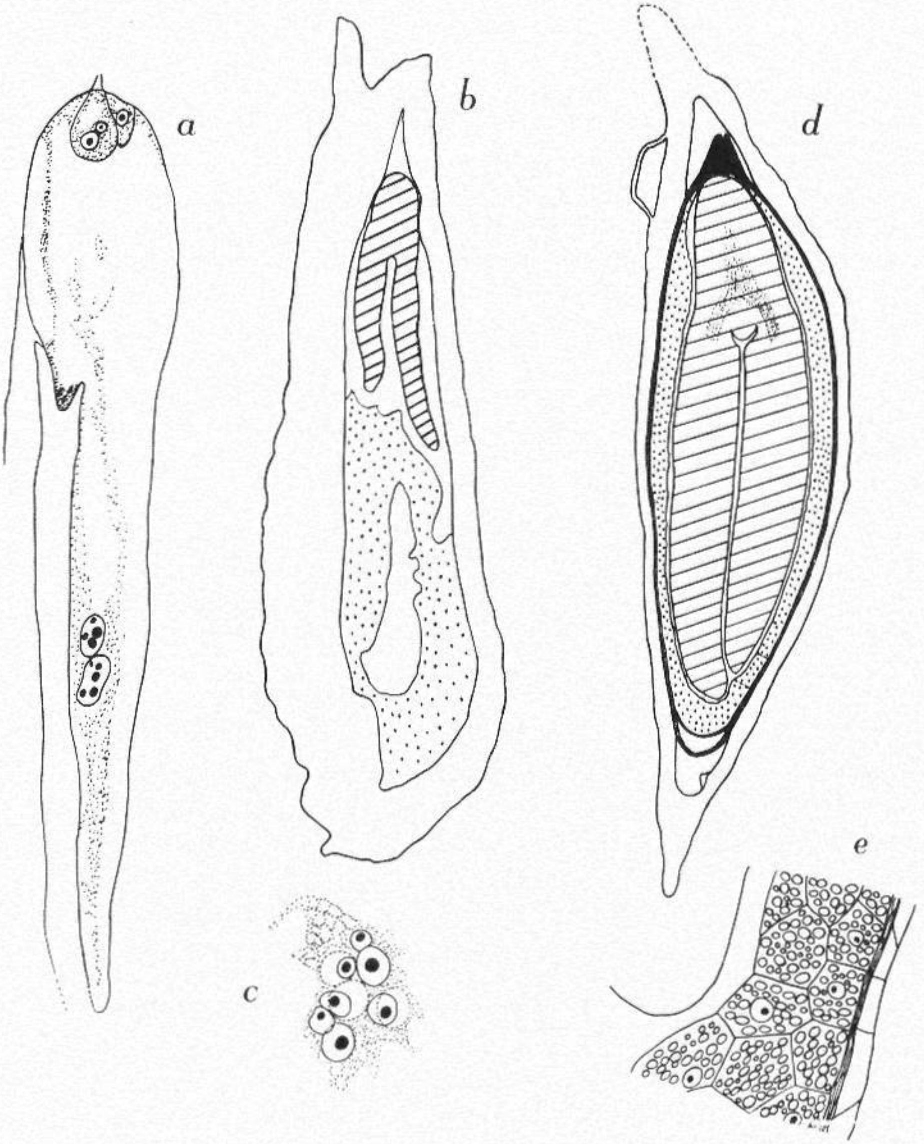


Fig. 5. *a Castanea sativa*, embryo sac (20/8) with large prolongation, containing two big endosperm nuclei. In the egg cell a sperm nucleus, the antipodals degenerating. *b* The same, seed (17/10) with a large embryo, penetrating in and dissolving the endosperm tissue (dotted), which has a great cavity in the lower part. *c* The same, nuclei from a large endosperm cell, partly in fusion, *d Betula nana*, longitudinal section of fruit and seed. The embryo is surrounded by nutritive endosperm tissue (dotted). Testa black, *e* Part of the endosperm in 5 *d* (between the striated lines) in greater enlargement. The cells filled with aleurone grains. — *a* c.×200, *b* c.×15, *d* c.×50, *c* and *e* more enlarged.

divided by an oblique and somewhat valvate wall, after which a second similar wall has been formed at a rather acute angle to this. A smaller cell has apparently in addition been cut off at the base; of the three other cells formed in the embryo proper one has obviously been divided by a transverse wall.

A later stage in the embryo development is seen in Fig. 6 *k* (material of 17/7). Here the big suspensor cell has divided into two cells, the one partly behind the other, and in the embryo proper divisions also have taken place, so that the cell number is about 12 (all not visible in the figure, as the embryo was divided into two sections). The original oblique walls are still visible, though the wall system does not quite agree with that of the above-mentioned embryo; the development is here also variable. Only in one of the suspensor cells was a nucleus visible, which was in degeneration.

A later stage is shown in Fig. 6 *l*—*m*. The embryo is here multicellular but still undifferentiated, of oblong, rounded shape. At the base there is a small, protruding suspensor, consisting of two cells, one lager and one smaller one. Apparently these two cells, with their vital nuclei, do not correspond to the original suspensor but have arisen from the embryo part close to this, while the primary suspensor cells have been superseded.

Fig. 6 *n* shows a later stage, from an embryo with two narrow cotyledons. The suspensor (which is divided into two sections) is made up of several cells which form a small protruding tap, in the same way as in the older embryo of *Quercus*. The cell division is still in progress. Towards the rest of the embryo the limit is undistinct. Owing to the changed appearance and the late development of this suspensor it may be called a secondary suspensor.

The meristems in the radicle of *Fagus sylvatica* have been described by Clowes (1950). Their complicated arrangement, issuing from a promeristem, is held by Esau (1953) to be in principle the same as in *Pseudotsuga*; in any case there are also here great agreements with the Gymnosperms. A similar arrangement is also found, according to the observations of the present writer, in the embryo of *Castanea sativa*, which already was referred by Flahult (1878) to the same type as *Fagus*.

The embryo development of *Nothofagus* has been touched upon by Poole (1952). According to this author the zygote is severed by a transverse wall and then the basal cell is divided by a longitudinal wall, the apical one by way of »irregular division». No true suspensor was

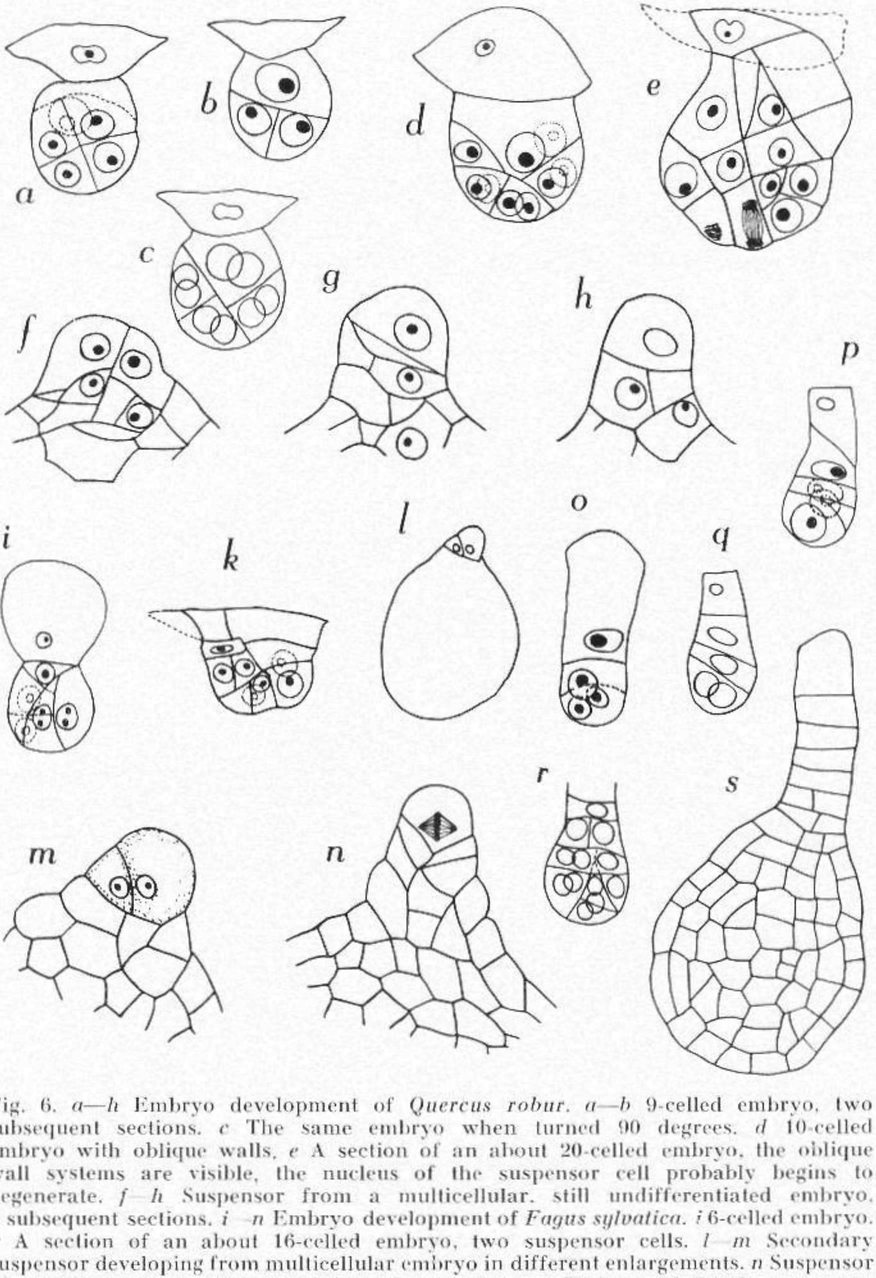


Fig. 6. *a—h* Embryo development of *Quercus robur*. *a—b* 9-celled embryo, two subsequent sections. *c* The same embryo when turned 90 degrees. *d* 10-celled embryo with oblique walls. *e* A section of an about 20-celled embryo, the oblique wall systems are visible, the nucleus of the suspensor cell probably begins to degenerate. *f—h* Suspensor from a multicellular, still undifferentiated embryo, 3 subsequent sections. *i—n* Embryo development of *Fagus sylvatica*. *i* 6-celled embryo. *k* A section of an about 16-celled embryo, two suspensor cells. *l—m* Secondary suspensor developing from multicellular embryo in different enlargements. *n* Suspensor of an older embryo with cotyledons developed. *o—s* Embryo of *Betula verrucosa*. *o* 4-celled embryo. *p* 5-celled embryo. *q* The same embryo when turned 90 degrees. *r* Embryo with several cells. *s* Older embryo with well-developed suspensor and hypophyse. — Enlargement about ×470, except 6 *l*, about ×200.

observed. Probably this account implies that the development is about the same as in *Fagus*.

Summarizing, it may thus be said that the endosperm of the Fagacean genera investigated is characterized by the formation of a great number of free nuclei and a subsequent cell formation, beginning in the micropylar part and proceeding centripetally, yet always leaving a central cavity in the embryo sac. If it is true that the total cell formation is more primitive than the partial one (cf. Håkansson, 1954, p. 331), then the endosperm conditions of *Fagaceae* are in good agreement with the assumptions that for other reasons have been made about the position of the genera. *Quercus*, which is to be considered more primitive, has almost complete tissue formation in the endosperm, in *Castanea*, which appears somewhat more advanced, the cell formation does not proceed so far, and the comparatively derived genera *Fagus* and *Nothofagus* have a very incomplete tissue formation. On the other hand, the embryo formation, as far as it has been investigated, is of a type that does not fit into any scheme; there is no regular sequence of transverse and longitudinal walls, as in the types of Souèges, but the embryo is characterized by oblique walls and shows, moreover, a rather great variability. A peculiar feature is the secondary suspensor which is formed in a later stage of the embryo development.

A comparison of the endosperm and embryo formation with the other orders which have been regarded as related to *Fagales*, and sometimes together with this order have been designated as *Amentiferae*, shows some interesting facts. To begin with the order *Juglandales*, with *Myricaceae* and *Juglandaceae*, the conditions here are best known in the family *Juglandaceae*, on which several special investigations have been made (Langdon, 1934; Nast, 1935, 1941; Mc Kay, 1947). From these it is evident that in the endosperm formation, as in *Fagales*, a great number of free nuclei at first arises and that subsequently cell formation takes place in a centripetal development. In *Juglans* (Nast, 1941) the cell formation is said to begin in the micropylar part as in *Fagales*; in *Carya* it is stated to emanate from the chalaza (Mc Kay, 1947); the latter statement has been doubted, as a such development is very unusual. As is the case in *Fagales*, the endosperm is never quite cellular, but a central vacuole remains. The embryo formation (Lagndon, 1934; Nast, 1941) agrees with the one observed in *Fagales* with regard to the facts that the embryo is generally divided by oblique walls and that, moreover, a great variation occurs, as has been shown in detail by Nast (1941) for *Juglans regia*. A difference is that here no primary suspensor cell is detached by a transverse wall; in *Juglandaceae* it is thus the embryo in its entirety which is divided by oblique walls, whereas in *Fagales* it is the terminal cell. The meristem system in the root part of the embryo appears, according to the descriptions of Neumann (1939) and Nast (l.c.), to agree with that one of *Fagales*. — The family *Myricaceae* is not equally thoroughly investigated; as to the endosperm there is however the statement that it in *Gale palustris* shows a complete tissue formation (Håkansson, 1955); otherwise it is in its general development reminiscent of *Juglandaceae*. Further investigations of the other genera of *Myricaceae* are desirable; especially it would be of interest to know the embryological conditions in the genus *Canacomyrica*, a deviating and apparently primitive genus, which has been referred by Leroy (1949; 1955, p. 215) to a subfamily of its own.[1]

The agreements found between *Fagales* and *Juglandales* in endosperm and embryo development confirm the mutual affinity between these two orders.

The order *Betulales*, which earlier has been united with *Fagales*, is not investigated as to endosperm and embryo development. On this account some observations were made on material of *Betula verrucosa* and *nana*, of Swedish origin. The development of the endosperm resembled in its general features the conditions in *Fagales* (a more detailed account is prepared by professor A. Håkansson), but there is the important difference that, contrary to the statements in the literature, it forms in *Betula* a persisting nutritive tissue around the fully developed embryo. This tissue consists of 2—4 cell layers round the greater part of the embryo; only at the radicle is it tapering (Fig. 5 *d*—*e*). The cells, like those of the embryo, are filled with aleurone grains, which as a rule are heavily stained with haematoxylin, eosin and picric acid. This nutritive tissue was observed in *Betula verrucosa* and *nana*, and likewise in *Alnus glutinosa*; in *Carpinus betulus* it is apparently also present, though the material of this species was poor and more thorough investigations are needed of *Corylaceae*. Also some stages of the embryo development were observed in *Betula verrucosa* (some of them belong to material placed to my disposal through the courtesy of professor A. Håkansson). As is evident from Fig. 6 *o*—*s*, the embryo formation differs rather greatly from that observed in *Fagales*. The first transverse walls are a little oblique, it is true, and an

---

[1] The investigation of Yen (1950) on the floral morphology and anatomy of *Myrica rubra* gives no detailed account of the endosperm development.

apical sector is formed, delimited by oblique walls (Fig. 6 *r*), but otherwise the walls have a normal transverse or longitudinal arrangement, and there is a vigorous suspensor, made up of several cells, and a hypophyse (Fig. 6 *s*). The embryo here can rather well be referred to the *Astereae* type. A certain similarity exists to the embryo of *Casuarina* (Swamy, 1948), which, however, is referred to the *Cruciferae* type, as the basal cell is stated to take only inconsiderable part in the formation of the embryo proper.

The great differences that are found in endosperm as well as embryo formation between *Fagales* and *Betulales* corroborate that the two orders are not so closely related as was earlier assumed and strongly support the opinion of the present writer (1948) that they should be regarded as separate orders.

Through the occurrence of a persistent nutritive tissue formed by the endosperm the order *Betulales* forms a transition to the order *Leitneriales,* which otherwise is often regarded as deviating from the other *Amentiferae* in the possession of endosperm, as well as perisperm, in the ripe seeds. Also the perisperm occurrence, which according to Pfeiffer (1912) only forms a thin layer, does not imply a very great deviation. For instance in *Fagus* in late stages of the embryo development remnants of the nucellus may remain at the base of the ovule (cf. Fig. 4 *e*); the difference is thus only that these rests in *Leitneria* remain somewhat longer and surround the whole embryo. The embryo of *Leitneria* (Pfeiffer, l.c.) shows in addition by its oblique walls and irregular cell formation a great agreement with the conditions occurring for instance in *Juglandaceae*.

The order *Balanopsidales* has, like *Betulales* and *Leitneriales,* persistent endosperm in the seeds, but the embryological conditions are otherwise almost unknown, owing to the difficulty of procuring material, and it is hardly possible to draw any systematical conclusions from the embryology.

Finally, as regards the order *Salicales,* there is in the endosperm development of *Salix* (Håkansson, 1954) a great agreement with the conditions in *Fagales.* The development is more rapid, but the succession of nuclear and cell divisions is very suggestive of for instance *Fagus,* though the cell formation in *Salix* is more incomplete; nuclear fusions also occur (Håkansson, oral communication). For *Populus* it is stated that the endosperm completely fills the central cavity, but the picture that is meant to show this (Nagaraj, 1952, Fig. 83) is not fully convincing: in a stage when the embryo is of a rather advanced development, cell formation is only found in the outermost periphery of the endosperm; thus it appears improbable that the endosperm will be completely filled by cellular tissue. The statement that *Populus* has a complete cell formation in the endosperm has been quoted in support of the opinion that this genus should be more primitive than *Salix*; a confirmation however is needed before this can be done, as there are several important reasons speaking against this opinion (cf. Hjelmqvist, 1948), i.a., also the pollen morphology (Erdtman, in letter).

The embryo development, as it has been described for *Salix* by Souèges (1923) and for *Populus* by Nagaraj (1952), is greatly divergent from the conditions in *Fagales* and agrees with more "normal" conditions; at least *Salix* belongs to the *Astereae* type, the *Polygonum* variation (Souèges, l.c.). However it should be remembered that Chamberlain (1897) in *Salix* in some cases has found a cell formation by means of oblique walls, which cut off an apical sector. In these cases there is a great likeness to the embryo of *Betula* and thus we get a transition from the irregular type in *Fagales* and *Juglandales* over *Betulales* to the order *Salicales*, which in different respects is rather strongly derived from the other orders but yet shows an obvious connection with them.

The endosperm and embryo development thus give some contributions to the systematics of the *Amentiferae* and elucidate to some extent the relationships of the different orders. When, on the other hand, it comes to the question of the common systematical position of the whole group, it is, of course, difficult to base an opinion only on these characters. It is not known with certainty which characters, for instance in the endosperm formation, are primitive and which are derived. Håkansson (1954) obviously is of the opinion that a nuclear endosperm with a complete cell formation is to be regarded as more primitive than the type where cell formation is incomplete, such as it occurs at least in many of the *Amentiferae*. It is possible that this is the case, but it must then be pointed out that a development from complete to incomplete cell formation occurs already in the Gymnosperms, where in *Gnetales* we have instances of the latter. That the same character occurs in the *Amentiferae* is thus no proof against the primitiveness of the group: it agrees in this respect with a Gymnosperm group, with which there also are some additional resemblances in the endosperm, such as the nuclear fusions occurring both in the common endosperm room and in the separate cells (cf. Battaglia, 1951). As regards the organization of the embryo there are also some similarities between the types occurring in *Fagales* and *Juglandales* and the Gymnosperms. The peculiar division by means of oblique walls in the beginning of the development may be reminiscent of the growth by an apical cell temporarily occurring in the embryo of some Gymnosperms (see Johansen, 1950). In the development of the root meristems there are also, as mentioned, great agreements with the Gymnosperms, whereas the similarity with some *Leguminosae,* judging from the investigations of Neumann (1939), apparently are incomplete. Thus it appears as if there were nothing in the endosperm and embryo development speaking against the opinion that the *Amentiferae* are of a primitive nature but some facts supporting such a view.

In a recent publication Constance (1955) has criticized the opinion held by some authors, among them the present writer, that the orders designated as *Amentiferae* are a primitive group. The embryological resemblances that are found with the Gymnosperms are regarded by this author as partly very superficial, partly due to analogies, and especially with regard to the syncarpy and epigyny occurring in the group he is of the opinion, with reference to several authors, that it is a case of reduction of advanced types. To this may be said that hypogyny and epigyny often occur in the same group (this also in the *Amentiferae*), even in the same order or family, and that the same is true of apocarpy and syncarpy; these characters thus do not give any certain guidance for placing a group in the system. It may further be pointed out that also among the Gymnosperms coalescence often occurs between different organs in the floral region; this can thus also appear in primitive groups. As regards, then, those embryological conditions that are held to indicate primitiveness, the present writer must admit that he regards them as partly very important. The more essential embryological characters must be of great systematical importance, partly because they refer to early developmental stages, which are specially elucidating for the phylogeny, partly because they are very slightly influenced by external conditions. It is true that certain embryological conditions, as the aforementioned agreements in endosperm development between the *Amentiferae* and some Gymnosperms, have no greater importance, as similar conditions are found in many other groups (though some details may not be common there). But for instance such a feature as the branching of the pollen tube, sometimes resulting in a whole cluster of branches, and the long time from pollination to fecundation, sometimes a whole year, must be of systematical importance. It implies that the haploid generation has a comparatively great independence, and as the development from Gymnosperms to Angiosperms involves a reduction of the gametophyte, this must be held to be a primitive character. Also in the embryo organization there are, as mentioned above, in *Fagales* some connections to the Gymnosperms, and also the lability in the cell formation of the embryo, from which a development is conceivable in different directions, must be a primitive feature. Other embryological characters, which are usually regarded as primitive, have also isolated occurrences within other groups, but the combined occurrence of several such characters among the *Amentiferae* can scarcely be due to a chance but must speak in favour of the view that the group has an original position.

Conclusions

1. In the nuclear endosperm of *Quercus, Fagus,* and *Castanea* cell formation begins at a late stage and the cellular tissue never fills the endosperm completely, but a small vacuole is left in *Quercus,* a large one in *Fagus,* while *Castanea* is intermediary. Nuclear fusions occur both in the common endosperm room and in the separate cells.

2. In the embryo development of *Quercus* and *Fagus* a basal suspensor cell is detached, which in *Fagus* divides once, and the embryo proper is divided by oblique wall systems in a rather irregular way. At a late stage a "secondary suspensor" is formed. The radicle meristems of these genera are, as found by earlier investigators, reminiscent of those of the Gymnosperms, and in *Castanea* the conditions are similar.

3. The order *Betulales* differs sharply from *Fagales* in having a persistent nutritive endosperm tissue; in the genus *Betula* it was also observed that the embryo was of another, more regular type, with well-developed suspensor and hypophyse.

4. The embryological differences between *Fagales* and *Betulales* give support to the view that they should be regarded as separate, though related orders. Similarities in endosperm and embryo development between *Fagales* and *Juglandales* confirm the affinity of these two orders. To the orders *Leitneriales* and *Balanopsidales,* with persistent endosperm, *Betulales* to some extent may form a transition. The order *Salicales* has the same general endosperm development as *Fagales,*

but the embryo is deviating; however through the embryo type of *Betulales* there may be a connection.

5. There are no features in the endosperm and embryo development speaking against the opinion that the *Amentiferae* have a primitive nature. On the contrary, the embryo has some features that are reminiscent of the Gymnosperms, and in addition its irregular development (in *Fagales*, *Juglandales*, and *Leitneriales*) may be a primitive feature. Thus the view, partly based on embryological facts, that the *Amentiferae* are a primitive group, is further supported by the embryogeny.

References

BATTAGLIA, A., The male and female gametophytes of Angiosperms — an interpretation. — Phytomorphology 1, 1951, p. 87.

BENSON, MARGARET, Contributions to the embryology of the Amentiferae. I. — Trans. Linn. Soc. London, 2nd Ser., 3, p. 409.

CHAMBERLAIN, C. J., Contribution to the life history of Salix. — Bot. Gaz. 23, 1897, p. 147.

CLOWES, F. A. L., Root apical meristems of Fagus sylvatica. — New Phytologist 49, 1950, p. 248.

CONRAD, A. H., A contribution to the life history of Quercus. — Bot. Gaz. 29, 1900, p. 408.

CONSTANCE, L., The systematics of the Angiosperms. — A century of progress in the natural sciences 1853—1953. Calif. Acad. of Sci. S. Francisco 1955, p. 405.

ESAU, KATHERINE, Plant anatomy. — New York and London 1953.

FLAHAULT, C., Recherches sur l'accroissement terminal de la racine chez les phanérogames. — Ann. des Sci. Nat. 6e Sér. Bot. T. 6, Paris 1878. (Diss.)

HJELMQVIST, H., Studies on the floral morphology and phylogeny of the Amentiferae. — Bot. Notiser. Suppl. 2: 1, Lund 1948.

— The embryo sac development of Quercus robur L. — Phytomorphology 3, 1953, p. 377.

HÅKANSSON, A., Endosperm formation in Salix. — Bot. Notiser 1954, p. 326.

— Endosperm formation in Myrica gale L. — Bot. Notiser 108, 1955, p. 6.

JOHANSEN, D. A., Plant embryology. — Waltham, Mass. 1950.

LANGDON, LADEMA M., Embryogeny of Carya and Juglans, a comparative study. — Bot. Gaz. 96: 1, 1934, p. 93.

— The comparative morphology of the Fagaceae. I. The genus Nothofagus. — Bot. Gaz. 108: 3, 1947, p. 350.

LEROY, J. F., De la morphologie florale et de la classification des Myricaceae. — Comptes rendus hebdom. séances Ac. Sci. Paris 229, 1949, p. 1162.

— Étude sur les Juglandaceae. À la recherche d'une conception morphologique de la fleur femelle et du fruit. — Mém. Mus. Nat. Hist. Natur. N. Sér. B: 6. Paris 1955.

MC KAY, J. W., Embryology of Pecan. — Journ. Agricult. Res. 74: 9—10, 1947, p. 263.

NAGARAJ, M., Floral morphology of Populus deltoides and P. tremuloides. — Bot. Gaz. 114: 2, 1952, p. 222.

NAST, CHARLOTTE G., Morphological development of the fruit of Juglans regia. — Hilgardia 9, 1935, p. 345.

— The embryogeny and seedling morphology of Juglans regia L. — Lilloa 6, 1941, p. 163.

NEUMANN, O., Über die Bildung der Wurzelhaube bei Juglans, Mimosa und Lupinus. — Planta 30: 1, 1939, p. 1.

PFEIFFER, WANDA M., The morphology of Leitneria floridana. — Bot. Gaz. 53: 3, 1912, p. 189.

POOLE, A. L., The development of Nothofagus seed. — Trans. R. Soc. New Zeal. 80: 2. 1952, p. 207.

SOUÈGES, R., Embryogénie des Salicacées. Developpement de l'embryon chez le Salix triandra L. — Comptes rendus hebdom. séances Ac. Sci. Paris 177, 1923, p. 1234.

SWAMY, B. G. L., A contribution to the life history of Casuarina. — Proc. Amer. Ac. Arts and Sci. 77, 1948, p. 1.

TISCHLER, G., Die Chromosomenzahlen der Gefässpflanzen Mitteleuropas. — 's-Gravenhage 1950.

VECCHIERELLO, H., A study of the origin and development of the radicle histogens of Quercus prinus L. — Biol. ser. Cath. Univ. Amer. 8, Washington 1928. (Diss.)

YEN, TSU-KIANG, Structure and development of the flower and the fruit of Myrica rubra, Sieb. & Zucc. — Peking Natur. Hist. Bull. 19, 1950, p. 2.

Botaniska Notiser 1957 · Vol. 110 · Fasc. 2 · Lund

Notes on the Giant Chromosomes of Allium nutans

By Artur Håkansson

(Institute of genetics, Lund)

Our knowledge of the mode of formation and of structure of very large nuclei has been largely increased through the investigations of Lothar Geitler and his coworkers. In many tissues the nuclei after termination of mitotic activity undergo a considerable enlargement. In many cases this was shown to depend on endomitosis, repeated divisions of the chromosomes within the intact nuclear membrane; the result is high polyploidy, endopolyploidy. Some of the huge nuclei of certain special cells of a glandular or haustorial nature have been shown to possess chromosomes of highly increased size and of complicate structure. The chromosomes have repeatedly divided but incompletely, the different strands being held together. Thus such polytene chromosomes are very thick and through a large elongation of the strands they become "giant" chromosomes.

Observed are the giant chromosomes because the nuclei are in prophase; a metaphase stage does not follow. However, Brink and Cooper (1943) in dividing antipodals of *Hordeum jubatum*, in embryo sacs fertilized by rye sperms, observed the haploid number (14) of "giant" chromosomes in some divisions, in other a very high number of chromosomes of ordinary size. Hasitschka (1956) investigated more than 3000 of the large antipodals of *Papaver rhoeas*. She observed only one cell with mitosis, which was 128-ploid and had chromosomes of ordinary size. "Ruhekerne" showed five different structure types, one of them was seven "giant" chromosomes, bundles of despiralized chromosomes with a large, undivided, heterochromatic part in the centromere region. Tschermak-Woess (1956) reports that the nuclei of the wellknown giant antipodals of *Aconitum* increase in size through endomitosis causing a high degree of polyploidy; however, a small number of nuclei have the haploid number of giant chromosomes. As in *Papaver* they showed a tenfold increase in length, compared with normal metaphase chromosomes, and consisted of different strands, they here showed "eine kabelaktige Bündelung". Nuclei with doubled or trebled chromosome number have been observed in many endosperms, generally they have arisen after mitotic disturbances or, more rarely, endomitosis. Only a few cases of giant chromosomes have been reported. In the sickly endosperm of *Brassica oleracea,* which was formed after pollination with autotetraploid plants, very large endosperm nuclei were frequent; some of them showed prophase with enlarged chromosomes in the triploid number, other endopolyploidy with normal chromosome size (Håkansson, 1956). A closer study of enlarged nuclei in the endosperm of *Zea mays* was made by Duncan and Ross (1950); they seemed to have very enlarged chromosomes. Geitler (1955) has in *Allium ursinum* observed very large hexaploid nuclei in chalaza directed parts of the endosperm. Certain of the nuclei underwent a still higher increase in size; he found evidence that the latter contained giant chromosomes. Geitler also studied the structure of degenerating giant nuclei. The related *Nothoscordum fragrans* also has endosperm nuclei with doubled chromosome number near the chalaza (Håkansson, 1953).

In *Allium* one of the synergids regularly becomes very large, also the nucleus enlarges highly and has soon a dense content. During my study of parthenogenesis in *A. nutans* (Håkansson, 1950) I also investigated very old embryo sacs of emasculated flowers, where interesting anomalies occurred. In some hypertrophied synergid nuclei giant chromosomes were observed (compare Fig. 4 in this paper). During my work with *A. nutans* and *A. odorum* I have made further observations of enlarged chromosomes; synergidal changes were rather similar in the two species, but only the giant chromosomes in *A. nutans* will be described.

Such synergids which remain small, have soon a highly chromatical nucleus where no structures are visible. The large synergid nucleus also gets a dense structure during a long period of growth. Probably the changes within the nucleus take various courses. In embryo sacs with beginning embryo formation, which occurs through parthenogenesis, the synergid nucleus often becomes less dense; it could often be observed that the nucleus was in early prophase, consisting of very folded chromosomes which were rather broad and formed of several strands. The chromosomes had been closely packed previously, but now it was

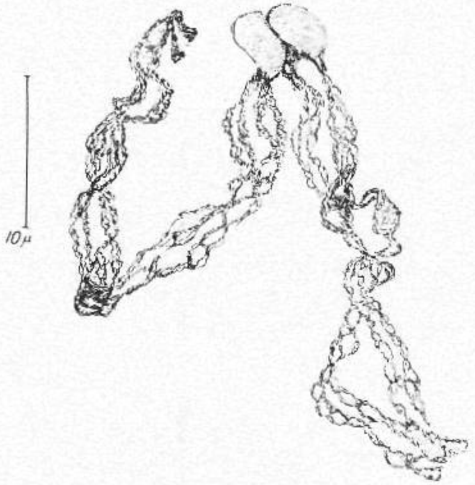


Fig. 1. Giant chromosome from a synergid nucleus of *Allium nutans*.

evident that the nucleus had enlarged, polytene chromosomes with cable structure. Fig. 2 and 3 show nuclei of similar appearance. That the chromosomes have a considerable length was seen in cases of cuts which showed the surface of the nucleus. The embryo sac has the zygoid chromosome number, that is 42. I have suggested that the large synergid nucleus is polyploid; Geitler thinks that in *A. ursinum* the nucleus surely was endopolyploid. Any metaphase which as in *Avena* and *Papaver* could prove polyploidy was not observed, however. Sometimes the nucleus contains true giant chromosomes. One such chromosome is separately drawn in Fig. 1 at a high magnification. The chromosome has several pecularities in common with the giant chromosomes mentioned above. It is very thick consisting of eight subsections. It has a cable structure where the primary strands, formed through the first division, here and there show larger loops. One short part of the chromosome is homogenous showing no fibre structure. It is probable that here heterochromatic segments including the centromere are visible.

Synergid nuclei of the appearance shown in Fig. 3 were also observed in *A. odorum* and here also in fertilized embryo sacs with some endosperm nuclei; the third increase in size observed in *nutans* after three or four weeks in ovaries of emasculated flowers was not observed in this species. Such hypertrophied nuclei are rare, though once two were observed in an ovary where the rest of the ovules were degenerated. Fig. 4 shows such an old nucleus. The synergid has lost its wall and original position and moved below the embryo, which counted in all

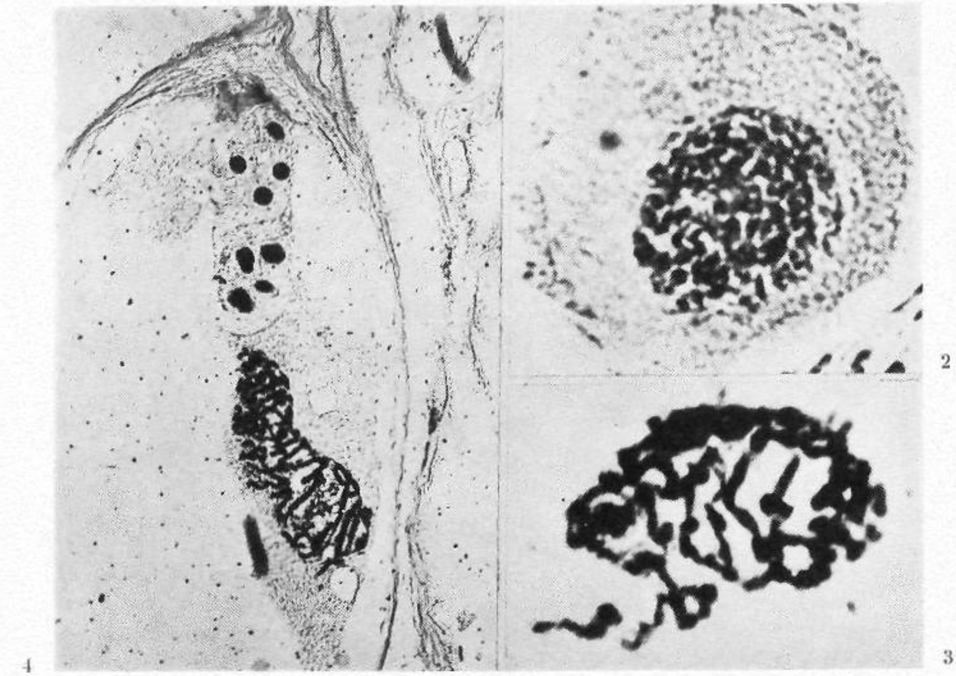


Fig. 2—4. Synergids of *A. nutans*. 2: synergid at the time of early stages of embryo formation. ×410. — 3: ditto, ×540. — 4: embryo and synergid in an old embryo sac from the ovary of a flower four weeks after emasculation. — ×140.

50 cells. The nucleus is very large, being easily observed with a magnifying glass; its length was nearly a quarter of a millimeter. There is now more "caryolymph" in the nucleus indicating an uptake of water. During the expansion of the nuclear membrane the chromosomes become more stretched but their polytene structure was in most cases distinct. The ends of different chromosomes often must be fused, because one rarely observes free ends. The nucleus figured also contained a nucleolus, other such nuclei had more nucleoles; some undifferentiated substance was no doubt a product of the senescence of the nucleus.

Some degenerating nuclei had a dense structure of fine threads, giving the impression, that the strands of giant chromosomes had separated. Geitler (l.c.) has made similar observations in old giant endosperm nuclei of *Allium ursinum*, which he interpreted in this way. Other degenerating nuclei in *A. nutans* had giant chromosomes which had completely lost any structure; they seemed to have been semiliquid which in one case was proved by the irregular contour of the chromosomes.

It is now clear, that many large synergid nuclei contain very large, polytene chromosomes with cable structure, similar to giant chromosomes described in recent publications on giant antipodal and endosperm nuclei.

Literature cited

BRINK, R. A. and COOPER, D. C. 1943. The antipodals in abnormal endosperm behaviour in *Hordeum jubatum* × *Secale cereale* hybrid seeds. — Genetics, 24.

DUNCAN, R. and ROSS, J. B. 1950. Nuclei of maize endosperm. — J. Heredity, 41.

GEITLER, L. 1955. Riesenkerne in Endosperm von *Allium ursinum*. — Öst. Bot. Zeitschr. 102.

HASITSCHKA, G. 1956. Bildung von Chromosomenbündeln nach Art der Speicheldrüsenchromosomen, spiralisierte Ruhekernchromosomen und anderen Struktureigentümlichkeiten in den endopolyploiden Riesenkernen der Antipoden von *Papaver rhoeas*. — Chromosoma, 8.

HÅKANSSON, A. 1950. Parthenogenesis in *Allium*. — Botaniska Notiser, 1950.

— 1953. Die Samenbildung von *Nothoscordum fragrans*. — Botaniska Notiser, 1953.

— 1956. Seed development of *Brassica oleracea* and *B. rapa* after certain reciprocal pollinations. — Hereditas, 42.

TSCHERMAK-WOESS, E. 1956. Notizen über die Riesenkerne und "Riesenchromosomen" in den Antipoden von *Aconitum*. — Chromosoma, 8.

Botaniska Notiser 1957 · Vol. 110 · Fasc. 2 · Lund

Notes on Endosperm Formation in Betula

By Artur Håkansson

(Institute of genetics, Lund)

Notwithstanding their general occurrence, contested systematical position among dicotyledons and economic importance, our knowledge of the embryology of many members of *Amentiferae* shows large lacunes. The seeds have generally been described as endosperm-less, which means, that the endosperm formed is destroyed by the growing embryo finally filling the seed, but the development and appearance of this endosperm is with certain exceptions unknown. As a rule only the earliest stages of the endosperm have been observed, which show free nuclei, that is, development occurs after the Nuclear type. Previously I have investigated endosperm development in *Salix* (1954) and *Myrica* (1955) more closely, last summer (1956) I fixed parts of catkins of *Betula verrucosa*.

The ovule of *Betulaceae* has a rather large nucellus and one integument with a rather short, straight micropylar canal which is not used by the pollen tube. The latter was shown by Nawaschin rather long ago, he has also described the development of nucellus and embryo sac before fertilization. Benson in the same year (1894) published contributions to the embryology of *Amentiferae* where also one finds some notes on *Betula*. Peculiar is a statement, "die eigentliche Schicht- oder Tapetenzelle wird also hier nicht abgeschnitten" (Nawaschin, 1894). Thus the cell layers above emc and embryo sac should be entirely of epidermal origin and cover cells lacking. This deserves a reinvestigation, however, the fine figures hardly prove absence of cover cells. There was usually one emc forming macrospores, the innermost growing to normal embryo sac. Thus Normal type of embryo sac development seems to occur in birch.

Benson found slightly more than four weeks between pollination and fertilization in *Betula*, ovules being very undeveloped at pollination.

Development of the vegetation being very slow in 1956, fixations were made for the first time on the 22/6. Some unfertilized ovules showed that in the embryo sac the polar nuclei had united to a central nucleus, while the antipodal cells had disappeared. Fertilized ovules had attained rather different size. Clearly fertilization induces a rapid growth, but it occurs at somewhat different time. A few ovules contained an undivided egg and endosperm nuclei, but generally a small embryo was present with an increasing number of free endosperm nuclei (Fig. 1). The embryo sac was still within the rather large nucellus, but as the endosperm grows, it encroaches on the lateral parts of the nucellus which disappear. The base of nucellus persists as well as the uppermost part, the latter is, however, less permanent. Then the endosperm tissue has been completed.

Before cell formation one often observes two free nuclei close to the embryo, and already in the earliest fixation and in most advanced ovules some large vacuolate endosperm cells could be observed around the small embryo. Similar observations have been made in *Salix*. In material fixed some days later one could observe a layer of small endosperm cells surrounding the large vacuole, free nuclei had previously taken position near the wall and cells had been formed. The embryo was a still small globe and a suspensor. Fixation procured from other trees and made on 3/7 showed more advanced stages. The endosperm may have partly or completely filled the central vacuole. As shown in Fig. 2 the peripheral cell layer has divided and endosperm tissue grows in centropetal directions against the centre of the seed. In the chalaza end the endosperm may for some time remain nuclear (Fig. 4). In this lower part of the endosperm, formation of small uni-nucleate cells at one time fills the lumen with tissue.

The tissue that soon fills the seed consists in its central part of vacuolate endosperm cells of varying form and often considerable size (Fig. 3). The peripheral parts of the endosperm are smaller cells with more cytoplasm. The volume of the endosperm increases and the inner layers of the integument are destroyed. The phase of rapid embryo growth begins after the endosperm tissue has attained its largest volume. Because of frequent degenerations only few instances of such growing embryos were seen. The elongating embryo clearly grows into the endosperm absorbing this tissue to a large extent. The fact is, that in birch the endosperm is not completely destroyed. The outer layers of small endosperm cells persist. Fixations made 11/7 and 27/7, the latter a collection made in another more shady locality, showed endosperm with

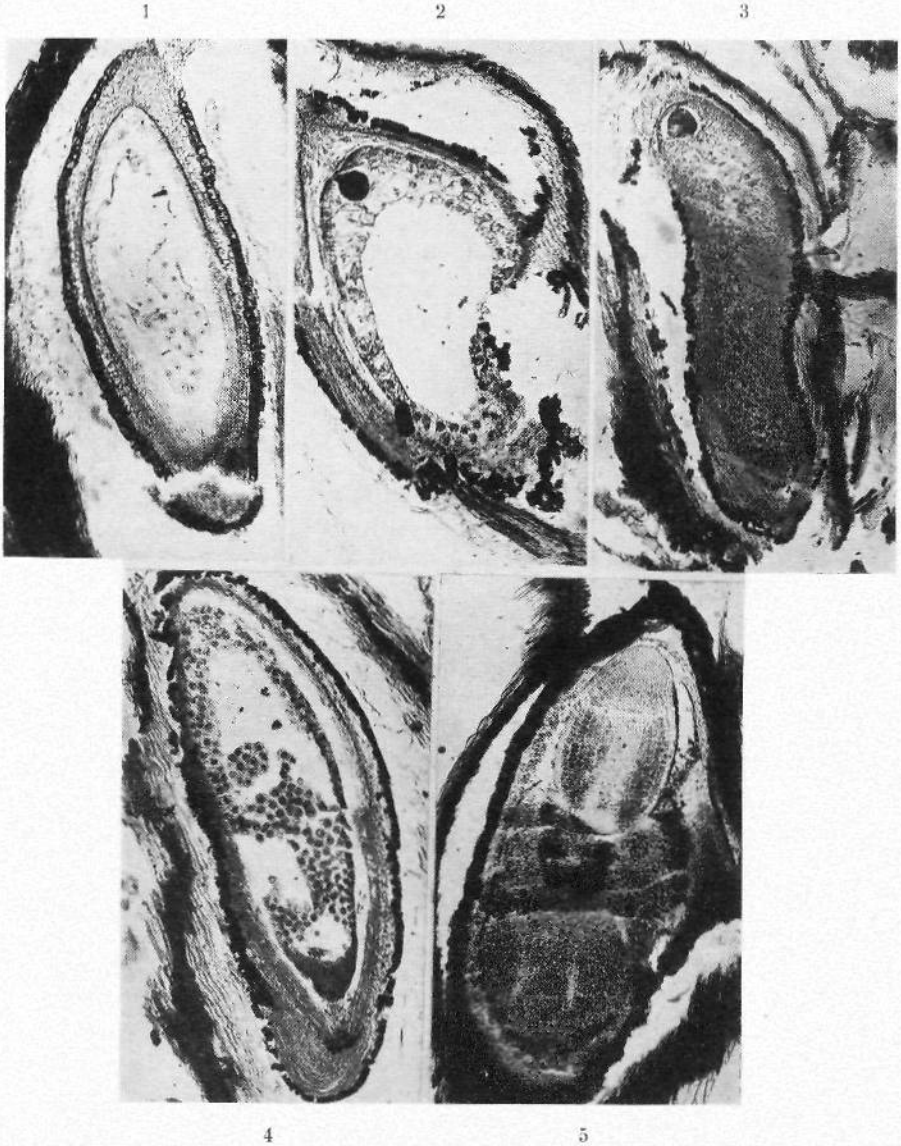


Fig. 1—5. Ovules of *Betula* showing different stages of endosperm formation. — 1: free endosperm nuclei with tree-celled embryo within the nucellus. — 2: cellular endosperm partly fills the central vacuole; lateral parts of the nucellus have disappeared. — 3: the young seed is filled of endosperm tissue, the embryo is still small. — 4: the endosperm near the chalaza is still nuclear. — 5: mature seed, somewhat obliquely cut; the embryo fills the seed, endosperm layers persist between embryo and testa.

storage substances filling the cells, in the latter case they were less abundant. The number of storage layers varied somewhat within the seed; it was three to five. The embryo had much storage in the cotyledons (Fig. 5).

The endosperm of *Betula* thus becomes a large, solid tissue; its outer part persists and is changed to a storage tissue, but the main of the storage of the seed is in the cotyledons of the embryo. We have thus found that the endosperm in the investigated genera *Salix, Myrica* and *Betula* was different. In *Salix* it only to a certain extent was cellular and never filled the central lumen, in *Myrica* it was completely cellular with no rest of lumen, but it had no storage and was replaced by the embryo, in *Betula* its outer cell layers became a storage tissue. There is no closer connections between these genera which belong to different orders.

The endosperm of *Alnus,* the second large genus of the family *Betulaceae* does not seem to have been described. A short paper on *A. rugosa* (Woodworth, 1930), shows a figure with embryos on the heart stage and a large endosperm tissue filling the seed, as well as photomicrographs of seeds with mature embryos and some surrounding endosperm; the question of occurrence of storage in this still persistent endosperm must remain open, however. In the family *Betulaceae* many authors (for instance Lawrence, 1951) also include the genera *Carpinus* and *Corylus*. I have, partly many years ago, investigated more young stages of seed development in *Alnus, Carpinus* and *Corylus.* These investigations show that *Betula* and *Alnus* are very similar in these regards, and, on the other side *Carpinus* and *Corylus,* while there are differences between the two pairs of genera. This supports the idea of a separate family *Corylaceae* favoured by other authors.

Literature cited

BENSON, M. 1894. Contributions to the embryology of Amentiferae. Part I. — Trans. Linn. Soc. London. Second ser. Bot., vol. III.

HÅKANSSON, A. 1954. Endosperm formation in *Salix*. — Bot. Notiser, 1954.

— 1955. Endosperm formation in *Myrica gale* L. — Bot. Notiser, Vol. 108.

LAWRENCE, G. H. M. 1951. Taxonomy of flowering plants. — New York.

NAWASCHIN, S. 1894. Über die gemeine Birke (*Betula alba* L.) und die morphologische Deutung der Chalazogamie. — Mem. l. acad. imp. sci. St.-Pétersbourg. Ser. VII. XLII, 12.

WOODWORTH, R. H. 1930. Parthenogenesis and polyembryony in *Alnus rugosa*. — Bot. Gaz., 89.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Marine Algae from Northern Norway. II

By ERIK JAASUND

(Marine Botanical Institute, Gothenburg)

A find of some short, unbranched, cartilaginous brown algae scattered between the haptera *of Alaria esculenta* on an exposed skerry outside Tromsö (Fagervär, 70°N) has proved to be of great interest and induced the author to revisit the locality during the following year. The alga has since been found to be rather common, at least in Finnmark, the northernmost part of Norway.

The samples were in many ways like *Chorda tomentosa* Lyngbye and would no doubt have been referred to that species, *were it not for an ectocarpoid epiphyte that was found on it and that could be seen to originate from the zoospores still in the unilocular sporangia of the host. This epiphyte thus had to be interpreted as another phase, probably the gametophyte, in the life-cycle of that same species.*

Only slight disagreement as to the taxonomic position of the brown alga, presented by Lyngbye (1819) as *Chorda tomentosa*, can be traced in the literature of algology. This is not surprising, as the species in most of its characters corresponds rather well to the diagnosis of *Chorda* Stackhouse: an unbranched, subcylindrical thallus tapering towards the ends, solid or hollow, slippery and cartilaginous. The surface of the two described species is covered by almost similar paraphyses and unilocular sporangia. The similarity is so close, that *Chorda tomentosa* has been considered by some authors to be a spring form of *Chorda filum* Stackh. (e.g. Harvey, 1846—51, pl. 107; 1849, p. 31; and Hauck, 1885, p. 394).

On the other hand, some dissimilarities also occur, although these are not very striking; for example, Hamel (1931—39, p. 314) states: "Ces poils sont bourrés de chromatophores discoides, contrairement à ceux de *C. Filum,* qui n'en possèdent que quelques-uns dans les cellulles jeunes de la base." He also mentions the different shape and content of the paraphyses in the two species, with chromatophores ribbon-shaped in *C. filum* and disc-shaped in *C. tomentosa.* See also: Rosenvinge and Lund, 1947, pp. 70—77 — who clearly separate *C. filum* and *C. tomentosa.*

The north-Norwegian specimens have been compared with some herbarium specimens of *C. tomentosa* from the west coasts of Norway and Sweden (now in Herb. Mar. Bot. Inst. Gothenburg). As these correspond in all respects to the north-Norwegian samples, the following discussion partly includes them also. Since the aim of the present paper is to prove that "*Chorda tomentosa*" in Scandinavia does not belong to the genus *Chorda,* it will be convenient to refer to this plant simply as *Tomentosa,* and to refer to *Chorda filum* simply as *Filum* in the ensuing discussion.

The assimilating filaments of *Tomentosa,* called "poils" by Hamel, differ quite a lot from the true hairs of *Filum.* Their lower part consists of more or less barrel-shaped cells, 12—17 μ diameter, and about twice as long. They number 3—6. Then follows a series of short cells, constituting the growth zone. The assimilating cells of the filament above it are rather uniform, 20—27 μ wide and 2—3 times as long, cylindrical and slightly constricted at the cross-walls, and containing numerous disc-shaped chromatophores. The hairs of *Filum,* on the other hand, show a sudden and well marked tapering towards the base (fig. 4, a). The cell diameter decreases from about 15—20 μ to 3—8 μ. The hair has a basal growth zone and is directly set on the cortical cell, the pedicel. So, when the barrel-shaped cells comprising the stalk of the *Tomentosa*-filaments are considered to be a part of these filaments, the growth zone can be said to be intercalary in *Tomentosa,* but basal in the *Filum*-hairs. As a result of studying the material, the author has come to the conclusion that the dissimilarities outlined above are not only a difference in shape, but point also to a difference in function. The *Filum*-hairs with their extremely long and colourless cells are true *Phaeophyceae*-hairs. In *Tomentosa,* the cells of the filament contain numerous disc-shaped chromatophores and their function must be to assimilate. The paraphyses also have the same disc-shaped chromatophores, but to much lesser extent. The *Filum*-paraphyses have a dense coloured "head" and contain more chromatophores than the other parts of the plant (compare the figures on Taf. 27,8 and Taf. 29,6 in Reinke, 1892). When the *Tomentosa* plant has reached the fertile stage, the filaments are shed, leaving only the basal stalk cells; this also suggests that their primary function is assimilation. According to what has been said above, the author interprets the *Tomentosa*-filaments as assimilators and this term will be used hereafter. Oltmanns used it for the paraphyses. The rounded cells forming the stalk may be the site of unilocular sporangia (fig. 3 c). In specimens from an extremely exposed rock, the stalk cells have thick cell-walls, 5—7 μ.

The paraphyses of *Tomentosa* vary both in their content and their shape. They are often elongate-clavate (on specimens from exposed localities), or conical-vase-shaped, *i.e.* with maximum width near the base and tapering upwards. Some of the plants also had cylindrical paraphyses with obtuse ends. According to measurements of the north-Norwegian material, all the samples from exposed localities had long and narrow paraphyses, 110—120×9—12 μ, increasing to 150—200× 9—10 μ with extreme exposure. The probable reason for this will be given below. Material from localities only moderately exposed to the waves, or from really sheltered localities had shorter and thicker paraphyses, 75—90×12—18 μ (cf. Reinke, 1892, Taf. 29). All these types of paraphyses have rounded apices.

The paraphyses of *Filum* are depicted by Harvey (1856—51, pl. 107), Newton (1931, p. 201), Reinke (1892, Taf. 27) and others. Their claviform shape is more pronounced and their top more flattened than is the case in *Tomentosa*. They could be compared with stalked, inverted pyramids. Further, they are shorter, about 30—50 μ in Norwegian specimens (fig. 4, a). In French, British and Scandinavian waters, *Tomentosa* is recorded as a spring species, *Filum* as a summer plant. This may to some extent be the result of the disappearance of the assimilators from the mature plant, giving it a *Filum*-like appearance. This is the case in northern Norway, where the alga in question has been collected at the end of the north-Norwegian summer.

The function of the *Tomentosa* paraphyses is probably mainly protective. The assumption is based on the observation that when conditions are rough as on exposed rocks, they are extremely long and crowded and always much longer than the unilocular sporangia. In specimens growing in sheltered waters or sublitorally in the fjords, the paraphyses are shorter, sometimes cylindrical or vase-shaped and are of about the same length as the sporangia. In such fjord-material it can also be observed that when the fructification is very rich, the sporangia predominate, and when poor the paraphyses predominate. Not so from the more exposed localities, where the paraphyses always are crowded. So the extent of development of paraphyses seems to depend on external conditions. In *Filum* the paraphyses presumably play a double role, partly assimilatory (their rich pigmentation) and partly protective (their shape). The hypothesis of the difference between the *Tomentosa* and the *Filum* paraphyses seems to be supported by another observation. In squash preparations of young specimens of *Filum* the cortical part of the thallus spreads out as regular cell-rows as shown in the upper part of figure 4, a. The cells have divided and the outer part develops into a paraphysis; the inner part is joined at both ends to the neighbouring cells, form the outermost cortical layer. The inner cells could be called the pedicels of the paraphysis. They stretch out parallel to the *Chorda*-axis, and on both sides of the paraphysis an unilocular sporangium usually forms, according to own observations and those of Reinke (1892, Taf. 27) and Kylin (1918, p. 32). As the tops of the paraphyses become broader, they fill out the space available and form together an assimilating as well as a protecting system of great efficiency.

If the paraphysis and the sporangium of *Filum* are regarded as formations of a first and a second order, both the sporangium and the paraphysis of *Tomentosa* seem to be of a second order.

In *Tomentosa* the pedicels do not lie in regular cell-rows on the surface. They are also more rounded, isodiametric, or have a conical-obovate top on the outer side, sometimes elongated somewhat radially. The paraphyses and the sporangia are seemingly set without any order on these pedicels and without any preference given to a paraphysis at the top of it. Sometimes the sporangia predominate in number sometimes the paraphyses.

The hyphae arising from the inner cortical cells in *C. filum* give rise to the wellknown septation of the thallus. This is not met with in *Tomentosa,* at least not in the material from northern Norway.

According to Kylin (1918), *Chorda filum* produces 16 spores in the sporangium; the number in *Tomentosa* exceeds 50 and is probably 64.

Sören Lund (in Rosenvinge & Lund, 1947) has made some interesting culture experiments on "*Chorda tomentosa*" to investigate whether the alternation of generations is the same as in *C. filum.* His illustrations of sporelings coincide perfectly with the appearance of young gametophytes observed on the north-Norwegian material. Even though his sporelings did not become fertile, they are regarded as supporting evidence that *C. tomentosa* Lyngb. will have to be removed to the new genus *Halosiphon.*

The discussion above has been based mainly on a detailed study of material collected from 22 stations located as shown on the map. The extreme exposure of some of the sites has permitted access only during favourable conditions of wheather and swell.

The occurrence and stage of development of the gametophyte are listed below:

Station	Occurrence of gametophyte	Stage of gametophyte
202 28/6	Only very few, with short vegetative filaments	
203 Langnässkjär F 29/6	None	
207 Knivskjellodden F 30/6	A few veg. filaments	One gametangium observed
208 Svärholtklubben F 2/7	A few filaments, only vegetative	
209 Kjöllefjord F 3/7	None	
211 Sletnes F 4/7	Not abundant	Fructification has started (Plurilocular sporangia)
214 Nordkynodden F 6/7	Only vegetative	
155 Kvitholmen T 11/7	Abundant	Fertile
158 Smalöy T 12/7	None. Sporophyte not fertile	
159 Flatbaken T 12/7	Abundant	Fertile
219 Kalakklubben F 10/7	Some few hairs indicating the presence of gametophytes. A single filament seen	
222 Bondöya, Laksefj. F 12/7	None	
168 Månnessodden Senja T 15/7	Some hairs observed	
228 Skarvberget F 15/7	Occurs in the vegetative stage only, inside the unilocular sporangia	
229 Jernöy F 15/7	None	
230 Porsangerneset F 16/7	Abundant	Branched or simple, uniseriate gametangia
170 Aglapen T 17/7	None	
234 Gåsöy-Ingöy F 18–19/7	Germination and short sporelings within the sporangia	
236 Kalvskjär, Rolfsöy F 20/7	Very abundant	Uniseriate, partly biseriate gametangia
114 Fagervär T 20/8	The rich fructiferous gametophyte vegetation dominates the outer layer of the sporophyte	
F 53 Fagervär 26/7 T	Not abundant, mostly in the vegetative stage	
131 Breivikbotn F 19/8	Like 114 Fagervär	

As indicated in the list, the zoospores were found to germinate in the last part of July generally. The sporelings branch in a most irregular manner and bear hairs of the common *Phaeophyceae*-type, 5—6 μ in diameter; see figures 3 and 4 and compare with Rosenvinge & Lund

(1947, p. 76, fig. 25). The filaments creep along the surface between the paraphyses or parallel to the surface between the top and bottom of the paraphysis system. Erect filaments may arise from every cell. In August the gametophyte develops gametangia. The gametangia are always plurilocular, mostly uniseriate and cylindrical, 40—60 μ long and 6—8 μ broad. In specimens from Fagervär 20 August, some of them were biseriate, up to 100 μ long and 11—12 μ broad, and in this material the gametangia also could be seen to be branched in a most irregular manner. In this autumn material the gametophyte also completely covered the peripheral part of the sporophyte. All the assimilators and most of the paraphyses of the latter had been shed.

Every cell of the gametophyte seems to be capable of developing into a gametangium. In this way the peculiar gametangia arise, depicted in fig. 4, d.

What happens to the supposed gametes? It is possible that they germinate parthenogenetically to give rise to further gametophyte generations during the winter, or zygospores may be formed and these may produce a diploid ectocarpoid plant similar to those described by Bernadette Caram (1955) for *Chordaria flagelliformis*. It will be an interesting task to investigate this problem by means of culture experiments, which it is hoped to be done later.

If sorted out according to their general characteristics, the collections fall into two groups, the one characterized by a dark colour and rather cartilaginous fronds, and the other by yellow or yellowish-brown and less cartilaginous, more *Scytosiphon*-like, plants. In this latter group one also finds slippery *Chorda filum* - like algae but with a lighter colour and without septations. They were collected from a sublittoral shelf, formed beneath an almost vertical cliff-wall from fallen masses of rock. The depth was about 0.5 m at low tide 3 meters from land, increased to 5 meters 10 meters out, and then rapidly increased to some hundreds of meters. The fjord is wide and open to the north (see S on the map). The prevailing winds here are north easterly. The same form (about 2 m in length) was found further out in the same fjord, southeast of Jernöy. The need for increased tensile strength was apparently greater here than at the other localities where specimens of this group had been collected; this caused a development towards a *Chorda* instead of the weaker *Scytosiphon*-like string. The light colour seems not to be a function of the depth, as the same form grew in the littoral zone at the same place; then the plants attained a length of only 30—50 cm, but had the same yellow colour.

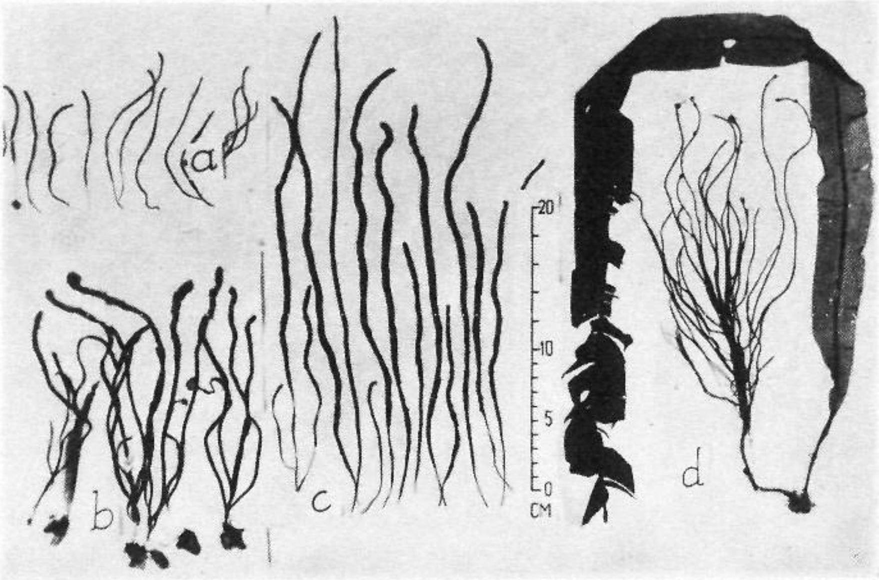


Fig. 1. *Halosiphon tomentosa* nov. comb. from exposed rocks. Because of the breakers, the simple thallus often are found forming twisted ropes between the Alaria, fixed to *Balanus* or the hapteres of the Alaria. With *Ectocarpus fasciculatus* epiphytically.

There are further indications suggesting that *Chorda tomentosa* Lyngb. is not a *Chorda* but a *Halosiphon*. Hamel says about *C. tomentosa* Lyngb. "vit dans un autre type de station. On le recontre en effet au printemps (Avril-Mai), sur les rochers très battus." In Denmark it is found near low water mark at coasts with currents in the water (Rosenvinge & Lund, 1947, pp. 73—74). The French specimens are 20—30 cm long. In these details they fully correspond with the north-Norwegian species *Halosiphon tomentosa*. The herbarium specimens available from the west coasts of Norway and Sweden have been soaked and studied and found to have the same anatomical structure as *Halosiphon*. In a sample, collected 5 July at Hordaland, Norway (near Bergen), the first cell-divisions within the sporangium could be traced with some difficulty. Studies will be continued with the object of shedding further light on this question of removing *C. tomentosa* Lyngb. to the new genus *Halosiphon*.

Halosiphon, nov. gen.

Frondibus solitariis aut gregariis, filiformibus, deorsum solida, sursum tubulosa. Cellulis interioribus majoribus, elongatis, versus peripheriam magnitudine descendentibus abbreviatisque, corticalibus in paraphyses saccatas, clavatas aut subcylindricas, liberas, demum evolutas. Planta annua, affixa callo discoideo fibras radicales descendentes articulatas emittente. Frons statu juniore pilis fulvis, longissimis dense vestita. Cellulae piliphori submoniliformes aut cylindricae. Sporangia unilocularia elliptica, altitudine paraphyses haud superantia. Strata fructifera demum totam frondem inferiori parte excepta obtegentia. Zoospora saepe vivipare Julio-Augusto germinent. Gametophyta, frondibus repentibus microscopicis, articulis irregularibus, ramulis brevibus, simplicibus, rectis incurvisve, diametro 5—6 μ, inter paraphyses erumpentibus. Gametangiis uniseriatis aut biseriatis, simplicibus aut interdum ramosis. Pilis hyalinis sessilibus praesentibus, 5 μ crassis.

Thallus annual, cord-like, simple, solid or hollow, without septations. Attached to the rock by a discoid holdfast, from which more than one plant may arise. Inner cells elongated, often with oblique cell-walls; their diameter decreasing radially outwards. The outermost part formed by paraphyses and stalked, assimilating filaments. Unilocular sporangia elliptical to subcylindrical. Hairs absent. Dimorphic. A small ectocarpoid gametophyte alternates, sometimes germinating viviparously from the zoospores in July and forming a system of radially directed, branched filament, 5—7 μ broad; hairs present, 5 μ in diameter; fructification in late summer; gametangia plurilocular, uniseriate, less frequently biseriate, 40—60(—100) μ long, simple or sometimes branched, 6—8(—12) μ broad. Chromatophores disc-shaped.

Halosiphon tomentosa (Lyngb.) nov. comb. (=*Chorda tomentosa Lyngb.*)

Fronde 10—30 ad 100 cm longa, 1.5—3 mm crassa, pilis olivaceis-nigris vestita, ad 7 mm longis, diametro 20—30 μ. Paraphysibus clavatis-linearibus, 120—150(—200)×9—11 μ. Sporangia unilocularia sessilia rarius lateralia, oblonga-cylindrica-piriformia, 80—120(—150)×12—15 μ.

Plant littoral or sublittoral, dark brown to almost black, cartilaginous, firm, 10—30 cm long when littoral, about 50(—135)cm long when sublittoral (see Rosenvinge & Lund, 1947, p. 74). Diameter of mature frond, 1—3 mm. Consists of more or less thick-walled cells with decreasing diameter towards the periphery. The outermost cells isodiametric or somewhat extended radially. Club-shaped to linear paraphyses. Superficial unilocular sporangia, elongated-obovate, shorter than the paraphyses (exceptionally of the same length). Paraphyses 110—200×9—11 μ. Stalked assimilators; the stalk, when fully developed, of 4—6 barrel-shaped cells, more or less thick-walled. The assimilating filament has basal growth and a length of 1—5(—7) mm.

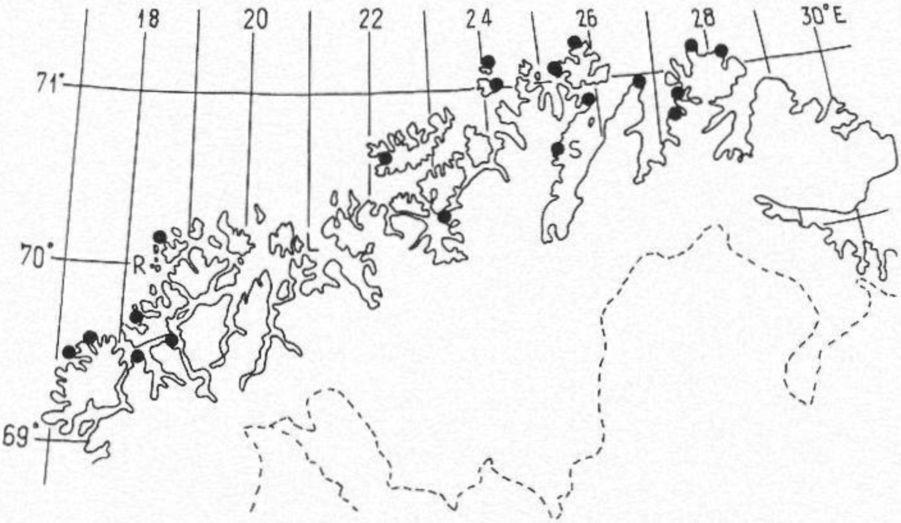


Fig. 2. The distribution of *Halosiphon*. The coast between Sletnes (about 28°E) and Kirkenes (30°E) has not yet been visited.

The cells of the filaments are cylindrical, 20—30(—40) μ diameter and 2—3(—4) times longer than broad. After fructification the assimilators are shed. Gametophyte in July, with gametangia in August. A common inhabitant of the upper *Alaria* zone on exposed rocks in northern Norway. No confusion with *Chorda* is likely because of the different localities they prefer and the lack of septations in *Halosiphon*. They differ mainly in the shape and content of the paraphyses (*Chorda* paraphyses have a more or less flattened top and richly pigmented, ribbon-shaped chromatophores; *Halosiphon* paraphyses are almost colourless with only a few disc-shaped chromatophores) — and in the fact that hairs are present in *Chorda*, but absent in *Halosiphon*.

Localities: *Troms*: Månnesodden and Kjölva (Senja), Flatbaken (near Sommaröy) and Fagervär (near Hattöy)

Finnmark: Kalvskjär (Rolfsöy), Gåsöy-Ingöy, Langnesskjär and Knivskjellodden (Mageröy), Porsangerneset, Svärholtklubben, Kalakklubben, Bondöya (Laksefjord), Nordkynodden and Sletnes.

Halosiphon altae nov. sp.

Fronde 50—100 cm, interdum elongata ad 200 cm, 2—3 mm crassa. Pilis subfulvis, flavescentibus, saepe absentibus. Cellulis interioribus majoribus, zoosporangia 75—90×15—18 μ, elliptica aut subglobosa, paraphyses saepe aequialtae.

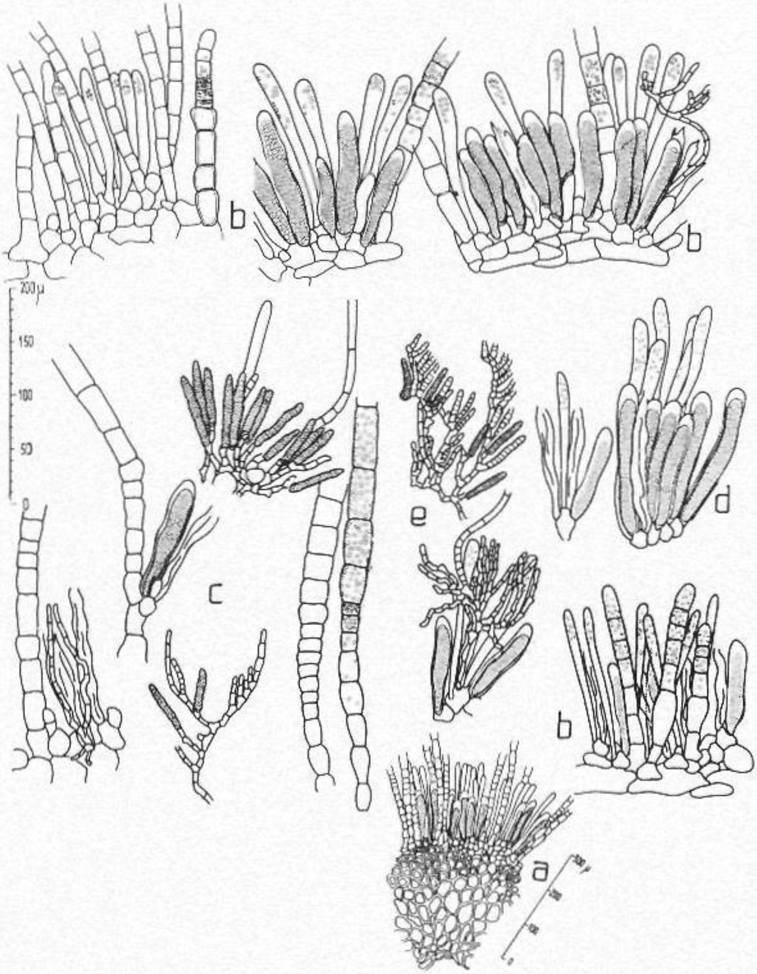


Fig. 3. *Halosiphon tomentosa* nov. comb. a: A sector of the circular cross-section. b: The paraphysis-assimilator system with unilocular sporangia. c: The assimilators, one with a lateral unilocular sporangium. d: The elongated paraphyses and sporangia on a specimen from the exposed Fagervær. e: The extremely branched gametophyte.

Differs from *H. tomentosa* principally in the lighter colour, yellow to yellowish-brown. It is mostly found in the sublittoral, less often in the littoral zone. The barrel-shape of the stalk-cells of the assimilators is less pronounced. Paraphyses shorter, cylindrical, obtuse-conical or vase-shaped, 75—100×15—18 μ. Unilocular sporangia obovate to broad elliptical, as long as or sometimes a little shorter than the paraphyses.

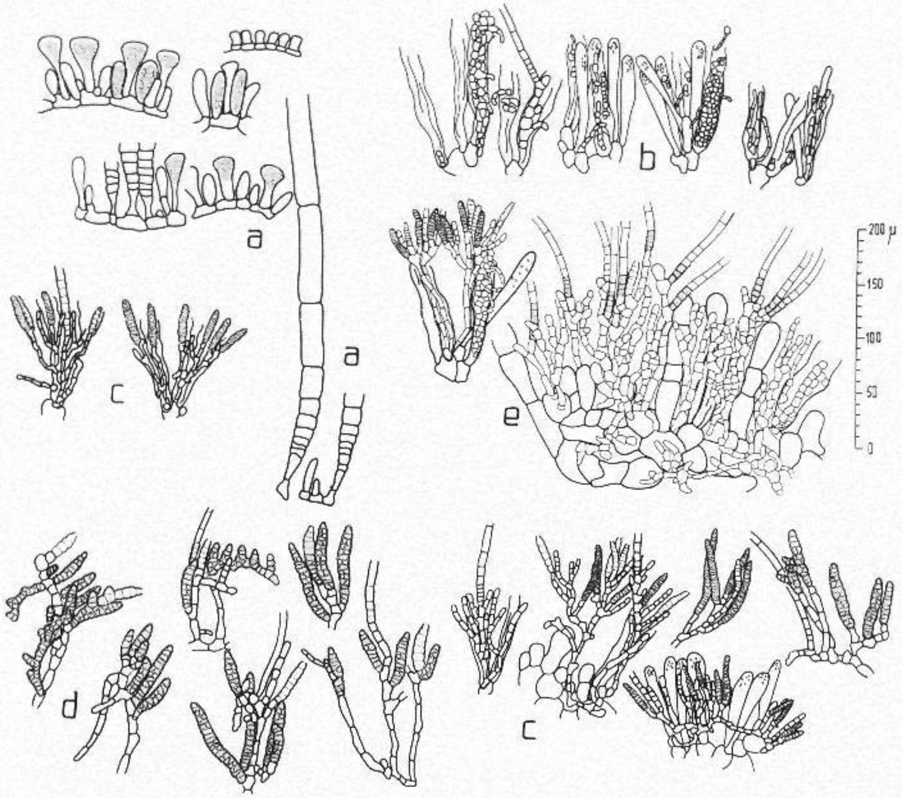


Fig. 4. *Chorda filum* (L.) Stackhouse. a: Hairs and paraphyses for comparison. — *Halosiphon tomentosa* nov. comb. b: Germinating spores in the unilocular sporangia. c: Further development of the gametophyte. d: Gametophytes from the Fagervär-specimens collected in the last part of August, showing branched and partly diseriate gametangia.

Development of sporangia seems to be a little delayed compared with *H. tomentosa*. Sterile or only slightly fertile specimens frequent. Found at more sheltered localities, and then approaching *Scytosiphon* in general appearance; plants collected at more exposed places, are rather like *Chorda*. *Halosiphon altae* differs from vegetative *Scytosiphon* in possessing assimilators and a firmer frond. *Scytosiphon* has hairs. The outer cortical cell system in *Scytosiphon* is more palisade-like than in *Halosiphon*. From *Chorda* it is distinguished by the same characters as mentioned above for *H. tomentosa*.

Are these differences (between *H. tomentosa* and *H. altae*) sufficient to justify a separate species? Could not *altae* be merely forms of *tomentosa* growing under slightly less favourable conditions? In the author's opinion the find of the yellow plants beneath Skarvberget in Porsangerfjord (described on page 210) seems to support this segregation. The pigmentation of the assimilators ought to be the same in these littoral, 20—30 cm long plants as in plants from the more exposed Svärholtklubben further out in the fjord (both localities are open to the north and northeast). The Svärholt-plants had the dark-brown colour typical in *H. tomentosa.*

Localities: *Troms*: Aglapen (Tromsöysund)

Finnmark: Lille Korsneset (Altafjord), Breivikbotn (Söröy), Skarvberget and Jernöy (Porsangerfjord)

As to the question, in which order and family this new genus should be placed, the dissimilar generations and the diffuse apical growth point towards a place in the family *Dictyosiphonaceae,* near *Delamarea.* It is thus to be included in the order *Ectocarpales* (sensu Fritsch, 1945).

Desmotrichum undulatum (J. G. Ag.) Reinke, 1892, Taf. 11 and Algenflora p. 57; Harvey, Phyc. Brit. pl. 248.

Examination of collections of *Ceramium* species from Langholmen in the Risöy archipelago outside Tromsö, showed that an endophyte was responsible for producing numerous plurilocular sporangia found scattered over the surface of the host. The endophytic filaments could be traced as a very irregular system of creeping filaments on the large *Ceramium* cells, covered by the smaller cortical cells. The dimensions of the cells of the brown endophyte varied between 10 and 75 μ in length and 4—30 μ in breadth. The ramification of the procumbent filaments was sometimes so rich that an almost confluent cell-layer was found to cover the *Ceramium* cell. The plurilocular sporangia were mostly terminal, pluriseriate, and measured 50—60 × 15—20 μ; intercalary sporangia were also present, though infrequently. Hairs were present and had basal growth and a sheath, diameter 8—11 μ. The correspondence to *Streblonema* (*Entonema*) *effusum* Kylin (1907), which is also found on *Ceramium,* was close. In order to find out if this endophyte was common, other *Ceramium*-finds were examined. The same endophyte was then seen to be present on material from Balsfjord and Ryströmmen, in the vicinity of Tromsö. The endophyte occurred together with *Desmotrichum undulatum* Rke. Sometimes the

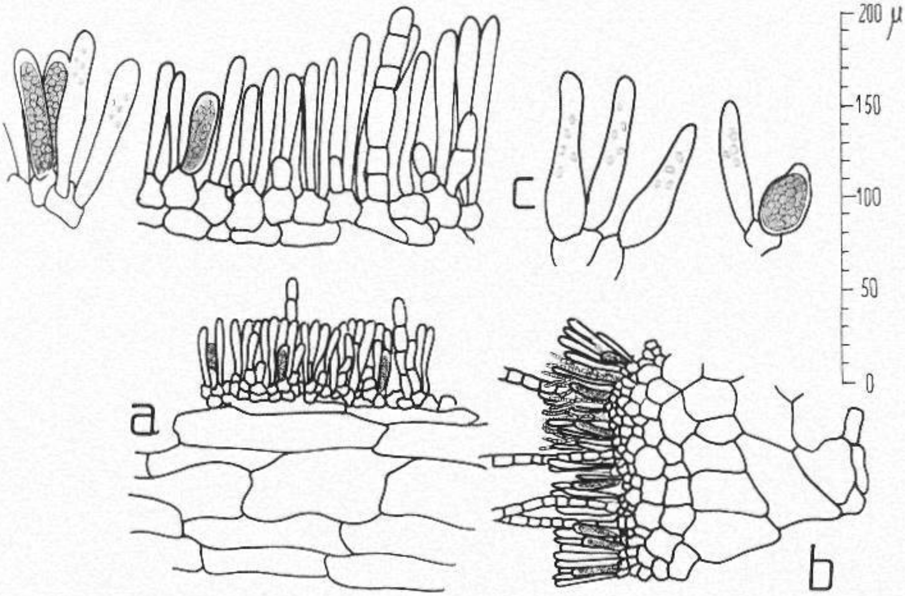


Fig. 5. *Halosiphon altae* nov. spec. a: Longitudinal section and b: Transverse section through the thallus. c: Different shapes of the paraphyses occurring.

endophyte became epiphytic and developed more regular cells. An interesting observation of some solitary, erect and simple filaments, crowned by a hair, intensified the study of the complete material. This led to the detection of a succession of stages of development, from a simple, monosiphonous thread to the mature, fertile *Desmotrichum*-ribbon. Fructification was rich in all parts of this heterotrichous system, which correspond well with the different stages of development depicted under the names: *D. undulatum* Rke, *D. balticum* Kütz., *D. scopulorum* Rke and *D. repens* Kylin (see Reinke, Atlas, and Kylin, 1907, p. 67).

Secondary rhizoids develop from the erect filaments at an early stage, penetrating into the host and bearing sporangia similar to those on the primary endophytic filaments. Also, erect shoots may develop from the creeping filaments, as shown in fig. 6, c. None of the mature ribbons met with was more than 0.2 mm broad and 2 cell-layers thick; the maximum length was 14 mm. The sheath found on the hairs of the *Streblonema*-stage also occurred in the *Desmotrichum*-stage, but could only be seen on young and short hairs; it is obviously shed early. (It is not present in Reinke's illustration in Atlas.) Unilocular sporangia have not been observed; probably they are produced later in the season. The material examined was all collected during June.

The endophytic plant described above would no doubt have been referred to *Streblonema effusum* Kylin, were it not for the presence of material showing different stages of development. It is probable that, in the future, the number of species belonging to *Streblonema* and perhaps to *Myrionema* (see below) will be reduced, as some of them are only stages in the development of large species. Compare for instance the *Streblonema*-like phase of *Chordaria flagelliformis* described and illustrated by Caram (1955) with *Streblonema chordariae* (Wollny) Cotton described and illustrated by Kuckuck (1954, in a paper edited by P. Kornmann); the suspicion that they are identical seems to be supported by the statement of Kuckuck: "Die Pflanze ist bei Helgoland immer leicht zu haben, *wenn Chordaria flagelliformis reif ist*" (present author's italics). "Bisher habe ich nur plurilokuläre Sporangien beobachtet."

Litosiphon laminariae (Lyngb.) Harvey (Man. 1849, p. 43, Phyc. Brit. pl. 295); Reinke (1892, p. 62)

In 1951 the author collected this alga as a widespread epiphyte on *Alaria esculenta* in Vestfinnmark and Troms. Collections were taken in August between Skjervöy and Breivikbotn on Söröy. The *Alaria* lamina was usually partly clothed, either by this brown alga, or by the red *Acrochaetium alariae* (Jónss.) Bornet. When the *Alaria* plant grew at a sheltered place, the lower half only of the lamina was covered by the brown alga, the upper half had no *Litosiphon* epiphytes; but when conditions were rough (outside the fjords) the lower part of the long and narrow *Alaria* lamina was free of epiphytes while the upper part was covered with *Acrochaetium* and looked like red velvet.

The usual length of the *Litosiphon* thallus was 10—20 mm. In Breivikbotn, however, the partly decaying *Alaria* was covered with *Litosiphon* thalli 30—35 mm long, making the *Alaria* look very ragged. The host plant grew either at low water level or just below or just above it.

According to Kjellmann (1890) and Newton (1931), the two species *Litosiphon pusillus* (Carm.) Harv. and *Litosiphon laminariae* (Lyngb.) Harv. should be recognized, the former as a light brown epiphyte on *Chorda*, the latter as a dark brown epiphyte on *Alaria*. Hamel (p. 219) says that *L. laminariae* differs from the other in having a smaller frond and a tendency to produce swellings on the surface of the host. How-

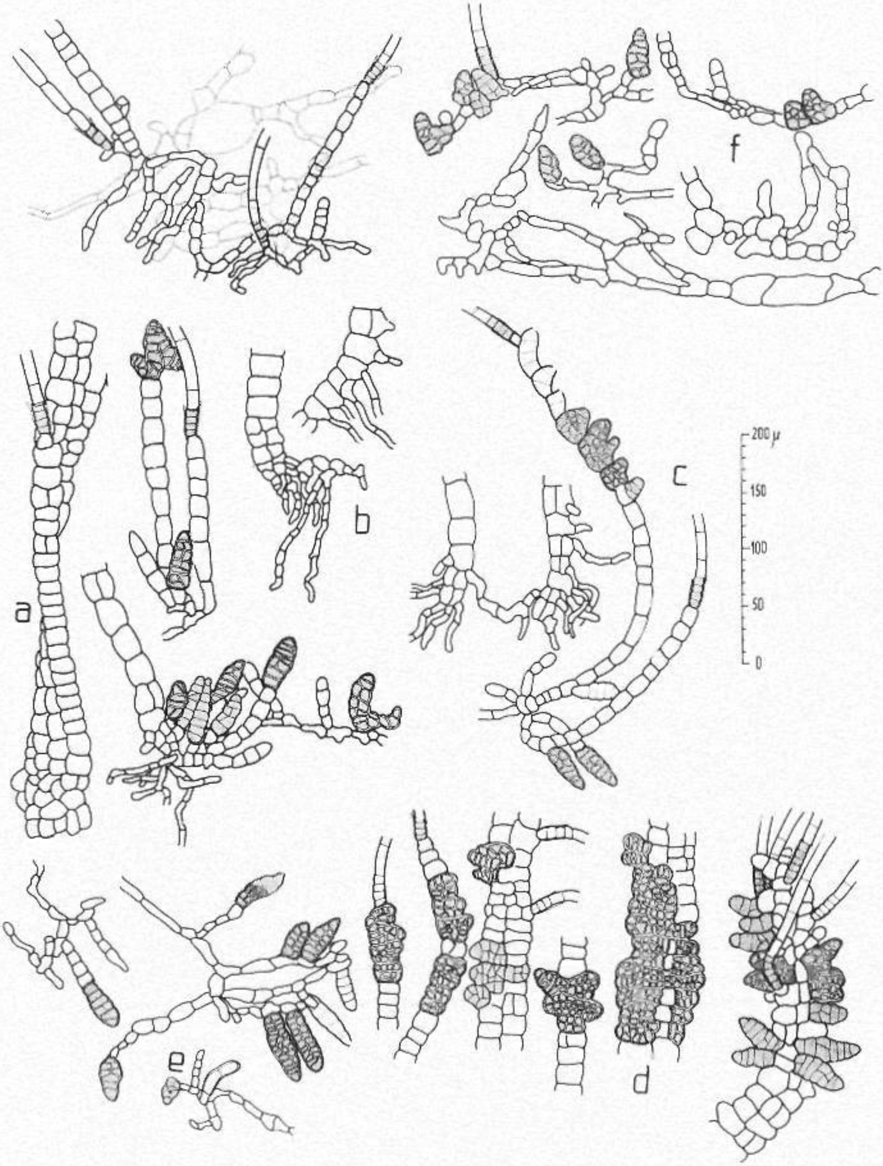


Fig. 6. *Desmotrichum undulatum* (J. G. AG.) REINKE. a: The *Desmotrichum* ribbon. b: Secondary rhizoids forming from the basal cells of the erect shoots. c: *Desmotrichum balticum* stage. d: Fertile parts of the mature thallus. e: Detail of the endophytic system, with a new hair forming inside the sheath. f: the endophytic *Streblonema*-stage.

ever, it seems to be difficult to point out any real morphological difference between these two species. Four species of this genus are recorded from the west coast of Norway, *viz., Litosiphon pusillus, L. laminariae, L. tenuis* Levring (1937) and *L. filiformis* (Reinke) Batters. Levring (1937) maintains that in this genus the host should be considered specific to the species: *L. pusillus* being confined to *Chorda filum, Litosiphon laminariae* to *Alaria, Litosiphon tenuis* to *Laminaria digitata* and *Litosiphon filiformis* to *Laminaria saccharina.* Records of *Litosiphon* on other hosts should be considered to be other, nearly related *Litosiphon* species. Since nothing is known at present about the effect of a change of host, and as some of the *Litosiphon* species listed above differ slightly from each other morphologically, it is at least convenient to consider the host specific to the species. The one conception may be as good as the other. The role played by the host can only be investigated by means of culture experiments in the sea.

Litosiphon pusillus has been the subject of culture experiments by Sauvageau (1929) and Kylin (1933). According to Kylin (pp. 26—32) creeping filaments develop from the spores produced in the plurilocular sporangia of *Litosiphon* plants. From these procumbent filaments, erect shoots develop, that later on may become polysiphonous, or are directly transformed into plurilocular or even unilocular sporangia. If now every cell of the creeping filament (see Kylin, 1933, p. 28, fig. 6 B and C) divides longitudinally and transversely, short and crowded upright filaments may form a carpet on the pseudoparenchymatous prostrate system produced by a continuous branching of the creeping filaments. The final result should be a *Myrionema*; and that was actually found on some small and thin *Alaria*, collected on Skjervöyskjäret, a skerry in Kvenangen exposed to the prevailing northerly or north easterly winds. The same epiphyte was found similarly on Söröy. The "*Myrionema*" gives to the *Alaria* a dark brown spotted appearance and corresponds rather well to the description given by Foslie (1894) for his *Myrionema foecundum* (Strömf.) Foslie. (Cotton has later shown that this species belongs to the genus *Ascocyclus* Magnus, see p. 228 in the present paper.) The only exception apart from the lack of ascocysts could be that some of the erect filaments in the present *Myrionema*-like plants were seen to branch. The prostrate system was only one cell-layer thick, the upright filaments 30—45 μ long and about 6 μ broad. Plurilocular sporangia were abundant, about 8—10 μ in diameter and uni- or biseriate. Locally, a single or a little group of erect filaments could be seen to project above the others, *Litosiphon laminariae* also

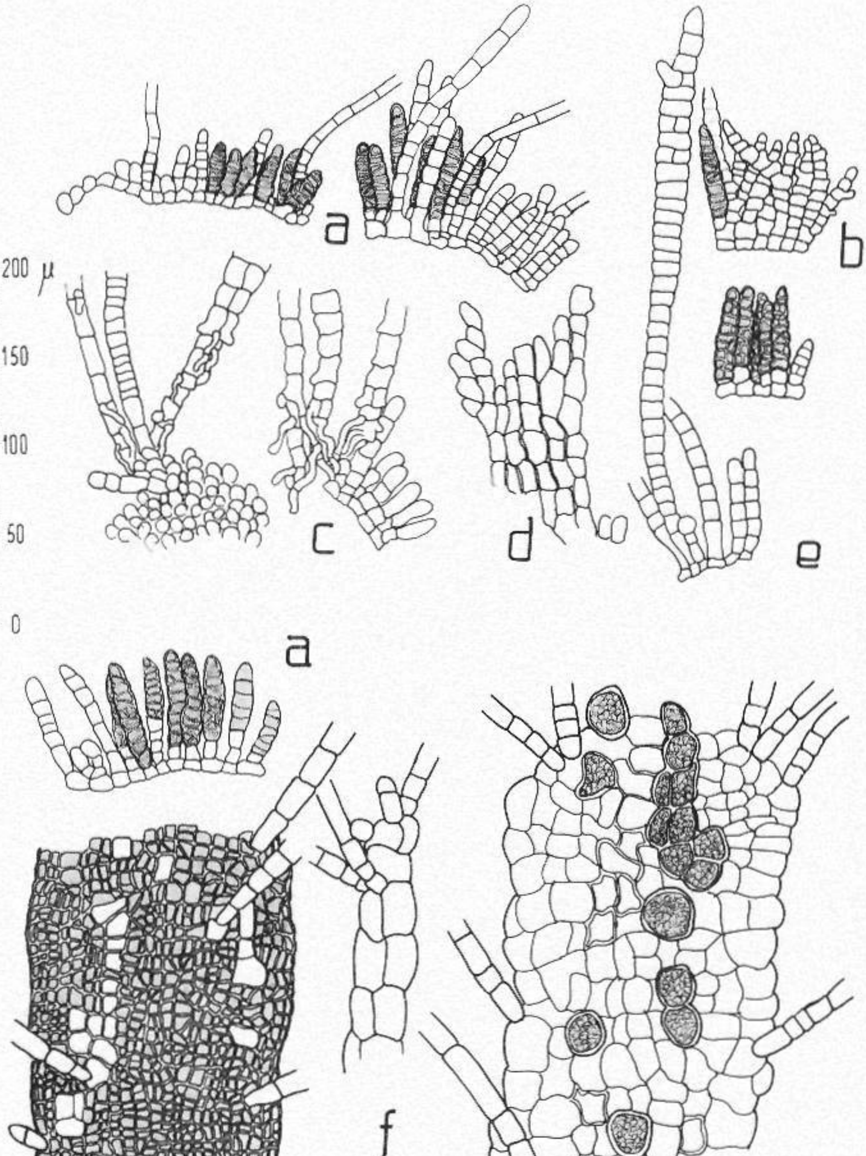


Fig. 7. *Litosiphon laminariae* (Lyngb.) Harvey. a: Fragments of the *Myrionema*-like first stage of development. b: A group of branching, vegetative erect filaments. d: Part of the prostratum seen from above. e: The young *Litosiphon* plant has developed. f: The mature and fertile *Litosiphon* plant, one with plurilocular and one with unilocular sporangia. Between them the tip of a thallus.

occurred, as young plants, on the same *Alaria*-fronds, and continued studies showed that this *Myrionema* in fact was only a first stage in the development of *Litosiphon laminariae*. All stages could be seen between the elongated *Myrionema*-shoot and the fertile, partly polysiphonous *Litosiphon* plant. Some of the upright filaments, exceeding 100 μ in length, were crowned by a hair, shown by Kylin to be the case in his *Litosiphon*-cultures too. The formation of rhizoids was seen to start very early (fig. 7, c) and to be very rich. They had soon produced a cortex as illustrated by Reinke (1892, p. 62).

In this way the formation of the fascicles so characteristic of *Litosiphon laminariae* is readily understood, as either small groups of erect *Myrionema* shoots develop further, or else new *Litosiphon* plants develop from the secondary rhizoids produced by an older plant. The swellings mentioned by Hamel appear later, when the *Litosiphon* thallus increases in length and the need arises for a better holdfast. The rhizoids then penetrate rather deeply into the substratum and form a swelling, consisting partly of *Alaria* cells and partly of *Litosiphon* cells.

The author can see no discrepancy between the development outlined above and the culture experiments referred to. The growth in artificial media can hardly be as good as under normal conditions. The same species may also possibly develop along different lines on different substrata, and finally the different species may develop differently.

The young *Litosiphon* plants on Skjervöyskjäret bore only plurilocular sporangia, both in the procumbent and in the erect parts. They may develop further to produce 10– 30 mm long thalli only under less rough conditions. Therefore, adult plants are only found in the fjords, where they reach the unilocular sporangia stage. Unilocular and plurilocular sporangia were found on plants in Breivikbotn as late as 19 August, occurring on different plants. As the procumbent part most probably is a juvenile stage of the plant, it had disappeared on the 20 cm broad, decaying *Alaria* fronds, bearing adult *Litosiphon laminariae*.

Localities: *Troms*: Skjervöyskjäret (Skjervöy)

Finnmark: Rosmålsbukta (Loppa), Knottene, Breivikbotn, Finkonvika (Hasvik).

Ectocarpus tomentosoides Farlow

In 1893 Gran described an epiphyte on *Laminaria saccharina*, collected on Nakholmen outside Oslo. He considered it to be a Norwegian form of *Ectocarpus tomentosoides* Farl., and called it *E. tomentosoides* Farl. f. *norvegicus*. A find of brown epiphytes on *Laminaria* spp. collected in

Troms in 1950 and 1951 has raised the question whether Gran's alga really is an *Ectocarpus* or not.

The brown tufts and felt on *Laminaria digitata* and *L. hyperborea* from northern Norway are mostly *Ectocarpus fasciculatus* Harvey. On some *stenophylla*-forms of *Laminaria digitata*, collected on the exposed E.N.E.-side of Lauköy (Kvenangenfjord, L on the map, fig. 2), *Ectocarpus fasciculatus* was again present but not so abundant as two other algae, one of which was *E. tomentosoides* Farl., growing on the haptera and on the long and narrow tips of the frond of the host; the other alga will be described below as a species of *Myrionema*. The material was collected 15 June 1950.

From a partly endophytic base arise entangled masses or bundles of long (up to 2 mm) and slender filaments (6—7 μ diameter), bearing those short branchlets (so typical of this species) that form a right angle with the axis and consist of 1—4, more rarely 6—8 cells, isodiametric in shape or up to twice as long as broad. The cells of the filaments are cylindrical, and usually 1—3 (infrequently 5—8) times longer than broad. The branches are transformed to plurilocular sporangia, uni- or biseriate, 50—100 μ long and 6—7 μ broad. When the tips of the simple filaments arising from the basal system develop into sporangia, these terminal sporangia attain a length of 100—200 μ, and in one case 240 μ. The latter plant was epiphytic on a plant of *Laminaria hyperborea* dredged from 15 m depth in a Sound with strong tidal currents (Kvalsund).

Localities: *Troms*: Kvalsund (Tromsöysund) and Lauköy (Skjervöy).

Myrionema corunnae Sauv. emend.

Thallus epi-endophyticus, maculas irregulares formans. Filis strati basalis radiantibus, irregulariter ramosis, statu juniore contortis, adultiore in pulvinatum conjunctis. Rhizina intra et in cellulas hospitis penetrantia. Filis erectibus brevibus emissis. Sporangiis plurilocularibus cylindricis, uniseriatis 50—100×6—7 μ, statu juniore sessilibus aut breviter pedicellatis, altitudine constantibus, adultiore filamentis unilateraliter ramosis, ad 600—800 μ longis, 6—7 μ crassis, cellulis elongatis, diametro 10—17-plo longioribus, subclavatis. Pilis hyalinis praesentibus, 6 μ latis. Sporangia unilocularia ignota.

Thallus forming irregular cushions when adult, irregular creeping filaments when young, on the surface of the stipe of *Laminaria digitata*. Hairs are abundant on young plants, with sheath and basal growth. Erect filaments simple or unilaterally branched, and composed of elongated, more or less barrel-shaped cells, 6 μ in diameter and up to

4—10 (infrequently up to 17) times longer than broad. Also isodiametric, globular cells occur, in short moniliform filaments. Plurilocular sporangia simple or branched, 50—100 μ×6—7 μ, mostly uniseriate. Fertile plants found in June, July and August.

The epiphyte on the stipe of *Laminaria digitata* f. *stenophylla* collected on Lauköy, mentioned above, proved to be a dense growth of separate long-celled filaments with a very characteristic pectinate appearance. Their tops all reached the same level, 400—600 μ, or sometimes 600—800 μ, above the surface. The cells of the filaments were long and rather barrel-shaped and differed from the filaments of *Ectocarpus tomentosoides* occurring on the lamina and haptera of the same plant. The basal part of the epiphyte consisted of cushion-like formations, or sometimes a single layer of *Myrionemataceae*-type. Rhizoids were abundant and penetrated into the tissue of the host. The erect filaments could be simple and short, but were mostly half a millimeter long and unilaterally branched. The unbranched filaments were terminated by a plurilocular sporangium, usually uniseriate and about 100×6 μ. The number of pedicels varied, and sometimes sessile sporangia occurred. These parts of the algal carpet looked like the illustrations of *Myrionema corunnae* Sauv. given in Sauvageau (1897). When the length of the erect filaments was c. 500 μ, they were always unilaterally branched, and the branches developed into plurilocular sporangia similar to those just described for the short and simple filaments. But branches of a second order occurred also, bearing branchlets or sporangia unilaterally on their upper sides. When cells of filaments of different orders all produce plurilocular sporangia, a pectinate appearance results (fig. 8, g). Comparing the alga now described with the description of Gran (1893) referred to above, one is impressed by the close correspondence. Gran also points out that when the plurilocular sporangia are formed, even the pedicel may take part, so that the sporangium will be partly intercalary. This is also depicted in fig. 8.

Hairs are present but are not frequent. They are sessile, lateral or terminal, furnished with a sheath and have a basal growth; diameter 5 μ. Gran stated that no hairs occurred in his plants but, because of their rarity, he may have overlooked them. This absence of hairs, and the different length of the upright filaments (10 mm according to Gran, half a millimeter in the present material) are the only points of difference that have been found between these algae. (It is possible that his "10 mm" is a mis-print too.) As the present author has not had the opportunity to study Gran's material, it cannot at present be decided whether or not

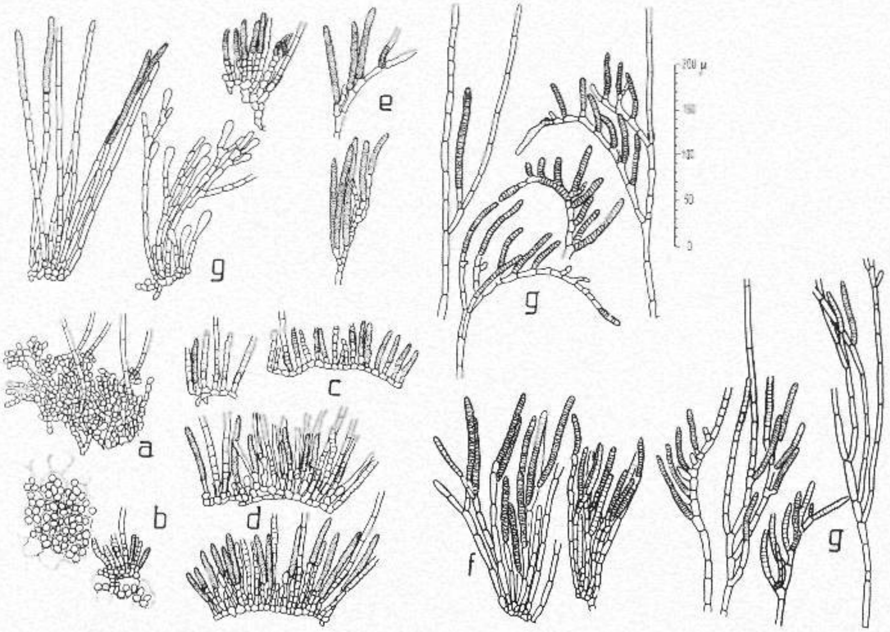


Fig. 8. *Myrionema corunnae* Sauv. emend. a—f: Specimens collected at Leiskjär, Risöy. g: Specimens from Lauköy. a: Peripheric part of the more or less confluent prostratum. b: Top of the endophytic cells filling up the cortical cells of the *Laminaria*. c: The first sporangia have formed. d: A new series of sporangia have formed in the dehisced sporangia. The remains of these disappear soon after. e: Elongated and fructiferous, unilaterally branched filaments. The one has been turned a right angle. f: A stage of transition to the Lauköy-appearance. g: Lower and upper parts of the bundles. The swollen apical cells were partly colourless, partly filled by a yellow content, and are presumed to be the same formations mentioned by Rosenvinge and Gran (see the text).

his species is an *Ectocarpus* or a *Myrionema*. — A similar epiphyte occurred on the tips of the lamina of *Laminaria digitata* collected in the Risöy archipelago in August 1951. In squash preparations, the alga squashes out into cell-rows, from which erect shoots project, usually one from every cell (fig. 8, c). The cells of the shoot develop either completely, or only partly into plurilocular sporangia of the same long and slender, uniseriate type described for the Lauköy specimens. The dimensions are (50—)90—100(—135)×6 μ. Hairs are abundant, with the sheath showing their endogenous formation. Their growth is basal. This Risöy plant corresponds very well with the description of *Myrionema corunnae*, as also did parts of the Lauköy material. Characters that do not correspond are the elongated pectinately branched filaments and the extreme development of the rhizoids, in the samples from Lauköy. However, because of the other similarities between the two samples, the author has hesitated to refer the Risöy plant to *M. corunnae* Sauv. A lot of preparations of the latter was examined systematically, and then some few of the erect filaments could be seen to exceed the length of the others, and the cells had got the very elongated barrel shape. These filaments also branched in the manner described for the Lauköy plant. The cell contents appeared to be similar in both (in the alcohol-preserved appearing as 1—2(—3) disc-shaped chromatophores).

As a result of a study of the material, the author has come to the following conclusions as to the lines along which the development of this particular alga (based on the material from Risöy and Lauköy) seems to run: The spore germinates to form a protonema, that branches laterally and longitudinally to form a net-work of widely spreading filaments, the meshes of which are gradually filled as the branching continues. Parts of the creeping system become endogenous and seem to occupy the outermost cells of the *Laminaria* tissue. Seen from above, the cells of the epi-endophyte are grouped according to the cell-wall pattern of the host. In this connection it is noteworthy that *Clathrodiscus* (*Myrionema*) *mandoulii* (Sauv.) Hamel (1931—39) resembles the present alga in many respects. It occurs on *Sacchoriza polyschides*, forms an ectocarpoid procumbent system, and has no disk of the usual *Myrionema*-type. The creeping filaments seems to follow the anticlinal walls of the host and it is presumed to be partly endophytic, sub-cuticular. The sporangia are of the *M. corunnae* - type, uniseriate. *Myrionema densum* Skottsberg (1921, p. 17) could be referred to the same *M. corunnae* group because of its irregular basal layer and its sporangia.

The superficial filaments of the Risöy alga produce erect shoots that soon develop into plurilocular sporangia. When the sporangium has discharged its spores, a new shoot may grow up through it, and the dehisced sporangium then disappears. The cells of this shoot are more or less rounded. A new sporangium may form on top of it; the sporangium discharges the spores and so on (see fig. 8, c). The development leads to the branched and elongated upright filaments that are predominating in the Lauköy material, and only now and then found in the Risöy material. The basal cells also continue branching, giving rise to a very dense, polystromatic cushion, with rhizoids penetrating deeply into the host. Because of these rhizoids, the alga is not easily removed from the *Laminaria*; this is the stage reached by the Lauköy material.

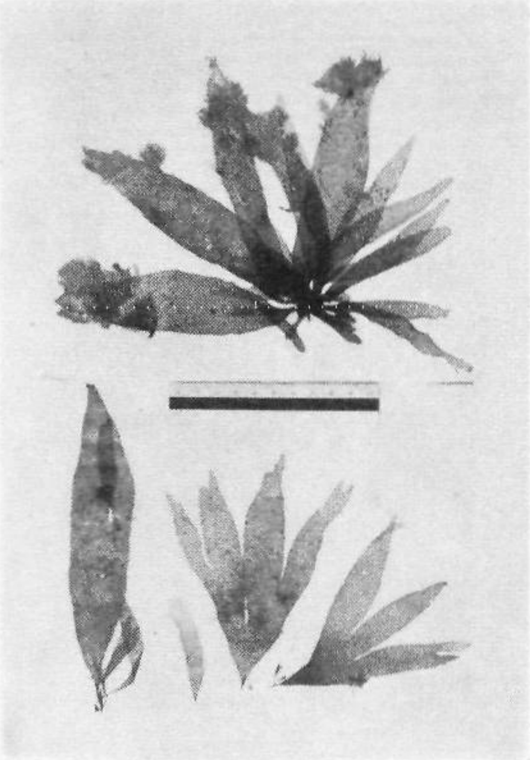


Fig. 9. *Rhodymenia palmata* (GREV.) AG. with spots of the epiphytic *Ascocyclus foecundus* (Strömf.) Reinke.

In squash preparations, the superficial rather than the rhizoidal cell system breaks, and so bundles of erect and fertile filaments resembling an *Ectocarpus* are obtained instead of the long cell-rows with erect filaments that are usually seen in the *Myrionema* preparations. The Lauköy plant cannot be an *Ectocarpus* because of its endogenous hairs (according to Hamel, 1931—39 pp. 4 and 86).

Gran described unilocular sporangia in his *E. tomentosoides* f. *norvegicus*. Rosenvinge & Lund (1941, p. 44) report similar structures in specimens from Greenland but presumed they were not sporangia; the swollen cells had a dense and refractive content and were compared rather with the ascocysts of the genus *Ascocyclus* Magnus. Similar structures have been observed in the present north-Norwegian material. Sometimes the cells were colourless, sometimes filled with a yellowish content. Such cells thus seem to occur in algae belonging to different genera. Fungi may also cause malformations reminiscent of unilocular sporangia; it seems probable that the Oslofjord specimens lacked such sporangia.

Foslie based the genus *Ulonema* on material from Lyngöy, about 1 kilometer south of Risöy. It differs from *Myrionema* in having more prominent rhizoids and in the open net-work of the peripherial part of the prostrate system. As Foslie included a species character (only unilocular sporangia, no plurilocular) in the diagnosis of this genus, he has restricted the number of species belonging to the genus to the one he found, *Ulonema rhizophorum*. Since rhizoids also occur in species of *Myrionema,* however, it is questionable whether the genus *Ulonema* can be maintained. The new genus *Clathrodiscus* Hamel (1931—39, p. 87) seems to be based on a more significant difference: the "non-héteroblastie". The reference of the north-Norwegian alga, i.e. plants from Risöy and Lauköy, to *Myrionema* is provisional as the author suspects it to belong to the same group as *Clathrodiscus mandoulii.* An Icelandic *Laminaria*-epiphyte also showed characters comparable with the alga described above and caused Jónsson (1903, p. 145) to describe a new form, *Myrionema corunnae* var. *filamentosa.*

It is rather unlikely that an alga, growing on the same substratum, and corresponding so well as the French (*Clathrodiscus mandoulii*) and the north-Norwegian (*Myrionema corunnae* emend.) specimens obviously do in many respects, should belong to different species. The problem requires further study based on living material from both countries.

Localities: *Troms*: Risöy (Tromsöysund) and Lauköy (Skjervöy).

Ascocyclus foecundus (Strömf.) Cotton

In Altafjord, the author analysed the algal vegetation in 1952. At two sites the *Fucus* zone was interrupted by zones or wide patches of a nearly pure community of yellow-coloured *Rhodymenia palmata,* that attracted particular attention because of a rich growth of a brown algal epiphyte on the *Rhodymenia* fronds, giving them a brown spotted appearance (fig. 9). The spots was 1.0—2.5 mm in diameter and proved to be a species of the genus *Ascocyclus* Magnus. The material was collected in August 1952.

The pseudoparenchymatous prostrate system can be removed quite easily from the surface of the host. The cells are c. 6—9 µ broad and about 1—2 times longer than broad. This prostrate system is partly distromatic. From the basal layer, ascocysts and hairs develop, appa-

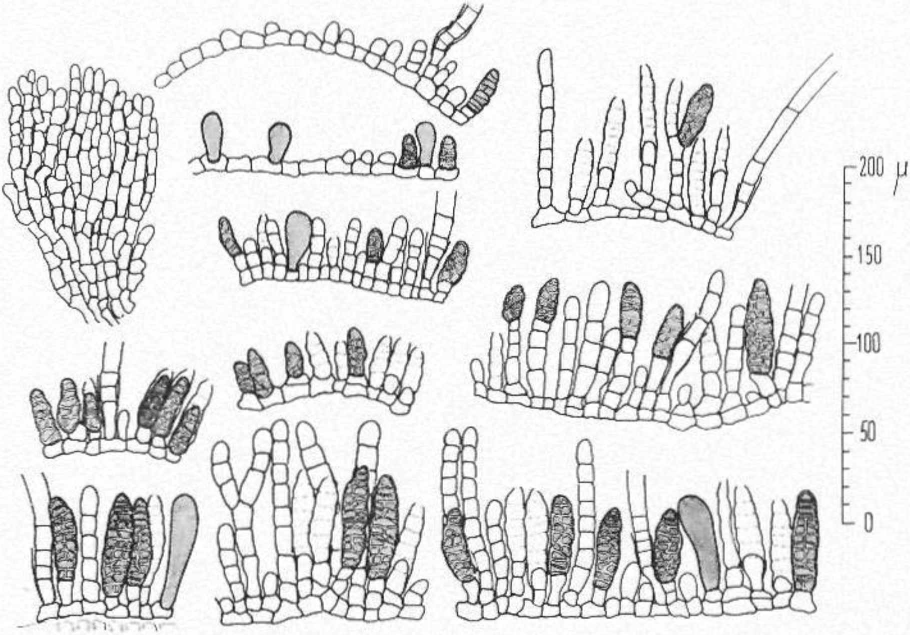


Fig. 10. *Ascocyclus foecundus* (Strömf.) Reinke with the peripheric part of the rather circular prostratum from above and from the side, with formation of ascocysts and hairs at an early stage. Scattered between the sporangia are vegetative filaments found, that may reach a length of 140 µ.

rently in that order. The former are 30—60 µ long, elliptical-clavate and 11—17 µ wide; they are abundant and invariably sessile. The hairs, also sessile, are 8—10 µ broad, and have a sheath and basal growth; the lowermost cell is somewhat elongated and tapers downwards. The plurilocular sporangia measure 25—50×12—15 µ, and are sessile or stalked. Sometimes two sporangia occur on the same stalk (fig. 10). They are frequently enclosed by the remains of dehisced sporangia. Scattered between the ascocysts and the sporangia, rather long assimilating filaments occur. They are usually simple, though a tendency to branching can be seen; length up to 140 µ, diameter 10 µ.

The epiphyte grew on both sides of the *Rhodymenia* fronds. Those on one side of the frond were better developed than the specimens on the other side; the smaller specimens were probably a shade form. In between these as to size, but perfectly corresponding to them in all other respects, we find *Ascocyclus islandicus* Jónsson (1903, pp. 149—151), also described as occurring on *Rhodymenia*. This is also the case with *Ascocyclus sphaerophorus* Sauvageau, both in France and on the west coast of Norway (Kylin, 1910). It should be noted also that the American *Rhodymenia*-epiphyte, *Ascocyclus distromaticus* Taylor, in most features corresponds to the European plants. (As mentioned above the prostrate layer was partly distromatic in the north-Norwegian plant too.) It was shown by Cotton (1912) that *Myrionema foecundum* (Strömf.) Foslie is in fact an *Ascocyclus*, and the name *Ascocyclus foecundus* (Strömf.) Cotton is therefore used here, including the synonyms *A. spaerophorus* Sauv., *A. islandicus* Jónss. and *A. distromaticus* Tayl. According to the description given for *A. saccharinae* Cotton (1912) this differs only in living on *Laminaria* instead of *Rhodymenia*, and should perhaps also be considered to be the same species (in agreement with Levring, 1937, and Newton, 1931).

Localities: *Troms*: Straumen (Malangen, collected by Foslie).
Finnmark: Lille Korsneset and Åröy in Altafjord.

References

CARAM, B. 1955. Sur l'alternance de generations chez Chordaria flagelliformis. Bot. Tidsskr. 52, 18—36 Köbenhavn.

COTTON, A. D. 1912. Marine Algae. Clare Island survey 15. Proceed. Royal Irish Acad. Vol 31. Dublin.

FOSLIE, M. 1894. New or critical Norwegian Algae. Norske Vidensk. Selsk. Skrifter 1894. Trondhjem.

GRAN, H. H. 1893. En norsk form av Ectocarpus tomentosoides Farlow. Christianias Vid. Selsk. Forhandl. No. 17. Kristiania.

HAMEL, G. 1931—39. Pheophycées de France. Paris.

HARVEY, W. H. 1846—51. Phycologica Britannica Vol II—III. London.

— 1849. Manual of the British Marine Algae. London.

HAUCK, F. 1885. Die Meeresalgen Deutschlands und Oesterreichs. Rabenhorst Kryptogamenflora Vol. 2. Leipzig.

KJELLMANN, F. R. 1883. The Algae of the Arctic Sea, Svenska Vet.-Akad. Handl. Vol 20: 5. Stockholm.

KLEEN, E. A. G. 1874. Om Nordlandens högre hafsalger. Öfversigt af Svenska Vet.-Akad. Förhandl. Stockholm.

KUCKUCK, P.—KORNMANN, P. 1954. Ectocarpaceen-Studien II Streblonema. Helgoländ. Wissensch. Meeresunters. Vol 5: 1 List/Sylt.

KYLIN, H. 1907. Studien über die Algenflora der schwedischen Westküste. Akadem. Avhandl. Uppsala.

— 1910. Zur Kenntnis der Algenflora der norwegischen Westküste. Arkiv för Botanik, Vol 10. Uppsala.

— 1918. Studien über die Entwicklungsgeschichte der Phaeophyceen. Sv. Bot. Tidskr. Vol 12: 1.. Stockholm.

— 1933. Über die Entwicklungsgeschichte der Phaeophyceen. Lunds Univ. Årsskr. N.F. Avd 2 Vol 33: 8. Lund.

Jonsson, H. 1903. The Algae of Iceland II Phaeophyceae. Bot. Tidsskr. Vol. 25: 2. Köbenhavn.

Levring, T. 1937. Zur Kenntnis der Algenflora der norwegischen Westküste. Lunds Univ. Årsskr. N.F. Avd. 2 Vol 33: 8. Lund.

Newton, L. 1933. A Handbook of the British Seaweeds. London.

Oltmanns, F. 1922. Morphologie und Biologie der Algen. Jena.

Printz, H. 1926. Die Algenvegetation des Trondhjemsfjordes. Norske Vidensk. Akad. i Oslo I Mat.-Nat. Kl. 5.

Reinke, J. 1892. Atlas deutscher Meeresalgen. Berlin.

Rosenvinge, L. Kolderup. 1893. Grönlands Havalger. Meddel. om Grönl. Vol. 3. Köbenhavn.

— 1898. Deuxième mémoire sur les Algues marine du Groenland. Ibidem Vol. 20. Köbenhavn.

— and Lund, S. 1941, 1947. The Marine Algae of Denmark. Vol. II Phaeophyceae. Det Kgl. Danske Vidensk. Selsk. Biol. Skrifter I: 4 and IV: 5. Köbenhavn.

Sauvageau, C. 1897. Sur quelque Myrionémacées. Ann. scienc. nat. Bot. S. 8 T. 5. Paris.

— 1933. Sur quelques algues pheosporees de Guéthary. Bull. Station biol. d'Arcachon. T. 30. Bordeaux.

Skottsberg, C. 1921. Botanische Ergebnisse d. schwed. Expedition VIII Marine Algae. Phaeophyceae. Stockholm.

Taylor, W. R. 1937. Marine Algae of the Northeastern Coast of North America. Ann. Arbor.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

On the Variation in Tortula subulata Hedw.

By SVEND RUNGBY

On the basis of a find from Hvalsø in the Danish island of Zealand C. Jensen (1923) described a new variety of *Tortula subulata* Hedw.: var. *lapidicola*, as follows: "Leaves a little narrower (than in the main species), border very distinct and continued close to the apex of the leaf and there confluent with the costa".

Until 1951 no other find, with a single exception for Denmark, seems to have been referred to this variety there or elsewhere, but during an examination in the year just mentioned of the material of *Tortula subulata*, collected in Denmark and kept in the Botanical Museum in Copenhagen, a number of the samples were found to correspond with the description of var. *lapidicola*, Rungby (1951).

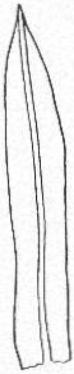
C. Jensen (1939), whose book undoubtedly is the only systematic work, except for the book quoted above and, recently, Podpěra (1954), in which var. *lapidicola* is mentioned, adds to the description: "Is evidently near var. *angustata* (Wils.) Limpr.", which then is described.

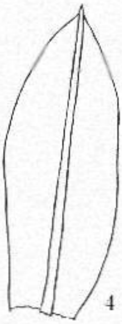
The moss just mentioned, to which, differently from var. *lapidicola*, many finds from stations spread over large areas of the northern hemisphere, none from Denmark, however, seem to be referred, was for the first time pointed out in 1855 by Wilson, who took it for an independent species, which he named *Tortula angustata*.

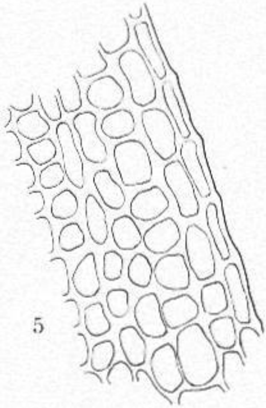
Wilson's own description has not been printed, but, after being treated by Lindberg (1864), the moss is in principally similar descriptions included in undoubtedly all important later systematic works under different synonyms.

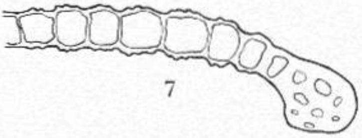
Schimper (1876) was the first to treat it as a variety: *Barbula subulata* var. *angustata*, and Limpricht (1888) agreed with this view, terming it *Tortula subulata* var. *angustata*.

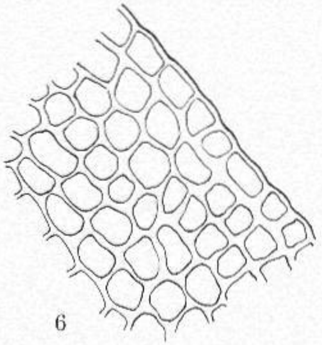
The particular descriptions are principally expressed in C. Jensen (1939): "Leaves narrow, with a longer tapering (than in the main spe-











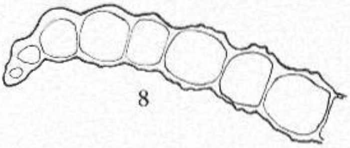


Fig. 1—4. Leaves of: 1. *Tortula subulata* var. *angustata* from Bornholm. — 2. *T. subulata* var. *lapidicola* from Hvalsø. — 3. *T. subulata* from Højby, Form II. — 4. *T. subulata* from Mogenstrup, intermediate between Form I and II. — ×10.

Fig. 5—6. Cells of the upper part of: 5. leaf 3. — 6. leaf 4. — ×300.

Fig. 7—8. Transverse sections, showing the border-cells of: 7. Leaf 1. — 8. Leaf 4. — ×300.

cies), at the apex distinctly toothed; border large, double-layered with lengthy, very thick-walled cells, at the apex confluent with the costa; capsule narrow".

A good picture is found in Braithwaite (1887).

In 1951 the Botanical Museum in Copenhagen received a sample of a moss found in the island of Bornholm, which very distinctly corresponded with the description of var. *angustata*, but compared with the material of var. *lapidicola* proved to be the extreme link in a series of forms in which all links in the main show all the characters of var. *angustata* with but little decreasing strength toward another extreme link, which is a little nearer to the main species, from which, however, it is clearly different (Rungby, 1951).

The material from Bornholm, directly appearing as var. *angustata*, could in other words be determined to var. *angustata* as well as to var. *lapidicola*, so that the question must arise, whether a distinction between these can be maintained.

By courtesy of the British Museum the author later had an opportunity to study Wilson's original material as well as his drawings and notes, all of which corresponds exactly with the description in C. Jensen (1939) and with the material from Bornholm.

For numerical illustration of the statement some measures are given in the table adjoined, including

1. The material from Bornholm.
2. C. Jensen's original sample of var. *lapidicola*.
3. Common *Tortula subulata* Hedw. from Mogenstrup in Zealand, intermediate between the forms I and II, mentioned below.

The broadness of the leaves and the costa is measured a little below the middle, the thickness of the capsule in the middle.

The leaves of 1 are sublinear or linear, partly with very long tapering (Fig. 1), of 2 for the most part sublinear or linear (Fig. 2), of both distinctly toothed at the apex, partly rather far down. The border is in both double-layered, the lumen of its cells is frequently small, sometimes almost vanishing (Fig. 7). In 3 the leaves are obovate (Fig. 4), partly very large, entire or insignificantly denticulate at the apex. The border is single-layered (Fig. 8).

As, accordingly, the characters stated by C. Jensen for var. *lapidicola* coincide with characters described for var. *angustata*, and the specimens referred to var. *lapidicola*, as stated, in addition mainly have all the other *angustata*-characters described, particularly leaves with long tapering and toothed at the apex, double-layered border of lengthy, thick-walled cells, narrow capsule, and as no new distinctive characters could be pointed out, it seems proper, in future, to ignore var. *lapidicola* C. Jensen (1923) and to refer all samples showing the characters here dealt with to *Tortula angustata* Wilson.

As to the systematic value of this, the series of forms described above and illustrated by the table, even if the links differ little from each other, supports Schimper's and Limpricht's conception, so that the most proper name seems to be the name common today outside England: *Tortula subulata* Hedw. var. *angustata* (Wils.) Limpr.

Table I.

	a	b	c	d	e	f	g	h	i	j	k	l
1.	5	660	80	140–270 *	15–19	15–19	4–8	20	6	600	1320	12–15 ††
2.	6	840	80	140–270 *	11–15	12–19	3–7	25	6	600	1450	12–15 ††
3.	4	1260	130	110–160 **	7–12	12–19	2–3	15	5	960	1200	12–19 †

a. Length of leaves, mm
b. Breadth of leaves, µ
c. Breadth of costa, µ
d. Length of border cells, µ
e. Breadth of border cells, µ
f. Breadth of other cells in upper part of leaf, µ
g. Thickness of walls of border cells, µ
h. Length of seta, mm
i. Length of capsule, mm
j. Thickness of capsule, µ
k. Length of basal membrane, µ
l. Spores, µ
* and shorter or longer
** or shorter
† very finely papillose
†† most finely papillose

A similar opinion is expressed by Steere (1940), who in favour of this conception mentions the occurrence of intermediate forms between *Tortula subulata* and *Tortula angustata*. Such intermediate forms can hardly be others than such as C. Jensen would call var. *lapidicola*.

Mention may be made of the following statements in the literature concerning the frequency and habitats of var. *angustata*: Dixon (1924). High exposed banks, rare. — Mönkemeyer (1927). An sonnigen Stellen. Weniger häufig. — Steere (1940). Known in North America only from California.

In the case of Denmark it may be mentioned in connexion with the statement by Rungby (1951), that the material from Bornholm was found on limestone slightly covered with earth, in the shade, on the border of a brook, and that distinct var. *angustata* is found on calcareous soil in a wood near Fakse Ladeplads in Zealand.

As to the main species it may be added that two forms can be distinguished:

I. More rigid, dark green; leaves large with very short tapering and with slight short border; the upper marginal cells almost isodiametrical, as the cells inside the margin (Fig. 6 partly).
II. A little softer, brownish green; leaves less large, tapering (Fig. 3), with somewhat stronger border; the upper marginal cells partly, frequently to a considerable extent, a little narrower and longer than the cells inside the margin, which in the uppermost part of the leaf, even close to the costa, can be somewhat longer than broad (Fig. 5).

The two forms gradually pass into each other. From the same locality they are in the Danish herbarium represented by finds from Højby in the island of Funen. What is said about them might serve as an addition to the description in Subsection I. Integrae in Warnstorf (1912), which treatise presumably includes all marked forms of *Tortula subulata* described at that time.

In this connexion it may be mentioned that a certain material, referred to var. *angustata,* found in Sweden and kept in the Botanical Museum in Lund, which was borrowed in connexion with the examination here dealt with, does not seem to correspond to the characters stated for var. *angustata,* but rather with Form II inside the main species.

Finally the author offers his best thanks to K. Holmen, M.sc., for drawing the figures and for advice in many respects, to the British Museum for permission to study Wilson's material, and to the Botanical Museum in Lund for placing material at his disposal for the investigation.

Literature cited

BRAITHWAITE, R. 1887. The British Moss-Flora I. 221. — T. XXXII, c. — London.

DIXON, H. N. 1924. The student's handbook of British Mosses. Ed. 3. 200. — Eastbourne.

JENSEN, C. 1923. Danmarks Mosser II. 350. — København.

— 1939. Skandinaviens Bladmossflora. 198. — København.

LIMPRICHT, K. G. 1888. Die Laubmoose Deutschlands, Österreichs und der Schweiz. — Rabenh. Krypt. Fl. — Abt. I. Lief. XI. 671. Leipzig 1890.

LINDBERG, S. O. 1864. De Tortulis et ceteris Trichostomeis europæis. — Övers. Kgl. Vet.-Akad. Förh. XXI. 243. Stockholm 1865.

MÖNKEMEYER, W. 1927. Die Laubmoose Europas. — Rabenh. Krypt. Fl. IV. — Ergänz.band. 307. Leipzig.

PODPĚRA, J. 1954. Conspectus Muscorum europaeorum. 250. — Praha.

RUNGBY, S. 1951. Moss. udbr. i Danm. IV. Sl. Tortula Hedw. — Dansk Bot. Tidsskr. 48. 436. København.

SCHIMPER, W. PH. 1876. Synopsis Muscorum europaeorum. Ed. 2. II. 224. — Stuttgart.

STEERE, W. C. 1940. Tortula in North America north of Mexico. — The Bryologist 43. 16. Ann Arbor.

WARNSTORF, C. 1912. Der Formenkreis der Tortula subulata (L.) Hedw. und deren Verhältnis zu Tortula mucronifolia Schwaegr. — Hedwigia 52. 65. Dresden.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

De skandinaviska arterna i Cardamine pratensis - komplexet

AV BÖRJE LÖVKVIST

(Meddelanden från Lunds Botaniska Museum, Nr 117)

Släktet *Cardamine* tillhör familjen *Cruciferae* och förekommer i kalla och tempererade trakter samt inom högre bergsområden i tropiska och subtropiska regionerna. Sammanlagda antalet arter kan uppskattas till c. 160. Av släktets 12—14 sektioner är *Dentaria, Cardaminella* och *Eucardamine* representerade i Skandinavien. *Cardamine bulbifera* (L.) Crantz är den enda av våra arter, tillhörande *Dentaria, C. bellidifolia* L. den enda ur *Cardaminella,* medan våra övriga arter räknas till *Eucardamine.*

Inom *Eucardamine* urskiljes *C. impatiens* L. lätt genom att stjälkbladen har stipler, som saknas hos övriga skandinaviska arter. *C. flexuosa* With., *C. hirsuta* L. och *C. parviflora* L. är liksom *C. impatiens* småblommiga i motsats till *C. amara* L. och *C. pratensis* - komplexets arter, som äro storblommiga. *C. amara* har spetsigt, kalt märke, medan *C. pratensis* - komplexets arter, *C. pratensis* L., *C. palustris* Peterm. och *C. Nymani* Gand., har ett mer el. mindre halvklotformigt, papillöst märke, *C. amara* har därtill nästan alltid violetta ståndarknappar medan dessa hos *C. pratensis* - komplexets arter är gula, även om man någon enstaka gång kan finna en violett anstrykning hos starkt antocyanfärgade individ.

Cardamine pratensis - komplexets mångformighet är väl bekant. Om värdet av olika taxa, som beskrivits har delade meningar rått. Medan vissa forskare anser, att man kan få fram ett antal skilda taxonomiska enheter, anser andra, att dessa endast är produkter av ståndorternas modifierande verkningar.

År 1832 skiljer Hartman ut *C. pratensis* β *speciosa* och påpekar att den förutom större kronblad och bredare småblad än huvudformen även har skild ekologi.

År 1903 utkom en omfattande *Cardamine*-monografi av O. E. Schulz. I den användes *C. pratensis* L. i sin allra vidsträcktaste bemärkelse. Schulz' indelning blir därför mycket komplicerad, och han använder sig av undergrupperingar omfattande en serie av subspecies, en av prolae, en av varietates och tre serier av formae. Inom några av dessa finnes därtill underavdelningar. Schulz' system ser ut så här:

C. pratensis L.
  B. subspec. *granulosa* (Allioni) O. E. Schulz
  C. subspec. *Iliciana* Fritsch
  D. subspec. *angustifolia* Hooker
  E. subspec. *chinensis* O. E. Schulz
 II. prol. *Hayneana* (Welwitsch) Schur
   f. *pumila* Haussknecht
 III. prol. *crassifolia* (Pourret) O. E. Schulz
   f. *rivularis* (Schur) O. E. Schulz
 b. var. *palustris* Wimmer et Grabowski
 c. var. dentata (Schultes) Neilreich
   f. *nemorosa* Lejeune
 d. var. *fluitans* O. E. Schulz
 2. f. *arctica* O. E. Schulz
 b. f. *grandiflora* Gilibert
 c. f. *parviflora* Wimmer et Grabowski
 2. f. *praticola* (Jordan) Rouy et Foucaud

Större betydelse för skandinaviska förhållanden än Schulz' monografi har ett arbete av Lindman (1914) haft. I detta kritiserar han rätt ingående vissa av Schulz' slutsatser, och föreslår i stället följande indelning vad det gäller svenskt material:

C. pratensis L. (emend.)
  f. *tenuifolia*
  f. *rivularis* Schur
  f. *grandis*
C. dentata Schultes (emend.)
  f. *isophylla* Petermann
  f. *heterophylla* Petermann
   f. *micrantha*
   f. *tenuifolia*
  f. *lapponica*

Lindmans indelning har emellertid visat sig vara svår att följa. Närmast av den anledningen togs denna grupp upp till förnyad behandling och undersökning med hjälp av odlingsexperiment, kromosomtalsbestämning och korsningsförsök. En närmare presentation av dessa undersökningars resultat har tidigare getts (Lövkvist 1956). Den systematiska indelningen är där följande:

C. crassifolia Pourret
C. Nymani Gandoger
C. Matthioli Moretti
C. granulosa Allioni
C. pratensis Linné
    var. *nemorosa* Lejeune
    var. *latifolia* Lejeune
C. rivularis Schur
C. palustris Petermann
    var. *isophylla* Petermann

Det material som studerats i odling omfattar mer än 3000 plantor från olika delar av Sverige och också från Danmark, Finland, Island, Norge, Spetsbergen, Brittiska öarna, Tyskland, Frankrike, Schweiz, Österrike, Italien, Portugal.

Odlingsexperiment visar, att de skandinaviska typerna kan hänföras till två grupper med rosettbladens småblad och pollenet som de viktigaste skiljande karaktärerna. På grund av de två gruppernas olika geografiska utbredning har de benämnts den tempererade gruppen och den arktiska gruppen. Rosettbladens småblad är hos den tempererade gruppens typer relativt tunna, nästan alltid loberade eller grovt tandade och med nerverna tydliga på småbladens undersidor. Den arktiska gruppens typer däremot har rosettblad med köttiga småblad, vars nervatur är mera insänkt i bladskivan, småbladen är helbräddade, möjligen kan uddbladet någon enstaka gång ha en grov tand på vardera sidan, särskilt tycks detta gälla plantor, som växer i extremt nordliga lägen eller i höjdlägen i Skandinavien.

Beträffande de pollenmorfologiska skillnaderna skall dessa ytterligare undersökas, men det kan framhållas, att den arktiska gruppens pollen har en finmaskigare ytstruktur än den tempererade gruppens. Det är ovanligt att inom familjen *Cruciferae* finna en så tydlig pollenmorfologisk skillnad mellan så närstående grupper. *Cardamine pratensis* L. och *C. palustris* Peterm. tillhör den tempererade gruppen och *C. Nymani* Gandoger är den arktiska gruppens enda art.

Kromosomtalsförhållanden

Undersökningar över kromosomtalen inom *Cardamine pratensis sensu latissimo* (Lövkvist 1947, 1950, 1956, Banach 1950, 1951) visar ett vidsträckt »polyploid complex» (Babcock & Stebbins 1938).

Basen för ett polyploid-komplex innefattar flera diploider, från vilka genom auto- och allopolyploidi typer på tetraploid och högre nivåer uppstår. Ju flera diploider, som ingår, desto mera kritiskt torde komplexet bli ur taxonomisk synpunkt. Morfologiska karaktärer kommer att växla inom samma kromosomtalstyp, därför att hybridiseringar mellan populationer på samma kromosomtalsnivå, men med skilda ursprung, sker. Utklyvningsprodukter härifrån kan stabiliseras genom selektion i samband med t.ex. ekologiska förändringar. I sådana hybridogena populationer, s.k. hybridsvärmar, torde den rent morfologiska variationen vara mycket stor, och även ge en vidare amplitud än de sammantagna diploida ursprungspopulationerna för hela polyploidkomplexet.

Inom *Cardamine pratensis* - komplexet gäller det ovan uppskisserade förhållandet särskilt för den tempererade gruppen. Emellertid kommer vi något utanför det vanliga systemet i polyploida komplex med jämna multipla serier av ett bestämt grundtal, på grund av en egendomlighet i kromosomstrukturen. För att få en klar bild av detta är det nödvändigt att också ta diploiderna i betraktande, ehuru de ej förekommer i Skandinavien. De har, så vitt man nu känner, det somatiska kromosomtalet 16, grundtalet tycks alltså vara 8. Rent regelmässigt skulle det tetraploida talet vara 32. Detta är även känt (Mattick 1950, Banach 1951), men det vanligaste talet är 30, vilket har meddelats av ett stort antal författare (Lawrence 1931, Guinochet 1946, Lövkvist 1947, 1950, 1956, Hussien 1949, Banach 1950, 1951). Redan Lawrence pekade på förekomsten av två långa kromosomer och antog att en fusion mellan två kromosomer av normal längd skett, varigenom talet reducerats till 30, utan att någon större förlust av genmaterial torde ägt rum. Fusionen kan också ha uppstått på diploid nivå. Det skulle då finnas eller ha funnits en diploid med $2n=14$.

I rotspetspreparat räknas de två långa kromosomerna lätt såsom fyra, varför kontroll i tveksamma fall måste företagas i meiosispreparat, och vad det gäller material, som jag haft i odling, har det alltid i sådana fall visat $n=15$. Ovan har nämnts att det normala tetraploida talet är 32, och att detta också är funnet av bl.a. Mattick, men hon har även iakttagit $2n=28$, detta i österrikiskt material. Således finns inom *Cardamine pratensis* - komplexets tempererade grupp två grundtal, förutom det tydligen mera ursprungliga 8 även 7. Med utgångspunkt från detta faktum, kan man våga påstå, att det tetraploida talet 30 finns hos plantor med 2 genom med 8 kromosomer och 2 genom med 7. På samma sätt måste vi tänka oss att de 56-kromosomiga octoploida plantorna har 8 genom alla med 7 kromosomer, medan de 64-kromosomiga octoploiderna har 8 genom med 8 kromosomer vardera.

Av *C. pratensis* finns diploida, tetraploida och hexaploida populationer, men endast tetraploida är företrädda i Skandinavien. Alla plantor har här $2n=30$ (c. 400 undersökta).

Av *C. palustris* finns octoploida, decaploida och dodecaploida populationer i Skandinavien. De octoploida talen är, som ovan nämnts 56 och 64, därtill förekommer plantor med 60 på ett fåtal lokaler på ett sådant sätt, att det inte är uteslutet, att de utgör en ren population. Sannolikare är dock, att de är av hybridogent ursprung och kanske primärhybrider mellan de två octoploida huvudtyperna. I hybridsvärmar är samtliga tal mellan 56 och 64 funna.

De decaploida talen är i rena populationer 72, 76 och 80. Plantor med talet 70 förekommer också, men frekvensen är för liten, för att avgöra om det gäller klonbestånd eller verkliga populationer. Plantor med $2n=72$ och 76 är vanliga inom stora delar av södra och mellersta Skandinavien och hybridsvärmar mellan dem är mycket ofta förekommande. Talet 80 finnes hos plantor i fuktiga skogar och längs skogsbäckar i östra Svealand och på Gotland. Endast på lokaler med något rikligare ljustillgång blommar de.

Dodecaploida plantor är hittills endast funna på Gotland. Det exakta kromosomtalet har varit svårt att bestämma, men det ligger mellan 90 och 96.

Det är möjligt att det inom *C. palustris* förekommer en population med $2n=68$. En rad lokaler har nämligen plantor med detta tal. Emellertid ingår flera av dessa i hybridsvärmar mellan *C. palustris* - plantor på octoploid och decaploid nivå. Det är möjligt att en stabiliserad population med 68 kromosomer kan uppstå.

Ovan har talats om hybridsvärmar mellan olika *C. palustris* - populationer. Man frågar sig därför, om det inte är tänkbart, att hybridsvärmar mellan de tetraploida *C. pratensis* - plantorna och t.ex. octoploida *C. palustris* kan förekomma. Endast en planta, som utgjort en hybrid mellan *C. pratensis* och *C. palustris*, har hittills iakttagits. Den var 43-kromosomig och växte i området mellan en *C. pratensis* - population och en 56-kromosomig *C. palustris* - population i Holmby (Skåne). Plantan var fullt fertil och kunde med gott resultat korsas med såväl *C. pratensis* - plantor som med flera olika *C. palustris*. Den var även fullt fertil med hexaploida ($2n=44$) plantor från Frankrike, tillhörande *C. pratensis*.

I Almundsryd, Norraryd (Småland), har en 45-kromosomig planta påträffats i en normal 30-kromosomig *C. pratensis* - population. Den torde vara resultatet av en sammansmältning av en reducerad och en oreducerad gamet.

Den arktiska gruppens enda art, *C. Nymani*, är cytologiskt något mera enhetlig, så vitt nu är känt. Det vanligaste talet är $2n=64$, bestämt från en rad lokaler i den skandinaviska fjällregionen och också från Spetsbergen (även av Flovik 1940). En lokal i norra Norge (Prestvatn, Tromsöya) har decaploida plantor av *C. Nymani* med $2n=80$. Från några områden i västra Jämtland har insamlat material kromosomtal mellan 60 och c. 90, tillsammans med det normala 64. Noggranna fältundersökningar på flera lokaler tyder på att dessa plantor kan utgöra komponenter i hybridsvärmar mellan den vanliga 64-kromosomiga populationen och en population med högre tal, kanske på dodecaploid nivå. Ytterligare fältundersökningar erfordras emellertid för lösandet av detta problem.

Cardamine pratensis L. — Även i den inskränkta bemärkelse som arten här tages är den mångformig, med diploida, tetraploida och hexaploida populationer. I Skandinavien har endast tetraploider ($2n=30$) påträffats.

C. pratensis är extremt allogam och så gott som samtliga undersökta plantor ha visat sig vara självsterila. Fröbildningen är sexuell. Vegetativ förökning förekommer regelbundet i form av adventivskott på rosettbladen. Dessa skott uppkommer ur epidermala cellkuddar och utbildas framförallt under perioder med hög fuktighet och då rosettbladen är skuggade av den omgivande vegetationen, normala år företrädesvis under sensommaren och hösten. Former med stora uddblad tycks ha en kraftigare vegetativ förökning än övriga.

Jordstam kort, med en eller flera bladrosetter; från varje rosett en, (sällan 2—3), 15—20 cm hög, glatt stjälk. Rosettbladen, hos de i Skandinavien förekommande typerna med 2—7 bladpar; småbladen mestadels oskaftade, av växlande form, vanligen hjärtlikt rundade och svagt loberade med en liten udd på varje lob, kanten särskilt hos plantor med få bladpar och stort uddblad ofta vågig; småbladens yta sträv; bladens smak starkt bitter. Nedre stjälkbladens småblad mer eller mindre skaftade, över oskaftade; småbladens antal minskar ju högre bladet är placerat, småbladens bredd likaledes; de övre stjälkbladens småblad smala, jämnbreda, med på mittnerven nedlöpande skiva. Blomställning med 8—30 blommor, toppställd, sidoblomställningar i vecken av de övre bladen förekommer ibland. Foderblad kortare än 4 mm. Kronblad vita—violetta, oftast med tydlig ådring i mörkare nyans, längd 8—11 mm, bredd 4—7 mm. Ståndarknapparnas längd i färskt

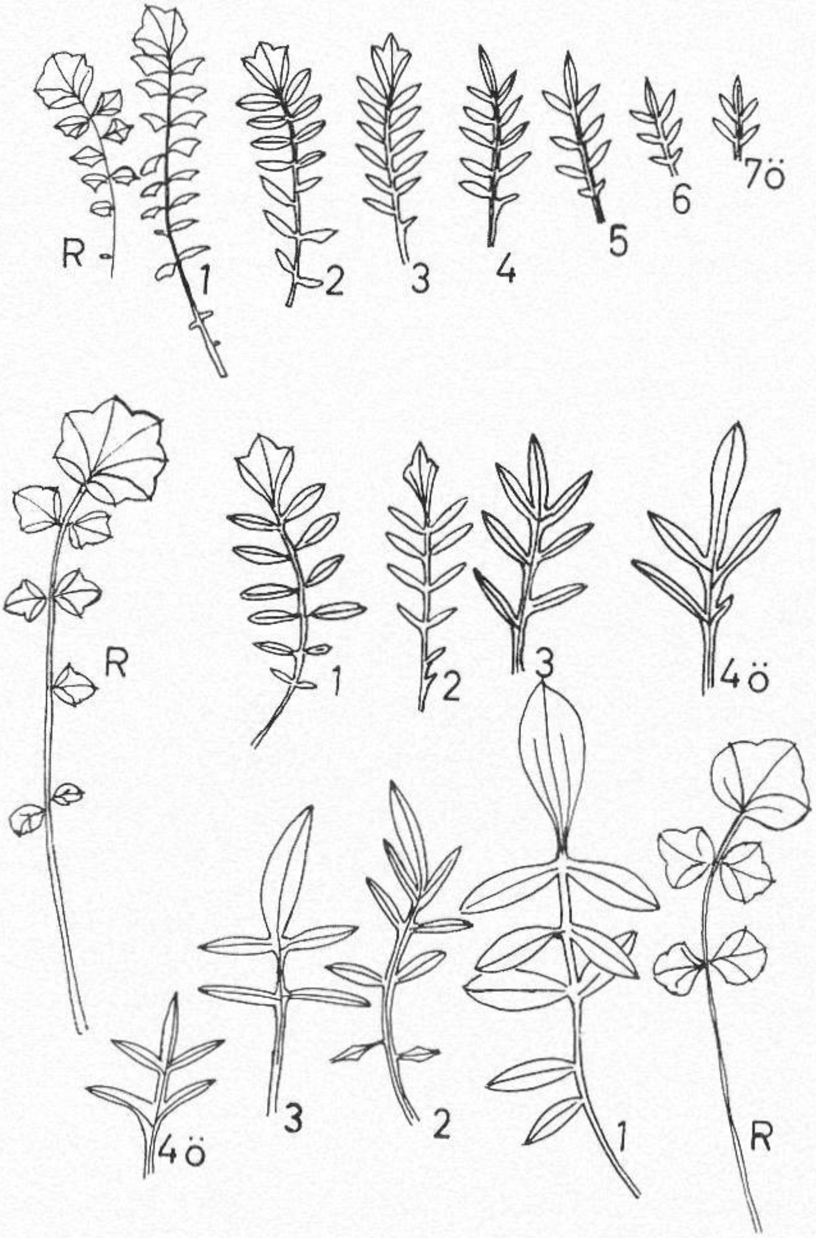


Fig. 1. *Cardamine pratensis* L. $2n=30$. Bladserier av plantor av tre olika typer. R=rosettblad. 1, 2, 3, o.s.v.=stjälkblad, siffran anger bladets placering på stjälken nedifrån räknat. ö=översta stjälkbladet.

tillstånd 0,8—1,4 mm. Pistillen smal, märke 0,7—0,9 mm brett; brevistyla typer förekommer sällsynt. Skidor 20—40 mm.

Utbredning. Sverige: vanlig i Götalands och östra Svealands jordbruksområden, endast två lokaler i Norrland kända (1 i Gästrikland, 1 i Jämtland). Danmark: vanlig inom jordbruksområden, sällsynt på vissa delar av Jylland. Norge: förekommer i odlade bygder i södra och västra delarna. (1 lokal på Tromsö undersökt av förf. Belägen mer än 6° nordligare än närmaste förut kända lokal.)

Cardamine palustris Petermann. — Arten är mångformig och omfattar typer på octoploid ($2n=56$, [60], 64), decaploid ($2n=72$, 76, 80), dodecaploid ($2n=$c. 96) nivå, samt ev. en typ med $2n=68$. Samtliga är påträffade även i Skandinavien.

Även *C. palustris* är strängt allogam och plantorna äro nästan undantagslöst självsterila, med sexuell fröbildning. Vegetativ förökning är starkt utpräglad, dels i form av adventivskott på rosettbladen, dels såsom rotslående skott i stjälkbladens veck och i blomställningen.

Jordstam vanligen kort, stjälk oftast enkel, glatt, intill 65 cm hög. Rosettblad med mestadels skaftade småblad, av växlande form: njurformade med väl utvecklade skaft; runda—äggrunda, men grovtandade, mer eller mindre skaftade; runda—ovala med 2—3 uddar på varje sida, kortskaftade. Bladens smak ej bitter. Alla stjälkblad, även de övre, med skaftade småblad, men 56-kromosomiga former kan modifieras under torrår i fråga om de övre stjälkbladens småbladsskaft, så att detta knappast framträder. Dessa former skiljes från *C. pratensis* genom de större foder- och kronbladen. Stjälkbladens småblad är hos de decaploida formerna långskaftade, hos 76-kromosomiga plantor med bred, grovtandad bladskiva (var. *isophylla* Peterm.), hos 72- och 80-kromosomiga med brett lansettlik, helbräddad småbladsskiva. Blomställning med 6—30 blommor, någon gång med sidoblomställningar i det översta stjälkbladets veck. Foderblad över 4 mm långa. Kronblad vita—ljust violetta, sällan med mörkare ådring; längd 12—19 mm, bredd 7—13 mm. Ståndarknapparnas längd i färskt tillstånd över 1,2 mm. Pistill grov, märke 0,8—1,2 mm brett. Skidor 30—55 mm.

Utbredning. Sverige: vanlig i Götaland och Svealand och inom jordbruksområden i Norrland. Norge: framförallt inom uppodlade områden i södra och västra delarna upp till Nord-Tröndelag. Danmark: vanlig inom större delen av landet.

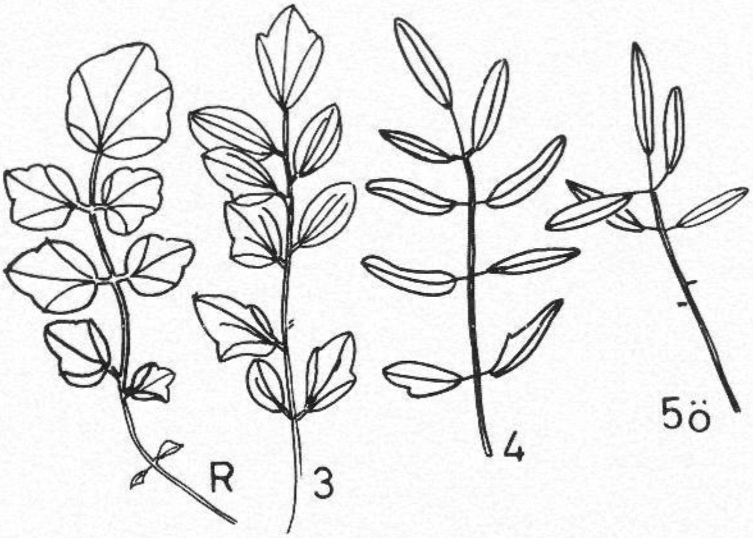


Fig. 2. *Cardamine palustris* Peterm. Bladserie (ej fullständig) av octoploid planta. Förkl. se fig. 1.

Cardamine Nymani Gandoger. — Denna art förekommer i sitt skandinaviska utbredningsområde med flera former på octoploid nivå ($2n=64$), en lokal har decaploida ($2n=80$) plantor, medan inom förmodade hybridsvärmar i västra Jämtland flera tal mellan 60 och c. 90 förekommer.

C. Nymani är liksom de två föregående arterna allogam och självsteril. Vegetativ förökning förekommer i mycket stor skala i form av adventivskott på rosettbladen och även från stjälkbladen, men mera sällsynt. Rosettbladens småblad är lätt avfallande särskilt efter frost, och har då förmåga att producera adventivskott. Under regniga perioder kan småblad med vattnets hjälp spridas långa sträckor, och det är inte ovanligt, t.ex. vid Torne Träsks stränder, att finna sådana nedspolade, »rotslående» rosettsmåblad.

Jordstam oftast kort, om submers mera långsträckt; vanligen flera bladrosetter, men endast en med stjälk. Stjälk 5—16 cm, i skugga —35 cm. Rosettbladen med köttiga småblad; nervaturen mer eller mindre inbäddad; småbladen cirkelrunda eller ovala, vanligen skaftade, helbräddade, dock kan uddbladet vara försett med en grov tand på vardera sidan, men sällsynt. Stjälkbladen 2—4 (hos högvuxna ex. 4—7) mestadels köttiga, nästan jämnbreda; småbladens antal minskar ju högre bladet är fäst, vanligen resp. 7, 5, 3 nedifrån räknat. Blomställning med 6—16 blommor. Foderblad 3,6—4,4 mm. Kronblad vita—violetta, 9—12,3 mm långa, 4,8—6,8 mm breda. Ståndarknappar i färskt tillstånd 0,9—1,4 mm. Pistill tämligen grov med c. 16 fröämnen. Skidor 10—18 mm.

Utbredning. Förekommer inom Skandernas fjällregion utefter hela dess längd och norr om 68° ofta ner till havets nivå. I Lappland förekomster även inom skogsområdet öster om den egentliga fjällregionen. En form med lansettlika rosettsmåblad har utbredningen inskränkt till de västligaste delarna av Lule, Pite och Lycksele lappmarker och förmodligen angränsande delar av Norge.

I fråga om den taxonomiska differentieringen inom denna art bör det påpekas, att huvudtypen är identisk med *C. dentata* Schultes f. *lapponica* Lindman (Lindman 1914). Formen med lansettlika småblad har av somliga uppfattats som varande *C. pratensis* L. var. *angustifolia* Hooker (Selander 1950). Någon avgörande ståndpunkt kan jag i det fallet inte inta, förrän jag haft tillfälle att odla kanadensiskt material sida vid sida med svenskt. I västra Jämtland förekommer som nämnts plantor med höga kromosomtal. Dessa plantor avviker rent morfologiskt från huvudtypen genom ett större antal stjälkblad och genom att antalet småblad är mycket stort. Det skulle vara mycket tacknämligt om skandinaviska botanister kunde ha denna typ i åtanke vid exkursioner i våra fjälltrakter, varigenom en bättre bild av dess utbredning och taxonomiska värde kunde erhållas.

Ekologi

Av *C. pratensis* - komplexets tre skandinaviska arter förekommer *C. pratensis* och *C. palustris* ofta på samma lokal, men regionalt fördelade med *C. pratensis* på torrare områden, *C. palustris* på fuktigare. Den tredje arten, *C. Nymani*, är bunden till fjällregionen och tycks endast i undantagsfall stöta samman med *C. palustris*, t.ex. i Jämtland.

Samtliga hittills i Skandinavien funna typer av komplexets arter är att betrakta som eutrofa. De två typerna av *C. Nymani* har närmare studerats av Selander (1950) i västra Lule Lappmark, och han har där funnit att huvudtypen är »amphicline» medan den lanceolata typen är »basocole». Mina egna fältundersökningar i fråga om den lanceolata typen pekar i samma riktning, men hänför sig endast till fyra lokaler, alla belägna inom Selanders undersökningsområde.

I Kungsmarken inte långt från Lund, förekommer *C. pratensis* och

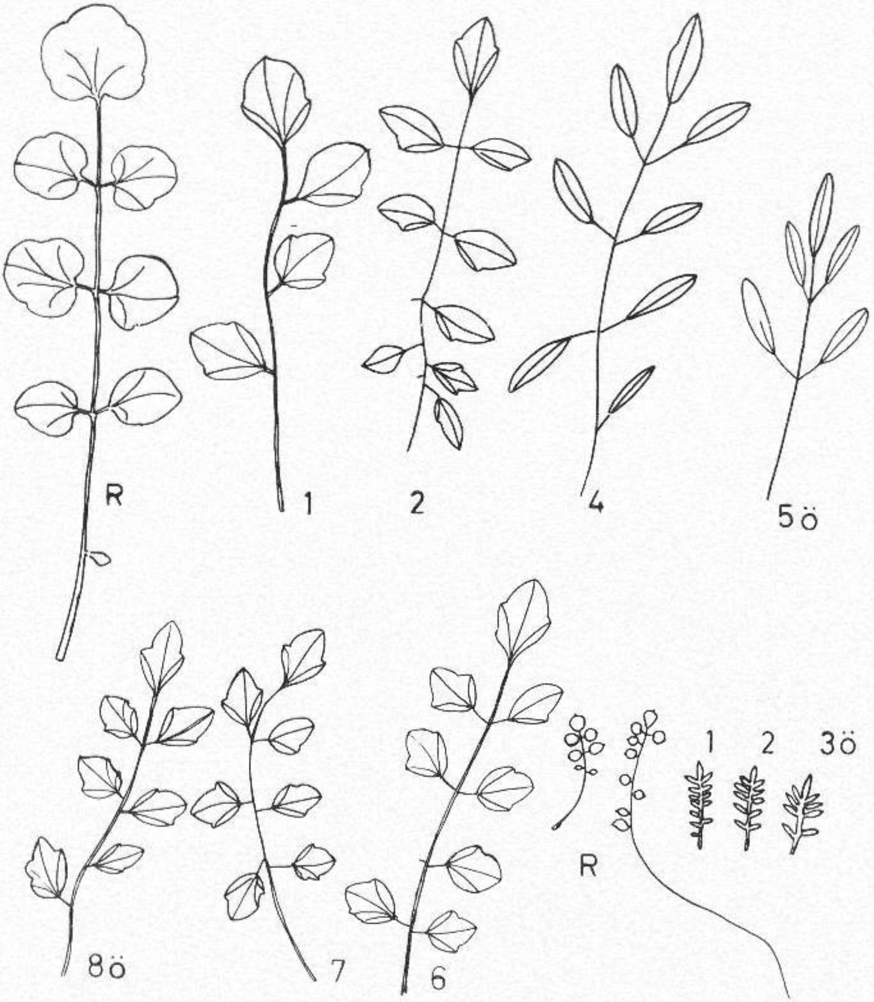


Fig. 3. Övre raden: *Cardamine palustris* Peterm. (R, 1—5 ö), hel bladserie av 72-kromosomig planta.
Nedre raden t.v.: *Cardamine palustris* Peterm. var. *isophylla* Peterm. (6—8 ö), de tre övre stjälkbladen av 76-kromosomig planta.
Nedre raden t.h.: *Cardamine Nymani* Gand. (R, 1—3 ö), hel bladserie av 64-kromosomig planta.

56-, 60-, 64-, 68-, 72- och 76-kromosomiga plantor av *C. palustris*. Inga säkra hybridsvärmar har iakttagits, utan man kan förutsätta, att de olika typerna förekommer i relativt stabila växtsamhällen, där i varje fall inga störande ingrepp gjorts i sen tid. Alla plantor från högre belägna delar tillhör *C. pratensis*. De växer där marken är relativt torr och växtsamhällena väl slutna. Inom de allra torraste partierna förekommer de endast i områden med friskare grön örtfärg än den allra närmaste omgivningen. Detta tyder på att vatten här finns lättare tillgängligt och kanske arten befinner sig på gränsen till sitt minimibehov av markfuktighet. *C. pratensis* är också vanlig på väldränerade sluttningar i tämligen högvuxen vegetation, företrädesvis av olika graminider. *C. pratensis* - plantorna är här svåra att upptäcka även under blomningen, eftersom blomställningen ofta har färre blommor än vad som är vanligt i lågvuxen vegetation.

I lägre delar av Kungsmarken, där markens vattentillgång är betydligt större, växer *C. palustris* - typerna. De är inte slumpvis utspridda utan fördelas regionalt, delvis beroende på markens fuktighetsgrad. Av de octoploida populationerna förekommer den 56-kromosomiga vanligast och är den som närmast ersätter *C. pratensis*, som ju är tetraploid. I Kungsmarken finns mellan *C. pratensis* och de 56-kromosomiga *C. palustris* - plantorna ett väl synligt bälte nästan utan *Cardamine*-plantor. Den 64-kromosomiga populationen av *C. palustris* växer något fuktigare än den 56-kromosomiga och plantfrekvensen är störst i närheten av en liten bäck. På denna lokal blommar de 64-kromosomiga plantorna senare än de med 56, beroende på bäckens översvämningar under våren. Plantor med $2n=60$ växer under ungefär samma ekologiska förhållanden som de 56-kromosomiga, och det är tvivelaktigt, om det verkligen rör sig om en ren population. Det kan vara en klon, eller möjligen flera, som uppkommit ur plantor med $2n=56$ och 64. Många lokaler har detta tal endast i hybridsvärmar.

I ännu fuktigare delar av Kungsmarken, företrädesvis vid den lilla sjöns stränder förekommer decaploida populationer. De ha kromosomtalen 72 och 76. De morfologiska skillnaderna är påtagliga, varför det är mycket lätt att i fält avgränsa deras utbredning. Nästan i vattnet vid den lilla sjön, men på ställen där vegetationen är dåligt sluten, finns den högsta frekvensen av plantor med $2n=72$. De växer delvis i skuggan av några alar. Här och var längs stranden och också ute i vattnet växer plantor med $2n=76$, representerande den typ, som har alla stjälkbladens småblad breda och skaftade. Den uppträder i mycket kraftiga bestånd, förmodligen kloner. Ute i vassbältet, fastvuxna i små dyöar, finns sterila rosetter av samma typ. De år då sjön har lågt vattenstånd, får dessa rosetter en kraftig utveckling och blommar året efter, om inte vattenståndet då är särskilt högt.

Från undersökningarna på denna lokal samt en hel rad andra har det framstått som mycket klart, att det finns en ekologisk differentiering inte enbart mellan de olika kromosomtalstyperna inom *C. palustris* utan också *C. pratensis* kan inpassas i ett ekologiskt schema, som pekar på att ju högre kromosomtal en population av dessa växter har, desto fuktigare ståndort fordrar de.

C. Nymani har en ganska vidsträckt ekologisk amplitud. Den förekommer dels i öppen vegetation i det subalpina bältet och på högre nivåer oftast i samband med snölegor, dels i fuktiga skogspartier och längs skogsbäckar. Jämförande odlingar har visat att vissa morfologiska skillnader kvarstår mellan plantor från skogspartier och dem växande öppet. Det kanske kan röra sig om ekotyper.

English summary

Three species of the *C. pratensis* complex occur in Scandinavia, namely *C. pratensis* L., *C. palustris* Peterm., and *C. Nymani* Gand.

C. pratensis is represented only by tetraploids ($2n=30$) in this region, while octoploid, decaploid, and dodecaploid populations of *C. palustris* occur. In the mountain region of Scandinavia *C. Nymani* occurs with a widespread octoploid form ($2n=64$) with orbiculate leaflets of the rosette leaves (one locality is known with decaploid plants). In the southern part of western Swedish Lapland a form with lanceolate leaflets occurs, which may be similar to the Canadian var. *angustifolia* Hook.

C. pratensis and *C. palustris* grow very often in the same locality. It is found that the water content of the soil is of importance for the population inhabiting a locality. The higher the water content, the higher is the chromosome number of the *C. pratensis-palustris* plants.

Litteratur

Babcock, E. B., and Stebbins, G. L. Jr., 1938. The American species of Crepis. Their interrelationships and distribution as affected by polyploidy and apomixis. — Carnegie Inst. Wash. Pub. 504: 1—199.

Banach, E., 1950, se Skalinska 1950.

— 1951. Studies in the karyological differentiation of Cardamine pratensis L. in connection with ecology. — Bull. Int. Acad. Polon., Serie B: 1, 1950: 197—211.

Flovik, K., 1940. Chromosome numbers and polyploidy within the flora of Spitsbergen. — Hereditas 26: 430—440.

Gandoger, M., 1925. Plantes du Spitzberg. — Bull. Soc. Bot. France 72: 1042—1045.

Guinochet, M., 1946. Sur l'existence, dans le Jura central de races ecologiques, aneuploides et polyploides chez Cardamine pratensis L. — Compt. Rend. Acad. Sc. 222: 1131—1133.

Hartman, C. J., 1832. Handbok i Skandinaviens Flora. 2. uppl. — Stockholm.

Howard, H. W., 1948. Chromosome number of Cardamine pratensis. — Nature 161: 277.

HUSSIEN, F., 1949. Chromosome races of Cardamine pratensis in the British Isles. — British Flowering Plants and Modern Systematic Methods, p. 77.

LAWRENCE, W. J., 1931. The chromosome constitution of Cardamine pratensis and Verbascum phoeniceum. — Genetica 13: 183—208.

LINDMAN, C. A. M., 1914. Cardamine pratensis L. und C. dentata Schultes (emend.). — Bot. Not. 1914: 267—286.

LÖVKVIST, B., 1947. Chromosome studies in Cardamine. — Hereditas 33: 421—422.

— 1950 (1953). Polyploidy and differentiation in the Cardamine pratensis complex. — Proc. VII. Int. Bot. Congress, Stockholm 1950, pp. 333—334.

— 1956. The Cardamine pratensis complex. Outlines of its cytogenetics and taxonomy. — Symb. Bot. Upsal. XIV: 2, 134+XVI pp.

MATTICK, R., 1950, se TISCHLER 1950.

PETERMANN, W. L., 1846. Über zwei neue Species der deutschen Flora. — Bot. Centralbl. f. Deutschland (Rabenhorst): 45—48.

SCHULZ, O. E., 1903. Monographie de Gattung Cardamine. — Englers Bot. Jahrb. 32: 280—623.

SELANDER, S., 1950. Floristic Phytogeography of South-Western Lule Lappmark (Swedish Lapland) I. — Acta Phytogeogr. Suec. 27.

SKALINSKA, M., 1950. Studies in chromosome numbers of Polish angosperms. — Acta Soc. Bot. Polon. 20: 45—68.

TISCHLER, G., 1950. Die Chromosomenzahlen der Gefässpflanzen Mitteleuropas. — s'-Gravenhage.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Contributions to the Knowledge of the Plankton in Scandinavian Mountain Lakes. 4

By KUNO THOMASSON

Staurastrum vulgaris n. sp.

Kennt man nicht den Namen, so ist die Kenntnis von Dinge wertlos (Isidorus Hispalensis, 560—630). Concerning *Staurastrum paradoxum* Meyen the opposite may be stated. When studying the different algae depicted in the literature under this name, one is struck by the richness of forms which have been referred to this "species", its limits having been extended "ad absurdum". It is obvious that we are here concerned with an array of different species, which are quite distinctive from taxonomic, geographical, and ecological points of view. Among the algae labelled as *Staurastrum paradoxum* we find quite frequent specimens of *Staurastrum cingulum* var. *obesum* G. M. Smith, e.g. Smith, 1924, pl. 72, fig. 18—20, and numerous other triangular species with processes at the angles.

I am convinced that it is often quite impossible to define the limits of *Staurastrum* species by only a few characters. Each species should be defined to give as complete an impression as possible, though this as a rule is very difficult to express adequately in words. Thus a good drawing is always of vital importance. One important question then is, what amplitude of variation is to be allowed for the various characters. This clearly must depend partly on experience and partly on the material available — one ought to have more than just one specimen for study. To place correctly a single specimen is often a really ticklish problem. Between different characters there is often only a quantitative difference, e.g. verrucae on the apex sometimes are present in pairs of granulae, even these can disappear or to be replaced by spines. The interpretation of many *Staurastrum* species remains quite a subjective matter, a fact which can sometimes make desmid studies resemble stamp-collecting, with the consequence that all connections between different forms will vanish and the subject becomes merely an unrelated collection of new forms, varieties, or species. That one must always keep an open mind concerning any species will be evident from the following paragraphs.

It seems to be quite impossible to find out clearly what was in reality the desmid *Staurastrum paradoxum* as described by Meyen in 1829. And yet to chose a neotype, however, would only add to the confusion. Therefore to avoid serious difficulty it is better not to use this name, for this then makes it necessary to describe anew many species and forms which have been lumped together under the name *Staurastrum paradoxum*. One of these is the alga pictured on fig. 1, and here called *Staurastrum vulgaris*. It has a very wide distribution and has often been reproduced in the literature, e.g.

Staurastrum paradoxum — West & Carter, 1923, pl. 145, fig. 5; drawn by N. Carter.
Staurastrum paradoxum — Irenée-Marie, 1939, pl. 48, fig. 11 & 12.
Staurastrum paradoxum forma — West & West, 1903, pl. 18, fig. 4.

Staurastrum vulgaris should be compared with:

Staurastrum paradoxum forma — Borge, 1923, pl. 2, fig. 24.
Staurastrum paradoxum var. *inflatum* Hirano, 1952, fig. 5.

Both are smaller, but like *Staurastrum vulgaris* they are provided with a row of granulae on the both sides of the isthmus; nothing about the structure of the apex can, however, be seen on drawings. A carefull comparison is necessary with some forms of *Staurastrum cingulum* var. *obesum* G. M. Smith, e.g. the drawings in Nygaard, 1949, fig. 39.

From fig. 1 it will be noticed that a row of verrucae can be observed on the apex, just within and parallel to the margin of the cell body in a vertical view of the cell. The size and development of verrucae is very variable and sometimes they are practically lacking. There is a ring of minute granulae just above the isthmus on the both sides of it.

Size of our specimens: length of cell body 41.3—44 μ, maximum breadth 61.5—69 μ. Radiation: It occurs in 3-radiate and 4-radiate facies; also Janus forms 3 + 4 and 3 + 5 have been observed.

In lake Gjende (Jotunheimen, Norway) this species was on July, 10, 1951 and August, 7, 1952 one of the dominant planktic algae, together with *Tabellaria flocculosa* var. *pelagica* Holmboe and *Staurodesmus glabrus* f. *limnophilus* Teiling. Furthermore it was also noted in the

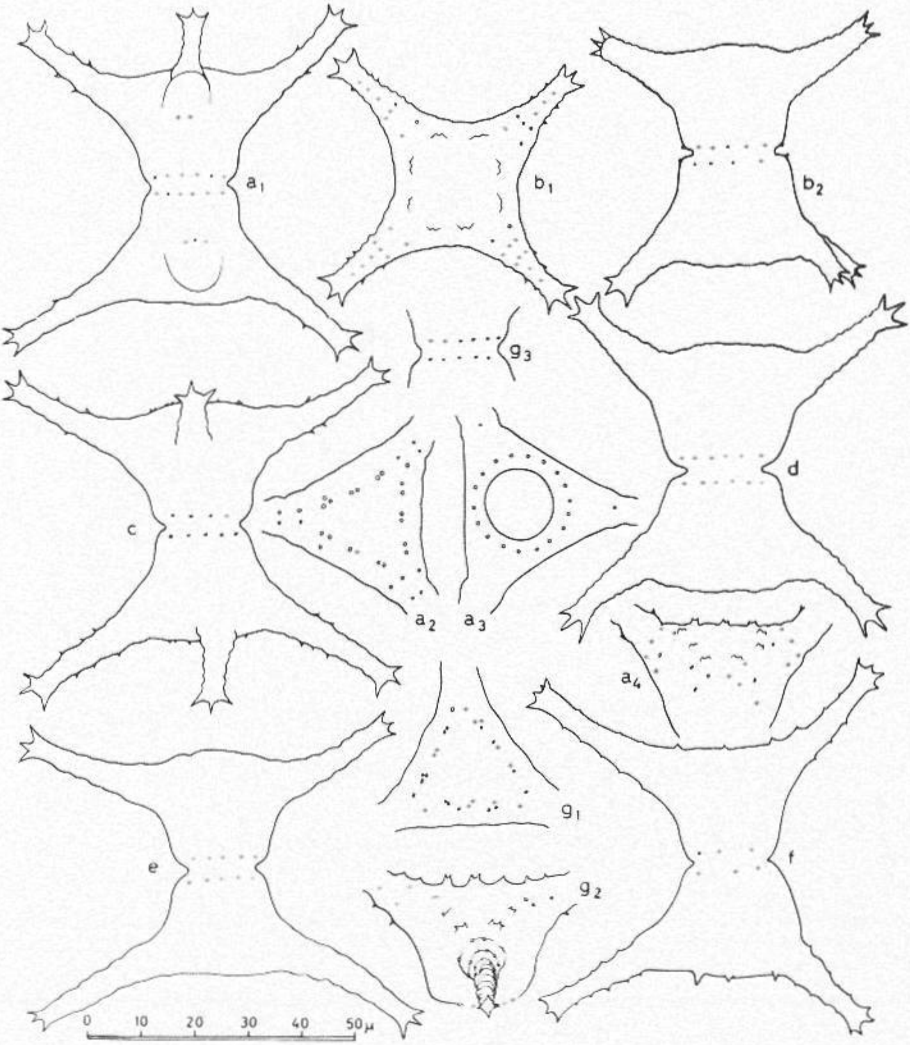


Fig. 1. *Staurastrum vulgaris.* — a. Gjende, Norway; b. Bessvatn, Norway; c. Övre Sjodalsvatn; d. Bessvatn, Norway; e. & f. Juvvatn, Norway, g. Gjende, Norway.

plankton several mountain lakes in Jotunheimen, e.g. Bessvatn, Juvvatn (composition of plankton see Thomasson, 1956), Övre Sjodalsvatn, here together with *Tabellaria flocculosa* (Roth) Kützing and *Tabellaria flocculosa* var. *pelagica* Holmboe. It also occurs in lowland lakes, e.g. lake Miaren, Södermanland, Sweden (M.-B. Florin).

Staurastrum petsamoense (Boldt) Järnefelt

Staurastrum sebaldi var. *depauperatum* Boldt, 1885, pl. 6, fig. 33.
Staurastrum petsamoense Järnefelt, 1934, p. 208, fig. 18.
Staurastrum sebaldi var. *depauperatum* Boldt — Messikommer, 1938, pl. 10, fig. 112 & 113.
Staurastrum petsamoense Järnefelt — Grönblad, pl. 2, fig. 36 & 37.

This species seems to be more common than one might gather from the algological literature. The cells are of medium size, my specimens being 75—79 μ long without processes, while their breadth with processes is 67.5—114 μ. The measurements given in the literature are: length 71—84 μ. and breadth 90—114 μ. The semicells are of very characteristic shape and the body of each is covered with short spines of variable length and variable density of cover. Sometimes an apical intramarginal row of rather prominent verrucae has been observed, see fig. 2 a_2.

This species was noted in the plankton of several lakes in the Torneträsk-area, Swedish Lapland, and from mountain lakes in Jämtland, Sweden. It has previously been reported from Siberia, Petsamo- and Kilpisjärvi-areas in Finland, West-Greenland, and Switzerland. The specimens figured in Thomasson, 1952, figs. 4 & 5 are best considered as belonging to *Staurastrum petsamoense,* both of them possessing very marked spinosity of the cell body.

Staurastrum petsamoense var. *minus* (Messik.) Thom.

Staurastrum sebaldi var. *depauperatum* f. *minor* Messikommer, 1942, p. 166, pl. 17, fig. 4.
Staurastrum petsamoense var. *biverticillatum* Nygaard, 1954, p. 313, fig. 3.
Staurastrum petsamoense var. *minus* (Messik.) Thomasson, 1956, p. 129.

This variety is distinguished from the type by its smaller size. The dimensions of our specimens are: length of cell body 42—50 μ, breadth with processes 62.5—78 μ. The measurements given in literature are: length 39—43 μ, breadth 46—57 μ, isthmus 11.5—12 μ.

Distribution: Switzerland, Southwest Greenland, several lakes in Torneträsk-area, Sweden, and mountain lakes in Jotunheimen and Dovre, Norway.

This variety is also probably more common than appears from the algological literature. It often seems to be considered as belonging to the *Staurastrum gracile* - group, as was done by present author with the guidance of fig 9. f & g in Smith, 1924. Compare fig. 3 c in the

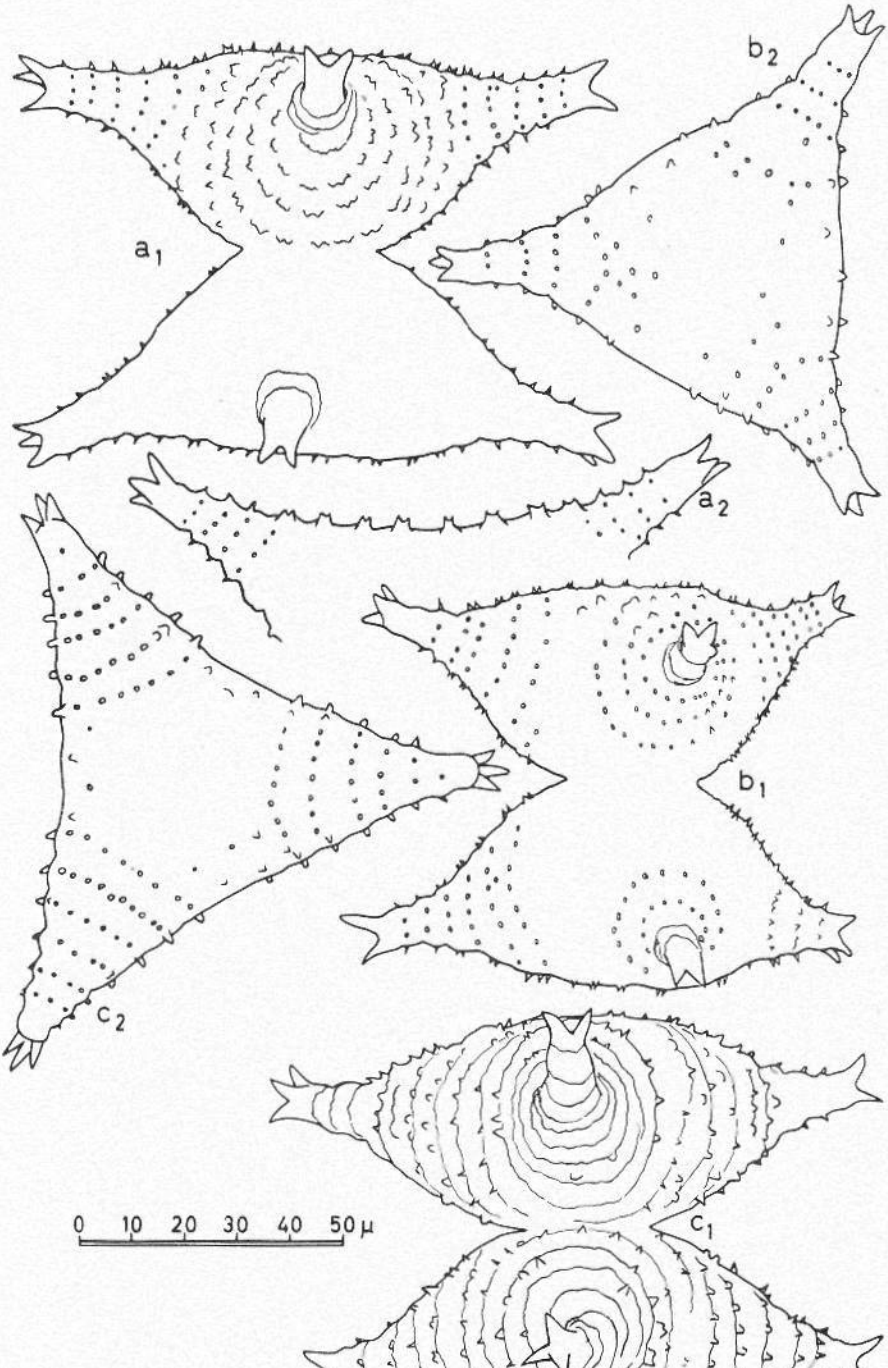


Fig. 2. *Staurastrum petsamoense.* — a. Nakerijärvi, Sweden; b. Kieddejaure, Sweden; c. Katterjaure, Sweden.

present paper and fig. 8 in Thomasson, 1952. The figures in Smith mentioned above are drawn from Norwegian material from the same area as our collections. They represents a form quite near to *Staurastrum petsamoense* var. *minus*. Even the fig. 20 in Thomasson, 1952, is best considered as belonging to *Staurastrum petsamoensis* var. *minus*. The occurrence of rather prominent verrucae on the apex only emphasises further the fact that a considerable quantitative variation ought to be allowed for the development of apical verrucae (cf. fig. 3 d_2 in our present paper).

The writer is more confused about the rows of paired spines observed on the apex of some specimens, cf. fig. 3 a_2. Such an ornamentation somewhat resembles the specimen of *Staurastrum polymorphum* Bréb. figured by Taft, 1945, pl. 5, fig. 15. This alga is of the same shape as our specimen, but considerably smaller. Even *Staurastrum polymorphum* Bréb. in Taylor, 1935, pl. 37, fig. 4, resembles our specimen but is smaller. As a matter of fact Taylor points out on p. 196 that his plant strongly resembles Smith's drawing of Norwegian *Staurastrum gracile*. This ought to be taken into account when considering the proper place for the algae similar to these two and named *Staurastrum polymorphum*, for its very name of the latter is suggestive of the validity of this "species". The above mentioned two plants also resemble in many ways some forms of *Staurastrum hexacerum* (Ehrenb.) Wittr. Taxonomically these rows of paired spines are of minor importance, for they are often replaced by rows of single spinulae. On the whole the arrangement of spines on the apex is variable as is also the length of the spines.

The algae described by Nygaard (1954) under the name *Staurastrum petsamoense* var. *biverticillatum* has as a characteristic feature an isthmal circle of minute spines. Even the specimen figured by Messikommer (1942) under the name *Staurastrum sebaldi* var. *depauperatum* f. *minor* shows on fig. 4 a_1 a similar row of spines. Among the specimens studied by the present author there were but few individuals in which the same feature could be noted. But it may be questioned whether we are here concerned with a distinct isthmal circle of minute spines or simply with spines belonging to the general ornamentation of the cell-wall. The cell-wall is covered with short spines arranged in concentric circles round the processes so that these could at the isthmus possibly be interpreted as forming an isthmal ring.

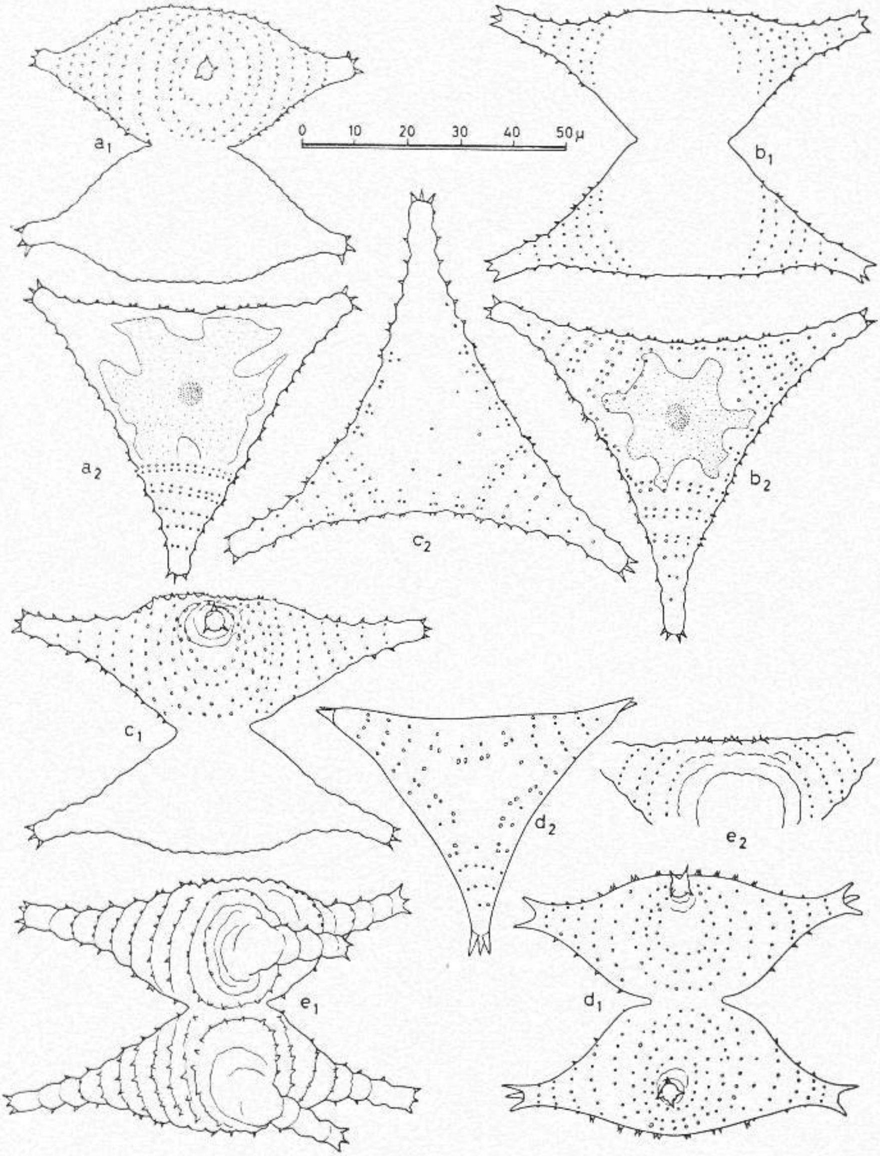


Fig. 3. *Staurastrum petsamoense* var. *minus*. — a. Bessvatn, Norway; b. Kaldvellsjöen, Norway; c. Katterjaure, Sweden; d. Inkajaure, Sweden; e. Katterjaure, Sweden.

Staurastrum landmarki Huitfeldt-Kaas

This species was described by Huitfeldt-Kaas, 1906, pp. 54 and 154, pl. 2, figs. 32 & 33. From the drawings given one can scarcely see what it is intended to represent. I have often wondered about the taxonomic value and the position of this species. In the course of a study of the plankton of Norwegian mountain lakes I looked especially for this problematic species or some specimen which could elucidate its mystery. It was noted by Huitfeldt-Kaas from several lakes, including lake Bessvatn, Jotunheimen. In a sample from this very lake I observed an alga, which could probably be regarded as identical or quite close to the species described by Huitfeldt-Kaas. The writer's specimens are of nearly the same size (length of body 61.5—64 μ, total breadth 75 μ) and shape as can be seen on fig. 4 a & b. The taxonomical connections should be evident by a comparison with fig. 4 c & d. The specimens figured on fig. 4 a & b belong to *Staurastrum sebaldi* - group, only they are of somewhat reduced and thus reminicent of the half-developed semicells of *Staurastrum sebaldi* var. *ornatum* Nordstedt. Our specimens should be carefully compared with *Staurastrum anatinum* var. *truncatum* W. West, 1892, p. 185, pl. 24, fig. 2, and the much better figure by Taylor, 1935, pl. 39, fig. 17, or the specimen figured by Irenée-Marie, 1939, pl. 54, fig. 4. Note the double row of verrucae across the top of semicell in this variety. It should be noticed that our form is lacking granulae at the isthmus under the arm-pits, which are characteristic of *Staurastrum sebaldi* var. *ornatum*. In West & Carter, 1923, *Staurastrum landmarki* was placed in the *Staurastrum anatinum* - group under *Staurastrum anatinum* var. *lagerheimii* (Schmidle) W. & W.

Unfortunately it is impossible to make out from the description given by Huitfeldt-Kaas if he ever saw a single or double row of verrucae on the apex of the semicell. He only says that in side view the top of the semicell is double saw-toothed. While the drawing is inadequate, there seems to be in the description of top view, an indication that *Staurastrum landmarki* should be placed in the *Staurastrum anatinum* - group. Huitfeldt-Kaas says on p. 54, that in top view the sides were shallowly serrated. Nevertheless our specimens at least could more reasonably be regarded as belonging to the *Staurastrum sebaldi* - group. The top view of our specimens strongly resembles the top view of *Staurastrum sebaldi* var. from North America in West & West, 1896, pl. 18, fig. 2 & 3. Here also should be mentioned a form noted by Grönblad, 1942, p. 42 as forma verrucis reductis, though unfortunately

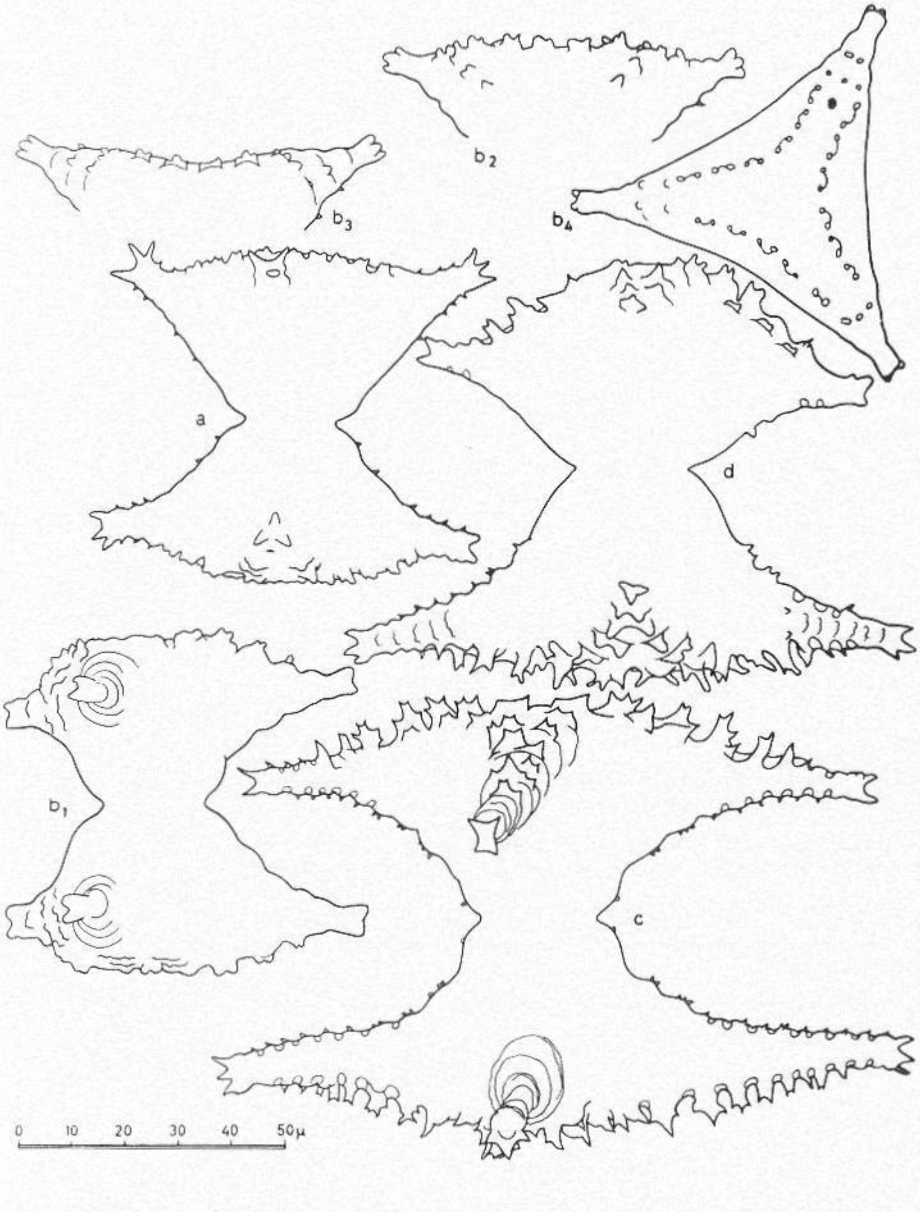


Fig. 4. *Staurastrum sebaldi* var. *ornatum.* — a. & b. Bessvatn, Norway; c. Kaldvellsjöen, Norway; d. Kieddejaure, Sweden.

without a drawing. Concerning the *Staurastrum anatinum* - group, a thorough revision is needed. It has already been pointed out in West & Carter, 1923, p. 143, that it consists of two distinct series of forms, a series of larger ones, length of body above 50 μ, (e.g. var. *lagerheimii* (Schmidle) W. & W., var. *truncatum* West) and the other series with smaller forms, (length of body under 50 μ, e.g. var. *curtum* G. M. Smith, var. *longibrachiatum* W. & W., var. *denticulatum* G. M. Smith). Very often it is impossible to limit and define the different varieties for there is often a continuous series of intermediate forms. Also the connections with *Staurastrum floriferum* W. & W. ought to be borne in mind, as well as those with *Staurastrum vestitum* Ralfs. The resemblance to the latter probably influenced W. West and G. S. West in devising the name *Staurastrum vestitum* var. *subanatinum* for an intermediate form. As a matter of fact there occurs a series of forms, which with respect to the length and development of the verrucae on the side of the semicells could be considered as intermediate forms between *Staurastrum anatinum* and *Staurastrum vestitum*. Compare also pl. 75, fig. 22 → 7 → 6 → 8 in G. M. Smith, 1924. It is the opinion of the present author that there are very sound reasons for regarding *Staurastrum floriferum* and *Staurastrum vestitum* as varieties of the *Staurastrum anatinum* - group, as well as species of their own. However such a re-arrangement requires a thorough revision of all the closely related species and varieties as already pointed out.

The specimen of *Staurastrum sebaldi* var. *ornatum* Nordst. figured on fig. 4 c originates from a mountain lake, Kaldvellsjöen, near Kongsvoll, Norway. This alga occurs rather abundantly in the plankton of this lake, the composition of which is given in Thomasson, 1956. It is quite like the magnificent one pictured by Nordstedt, 1873, fig. 15, from a nearby area. An excellent drawing is also to be found in Taft, 1945, pl. 5, fig. 15. Such magnificent specimens have frequently been noted in the plankton of Scandinavian mountain lakes.

Staurastrum borgeanum Schmidle

Staurastrum borgeanum Schmidle, 1898, p. 60, pl. 3, fig. 7.
Staurastrum hexacerum var. *ornatum* Borge, 1894, p. 37, pl. 3, fig. 43.
Staurastrum proboscidium (Bréb.) Arch. — Borge, 1913, p. 31.
Staurastrum proboscidium var. *productum* Messikommer, 1942, p. 165, pl. 17, fig. 3.
Staurastrum borgeanum Schmidle — Grönblad, 1926, p. 26, fig. 133 & 134.

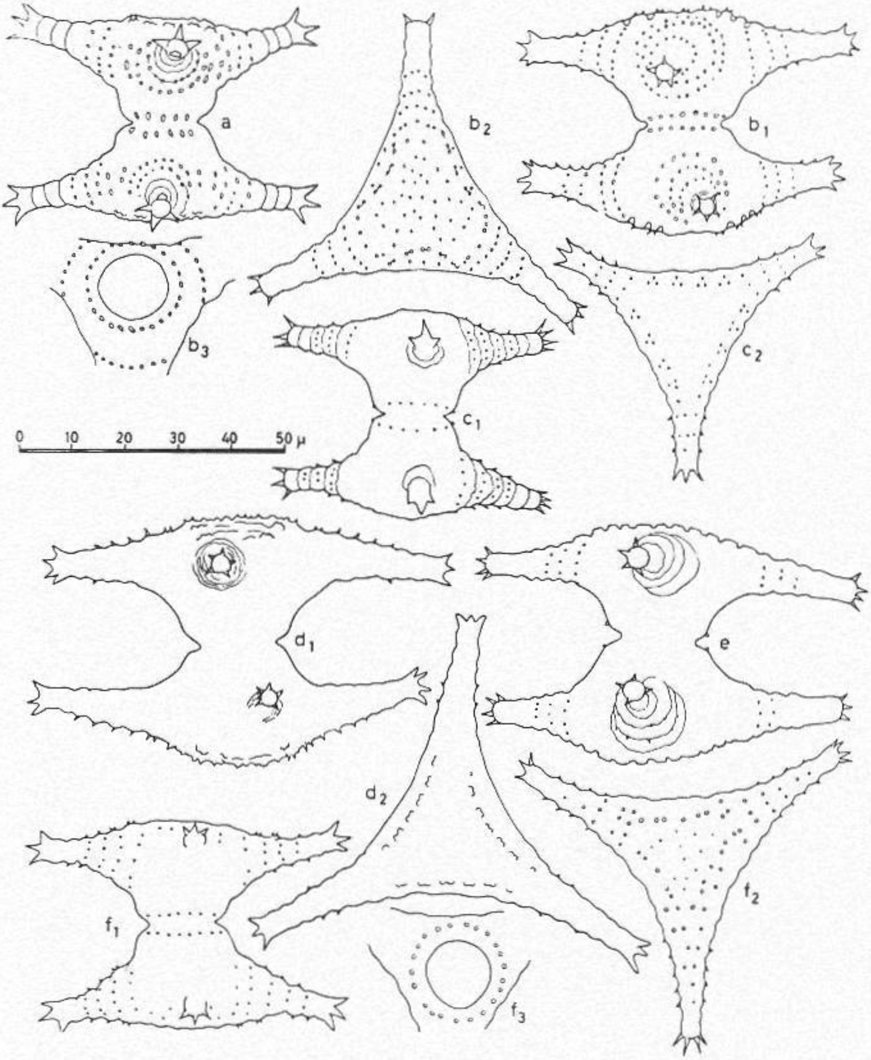


Fig. 5. *Staurastrum borgeanum.* — a. Kaldvellsjöen, Norway; b. Vassijaure, Sweden; c. Kieddejaure, Sweden; d. Vassijaure, Sweden; e. Katterjaure, Sweden; f. Kaldvellsjöen, Norway.

Staurastrum boreale W. & W. — Cedercreutz & Grönblad, 1936, p. 4, pl. 1, fig. 10.
Staurastrum borgeanum var. *parvum* Messikommer, 1949, fig. 17.

Staurastrum borgeanum was originally described in 1898 by Schmidle but since then it has been renamed several times. In Nordstedt's Index.

suppl. p. 32 it was transferred to *Staurastrum proboscidium*. Borge, (1913, p. 32), agreed with the opinion of Nordstedt, as did also West & Carter (1923, p. 129), though with some hesitation. Grönblad (1926) and Messikommer (1942) are however at variance with the authors just mentioned.

During the present authors past ten years of collecting from Scandinavian mountain lakes a plant was noted which directed my attention to *Staurastrum borgeanum*. This plant, shown in fig. 5, is from specimens collected from the lakes in the Torneträsk-area of Sweden, and from the Dovre-area, Norway.

Size: length of cell body 36—45 µ, breadth with terminal spines 52.5—60 µ. Some forms with considerably longer processes (73.5—75 µ) were noted, cf. fig. 5 d & e. I dare not express an opinion about the two last mentioned forms. They seem to represent the tendency of the extension of processes already noted by Messikommer in describing *Staurastrum proboscidium* var. *productum*. It should emphasize that neither *Staurastrum borgeanum* nor *Staurastrum proboscidium* var. *productum* are plankters. Our specimens on the other hand represent planktic forms. On the other hand the taxonomic position of some forms with very short processes grouped with *Staurastrum borgeanum* should to be carefully checked in relation to *Staurastrum margaritiferum*-group.

Our plants resembles most markedly *Staurastrum borgeanum* as drawn by Schmidle (1898) and Grönblad (1926), also the alga called *Staurastrum boreale* W. & W. in Cedercreutz & Grönblad, 1936, and in addition *Staurastrum boreale* var. *robustum* Messikommer, 1951, p. 64, pl. 2, fig. 24 should be compared with my specimens, though the latter are without verrucae just within the lateral margin in top view. In this connection it ought to be pointed out that *Staurastrum pseudosebaldi* var. *simplicius* West in West & Carter, 1923, p. 114, pl. 149, fig. 13, can with good reason be placed under *Staurastrum boreale*.

In 1942 Messikommer described *Staurastrum proboscidium* var. *productum*, which is very much like our specimens. As a matter of fact I have already considered them as identical by using Messikommer's name for my plants (Thomasson, 1956). Messikommer (op. cit.) admits the similarity between *Staurastrum borgeanum* and his plant, but rejects any real affinity on the grounds that the slender processes are tipped with only 3 spines. In the absence of any clear affinity he therefore named his specimen as the var. *productum* of *Staurastrum probosci-*

dium. Schmidle however had already included a form with slender processes to his species, viz. *Staurastrum hexacerum* var. *ornatum* Borge, 1894, and moreover the number of terminate spines is not always of taxonomic value, e.g. my specimens exhibit a considerable variation in the number of terminate spines on the processes, cf. fig. 5 in this note. The terminate spines on processes of my specimens are longer than those in Grönblad, 1926. My specimens and also the algae drawn by Borge (1894), Schmidle (1898), Messikommer (1942), and Grönblad (1926) are all characterized by a ring of granulae round the base of semicell. From the drawing in Ralfs, 1848, pl. 23, fig. 12 b & c practically nothing can be discerned about the ornamentation. Grönblad (1926) has proposed these drawings and a rather diverging specimen figured in West & Carter, 1923, pl. 149, fig. 9 and named *Staurastrum cyrtocerum*, as the type for *Staurastrum proboscidium*. They both are, however, lacking the row of granulae on the each side of isthmus. On the other hand, the figures in West & Carter of *Staurastrum proboscidium* formae show this character. Even the multifarious drawings in the algological literature which are endowed with the name *Staurastrum proboscidium* exhibit rather varying shape. In any case it is absolutely out of question to establish a drawing in Ralfs as the type for though they are indeed very attractive many of his *Staurastrum* "species" in particular, are inadequately represented for unmistakable interpretation.

The writer is fully convinced that the more cup-shaped basal part of the semicell in his plants, and in those of Messikommer's, is of importance from the taxonomic point of view. In *Staurastrum borgeanum* the basal part of the semicells is less cup-shaped than in our plants. But among them there are some specimens with more pronounced and others with lesser developed cup-shape of semicells, forming more or less a continuous transition towards *Staurastrum borgeanum*. It is obviously impossible to draw a limit between our specimens and those of Messikommer (1942) and Grönblad (1926). So it seems to be simply a matter of taste whether my plants is to be labelled as *Staurastrum proboscidium* var. *productum* or *Staurastrum borgeanum*. On the basis of the above mentioned confusion concerning *Staurastrum proboscidium*, and its uncertain relationships it seems for the present more reasonable to accept the name *Staurastrum borgeanum* for my plants and even for the alga described by Messikommer in 1942.

Växtbiologiska Institutionen, Uppsala, September 1956.

Literature

Boldt, R., 1885: Bidrag till kännedomen om Sibiriens Chlorophyllophyceer. — Vet. Akad. Förh., Stockh., 42.

Borge, O., 1913: Beiträge zur Algenflora von Schweden. 2. — Bot. Not., 1913.

— 1923: Beiträge zur Algenflora von Schweden. 3. — Ark. Bot., 18.

Cedercreutz, C. & Grönblad, R., 1936: Bemerkungen über einige Desmidiaceen von Åland. — Comment. biol., Helsingf., 7.

Grönblad, R., 1926: Beitrag zur Kenntnis der Desmidiaceen Schlesiens. — Comment. biol., Helsingf., 2.

— 1942: Algen, hauptsächlich Desmidiaceen, aus dem finnischen, norwegischen und schwedischen Lappland. — Acta Soc. Sci. fenn., N.S., 2.

— 1952: Desmids from West Greenland. — Medd. Grønland, 147.

Hirano, M., 1952: Plankton desmids from Fuij five lakes and lake Ashi. — Acta phytotax., Kyoto, 14.

Huitfeldt-Kaas, H., 1906: Planktonundersøgelser i norske vande. — Christiania.

Irenée-Marie, 1939: Flore Desmidiale de la Région de Montreal. — Laprairie.

Järnefelt, H., 1934: Zur Limnologie einiger Gewässer Finnlands. 11. — Ann. zool.-bot. fenn. Vanamo, 14.

Messikommer, E., 1938: Beitrag zur Kenntnis der fossilen und subfossilen Desmidiaceen. — Hedwigia, 78.

— 1942: Beitrag zur Kenntnis der Algenflora und Algenvegetation des Hochgebirges um Davos. — Beitr. geobot. Landesaufn., 24.

— 1949: Algologische Erhebungen im St.-Gallischen Abschnitt der NW-Sardonagruppe. — Vjschr. naturf. Ges. Zürich, 94.

— 1951: Grundlagen zu einer Algenflora des Kantons Glarus. — Mitt. naturf. Ges. Glarus, 8.

Nordstedt, O., 1873: Bidrag till kännedomen om sydligare Norges Desmidiéer. — Acta Univ. Lund., 9.

Nygaard, G., 1949: Hydrobiological studies on some Danish ponds and lakes. 2. — — Biol. Skr., 7.

— 1954: A new diatom species and two varieties from plankton in lake Tasersuatsiaq. — Medd. Grønland. 148.

Ralfs, J., 1848: The British Desmidieae. — London.

Smith, G. M., 1924: Phytoplankton of the inland lakes of Wisconsin. 2. — Bull. Wis. geol. nat. Hist. Surv., 57.

Taft, C. E., 1945: The desmids of the west end of lake Erie. — Ohio J. Sci., 45.

Taylor, W. R., 1935: The fresh-water algae of Newfoundland. — Pap. Mich. Acad. Sci., 20.

Thomasson, K., 1952: Contributions to the knowledge of the plankton in Scandinavian mountain lakes. 3. — Svensk bot. Tidskr., 46.

— 1956: Reflections on arctic and alpine lakes. — Oikos, 7.

West, W., 1892: A contribution of the freshwater algae of West Ireland. — J. Linn. Soc. (Bot.), 29.

West, W. & G. S., 1903: Scottish freshwater plankton. 1. — J. Linn. Soc. (Bot.), 35.

West, W. & G. S. & Carter, N., 1923: A monograph of the British Desmidiaceae. 5. — London.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Cytological Observations on Some Species of Globularia

By KAI LARSEN

(Royal Danish School of Pharmacy, Botanical Dept., Copenhagen)

I. Introduction

The genus *Globularia* L. has been monographed four times already and is therefore fairly well known from an orthodox taxonomical point of view. The first author discussing the genus as a whole was Cambessèdes (1826), who described 8 species. The next, more comprehensive, study was made by Willkomm (1850), who mentioned 12 species. Heckel (1894) in his monograph adds several important observations on the anatomy, chemistry, etc. of the *Globulariaceae*. Finally Wettstein (1895) supplements these studies with phylogenetic and nomenclative considerations.

The present genus comprises about 20 species, the majority of which is found in the Mediterranean zone. Three species extend their area to Central Europe and one occurs on the Swedish islands of Öland and Gotland.

Material for experimental and cytological studies was collected by the author on a travel to South Western Europe in the year 1949. This material has been supplemented later from various sources. The author is indebted to prof. Dr. Tyge W. Böcher for material from Austria and Sweden.

It proved rather difficult to grow these species, even the three Central European ones, in the Botanical Gardens of the University of Copenhagen (H. B. H.). Every winter one or more strains died or were weakened to such an extent that they were unable to produce flowers the following summer. For this reason the experimental cultivations were discontinued. However, the cytological results obtained will be presented here together with some remarks on the taxonomy involved.

II. Cytological observations

Previously two species only of the present genus have been studied from a cytological point of view, viz. *G. cordifolia* L. and *G. vulgaris* L. em. Nym. Sugiura (1936, 1937) gives the chromosome number n=10 for *G. cordifolia* L. in material of unknown origin. As far as can be seen it is the same material discussed in both papers by this author. Fig. 4 (Sugiura 1937) shows clearly the presence of 10 spherical bodies. It has not been possible for me to corroborate this number. Löve & Löve (1944) counted 2n=16 in *G. vulgaris* L. em. Nyman (wrongly quoted by Tischler, 1950, as *G. willkommii* Nym.). These authors used material "from the neighbourhood of Lund." This seems strange as the species in Sweden is reported to grow wild on the islands of Öland and Gotland only; nor has it been possible for me to confirm this chromosome count.

The cytological observations made by the present author are summarized in the table below.

Table I.

Species	Localities of collection	Collector	2 n	Cult. No.
G. salicina Lam.	Unknown	H.B.H.	16	
G. cordifolia L. subsp. *cordifolia*	France: Mont Salève (dept. Haute Savoi) 1000 m alt.	Author	32	1 826
— —	— Serres (dept. Hautes Alpes).	—	32	2 226
— —	— Col du Lauteret (dept. Hautes Alpes).	Grenoble[1]	32	3 632
— —	Switzerland: Court (dept. Bern) Rock crevices	Author	32	2 014
— subsp. *bellifolia* (Ten) Hayek	Unknown	H.B.H	16	
G. nudicaulis L.	France: Gavarnie (dept. Hautes Pyrénées)	Author	16	1 499
—	Switzerland: Col de Pillon (dept. Vaud) 1500 m alt.	—	16	1 882
G. willkommii Nym.	France: Dept. Isère.	Grenoble[1]	16	3 631
—	— Dept. Bas-Rhin.	Strasbourg[1]	16	3 742
—	Austria: Gumpoldskirchen, steppe veg.	T. W. Böcher	16	4 084
—	Hungaria: Budapest.	Budapest[1]	16	3 633
G. vulgaris L.	Spain: Soria, steppe veg.	Author	32	1 473
—	Sweden: Öland: Stora Alvaret, limestone pavement.	T. W. Böcher	32	4 714

[1] indicates that the seeds are obtained through a botanical garden as seeds of wild origin.

III. Remarks on the species studied

Globularia salicina Lam. (2n=16, Fig. 1). — A species endemic to the Canary Islands and the Azores. This species, together with a very close relative, viz. *G. amygdalifolius* Webb, has been separated from the genus *Globularia* by Wettstein (1895). This author established a new genus, *Lytanthus*, and named the species *L. salicinus* (Lam.) Wettst. He based the separation on the fact that *Lytanthus* is different from other species of *Globularia* in the mode of innovation of the stem and the build of corolla. To these characteristics mentioned by Wettstein can now be added the presence of two SAT-chromosomes in the mitotic complement. In other species of *Globularia* it has proved impossible to distinguish any SAT-chromosomes. No other essential differences in the idiogram between the two genera can be proved. In my opinion the genus *Lytanthus* should be reduced to a lower taxonomical rank, e.g. that of a section.

Globularia cordifolia L. subsp. ***cordifolia*** (2n=32, Fig. 2). — The collective species *G. cordifolia* is distributed throughout the range of the Iberian mountains, the Pyrenees, the Jura, and South Eastern France to the Alps and the Carpathians, furthermore found in the Apennines and on the Balkan Peninsula. The species is polymorphic and three subspecies have been isolated.

1. Subsp. *cordifolia* (=*G. cordifolia* var. *bellidifolia* Rouy, *G. cordifolia* subsp. *cordifolia* (L.) Hayek, *G. saxatile* Salisb.). — Leaves spatulate with emarginate or tridentate apex.
2. Subsp. *bellifolia* (Ten.) Hayek (=*G. cordifolia* var. *intermedia* Rouy). — Leaves spatulate-oblong, with short acuminate or rotundate apex.
3. Subsp. *repens* Lam. pro sp. (=*G. nana* Lam., *G. cordifolia* var. *nana* Cambess.). — Leaves linear-cuneiform, the majority ± crenelated at the margin, obtuse apex. Stem nude, very short or virtually missing.

Four strains of the typical subspecies have been studied. They all showed the same chromosome number 2n=32. As mentioned in the introduction the number n=10 found by Sugiura cannot be corroborated.

Globularia cordifolia L. subsp. ***bellidifolia*** (Ten.) Hayek (2n=16, Fig. 3). — One strain of this subspecies has been studied cytologically.

It was found to be diploid. Unfortunately the origin of this strain, grown in the Botanical Gardens of Copenhagen, could not be established.

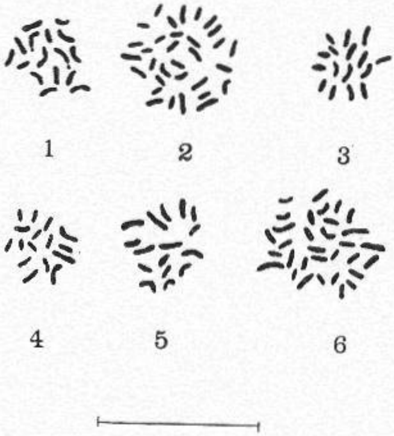
The consequence of the cytological results would be to adopt the old name of *G. bellidifolia* Ten., but more strains should be studied to establish the variation in chromosome number within this group. Finally, subsp. *repens* has not been studied; this should be done before changes of the nomenclature are undertaken.

Globularia nudicaulis L. (2n=16, Fig. 4). — Distributed throughout the range of the Spanish mountains, the Pyrenees, the Corbières, and the Alps to the Toscanine Apennines. It is fairly uniform throughout the geographical area in which it is found. Wettstein (l.c.) considers it an old species in which no great evolution is taking place at the moment and no close relatives are known. Also, the diploid chromosome level suggests an ancient origin.

Globularia willkommii Nym. (2n=16, Fig. 5). — Found throughout Central and Southern Europe from Northeast Spain and Belgium to the Caucasus and Roumelia. The plant is only slightly variable throughout this distribution area. Cytologically the species also seems stable, as chromosome counts from the eastern as well as the western part of its domain show the same diploid number.

G. willkommii is a species belonging to the *G. vulgaris* - complex. From *G. vulgaris* sens. str. it can be easily distinguished by the leaves. *G. wilkommii* has an entire or emarginate leaf apex, rarely retuse-tridentate. *G. vulgaris* has a leaf apex with 3—5 spinescent teeth, furthermore the leaves are cartilaginous which is never the case in *G. willkommii*.

Globularia vulgaris L. em. Nym. (2n=32, Fig. 6). — This species has an intermittent distribution being found on the Iberian Peninsula, the Balearic Islands and Southern France (Pyrénées-Orientales, Aude, Herault, Basses-Alpes) and, furthermore, on the Swedish islands of Öland and Gotland. No morphological differences seem to exist between the Swedish populations and the Iberian ones. A Swedish strain and a Spanish one have been studied cytologically. Both showed 2n=32, thus being tetraploid. The strain from Öland showed one root-tip with a sector of about $^1/_3$ on a higher level of polyploidy. The chromosomes, however, so crowded the cells that it was impossible to make an exact count. The chromosome number of the cells in this sector were esti-



Figs. 1—6. Metaphase plates from root-tips. — 1. *Globularia salicina* Lam., 2n=16. — 2. *G. cordifolia* L. subsp. *cordifolia*, 2n=32 (Cult. Nr. 3632). — 3. *G. cordifolia* L. subsp. *bellidifolia* (Ten.) Hayek, 2n=16. — 4. *G. nudicaulis* L. 2n=16 (Cult. Nr. 1882). — 5. *G. willkommii* Nym. 2n=16 (Cult. Nr. 3630). — 6. *G. vulgaris* L. em. Nym., 2n=32 (Cult. Nr. 1473). — The scale is 10 μ.

mated at about 60, thus being octoploid. As mentioned above the diploid number 2n=16 found by Löve & Löve could not be corroborated.

IV. Summary and Conclusions

1. The mitotic chromosomes of five species of the genus *Globularia* have been studied (see the table).
2. The basic number of the genus may be considered to be 8, and the number x=5 (or 10) cfr. Darlington & Wylie (1955) cannot be corroborated.
3. Only two groups show polyploidy, viz. the *G. cordifolia*-group and the *G. vulgaris*-group. The same two groups are, furthermore, the only species-complexes of the genus which show some degree of polymorphy. The *Globularieae* seems to be a relic group in which polyploidy has increased the variation and thus continued the evolution in the two above mentioned species.

Bibliography

CAMBESSÈDES, M. J., 1826: Monographie des Globulaires. — Ann. Sci. Nat. Paris. 9: 15—31; Pl. 40—41 in Atlas tome 7—9.

DARLINGTON, C. D. & WYLIE, A. P., 1955: Chromosome atlas of flowering plants. — London.

HAYEK, A., & MARKGRAF, FR., 1931: Prodromus Florae Peninsulae Balcanicae II. — Rep. spec. nov. reg. veg. 30,2.

HECKEL, E., 1894: Etude monographique de la famille des Globulariées. — Paris.

LÖVE, Á., & D., 1944: Cyto-taxonomical studies on Boreal plants. III. Some new chromosome numbers of Scandinavian plants. — Ark. för Bot. Bd. 31 A. Nr. 12: 1—22.

SUGIURA, T., 1936: A list of chromosome numbers in Angiospermous plants II. — Proc. Imp. Acad. Tokyo 12: 144—146.

— 1937: Studies on the chromosome numbers in higher plants, with special reference to cytokinesis II. — Cytologia, Fujii Jubilaei vol.: 845—849.

Tischler, G., 1950: Die Chromosomenzahlen der Gefässpflanzen Mitteleuropas. — s'Gravenhague.

Wettstein, R., 1895: Globulariaceen Studien. — Bull. Herb. Boissier III: 271—290.

Willkomm, M., 1850: Recherches sur l'organographie et la classification des Globulariées. — Leipsick.

— 1870: Globularieae in Lange & Willkomm: Prod. Flor. Hisp. II.: 383—386.

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Studies in Rhizoclonium

I. Life History of Two Species

By CARL BLIDING

(Borås, Sweden)

The genus *Rhizoclonium* gives the taxonomist trouble already for the reason that its limitation against the nearly related genera *Chaetomorpha* and *Cladophora* is not satisfactorily established. In addition to that the separation of the proposed species of *Rhizoclonium* presents obvious difficulties as long as the distinguishing characters are restricted almost exclusively to the breadth of the threads and the proportions of length to breadth of the cells — these measures being influenced within wide limits by environmental relations.

Therefore a knowledge of the life history in *Rhizoclonium* and of the structure of the reproduction bodies, combined — in case of sexuality — with cross-breeding experiments, ought to be of value as an extra control of the limits of the genus and of its species.

With reference to these questions, however, even recently published literature scarcely presents more than an iteration of the report of Wille (1901 p. 41), that *Rhizoclonium* should have zoospores with 2 cilia, one longer and pointed forwards, the other smaller and pointed backwards. Nothing is known about sexuality in this genus as understood by Hamel (after separation of the genus *Lola*).

1. *Rhizoclonium kochianum* Kg=*Rh. implexum* (Dillw.) Kg sensu Koster.

The living material is to a small extent from the Baltic Sea (Karlshamn on the south coast of Sweden), most of it is collected on the west coast of Sweden, at Varberg and especially in the vicinity of the marine zool. station of Kristineberg, where the alga was found entangled with *Enteromorpha clathrata*, growing on *Ascophyllum nodosum*.

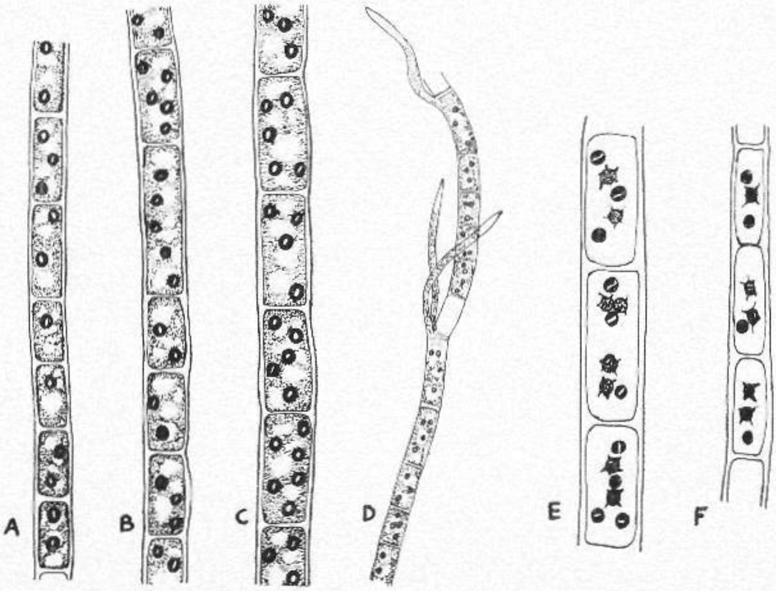


Fig. 1. *Rhizoclonium kochianum.* A—C: 3 filaments, drawn from living material. — D: cells with prolongations. — E—F: cells stained with haemat. — A—C and E—F ×500, D ×175.

Anatomy. — The cells in the grown-up but not fertile threads were 9.5—18.5 μ broad (cell walls 1.0—1.5 μ) and 1.5—3.5 times as long as their diameter (Fig. 1 A—C). Judging by these measures my material belongs to the species which most Swedish algologists have called *Rh. kochianum* Kg. According to Koster (1955 p. 343—350) *Rh. kochianum* is a synonym of *Rh. implexum* (Dillw.) Kg and also of *Rh. kerneri* Stockm. (see also Hamel 1931 p. 22), just the species which was the subject of the above-mentioned report of Wille.

The filaments had no rhizoidal branchlets of the usual type, but on very few occasions prolongations from cells, situated under dead or damaged cells, were observed (Fig. 1 D).

The chromatophore is a parietal, cylindrical network and the number of pyrenoids varies from 1 in small cells to about 7. The cells have 1—4 nuclei (Fig. 1 E—F).

Reproduction was mostly studied on material, taken into culture during the autumn. In a population, collected at Kristineberg in August 1955, there were at the end of September many fertile threads with their

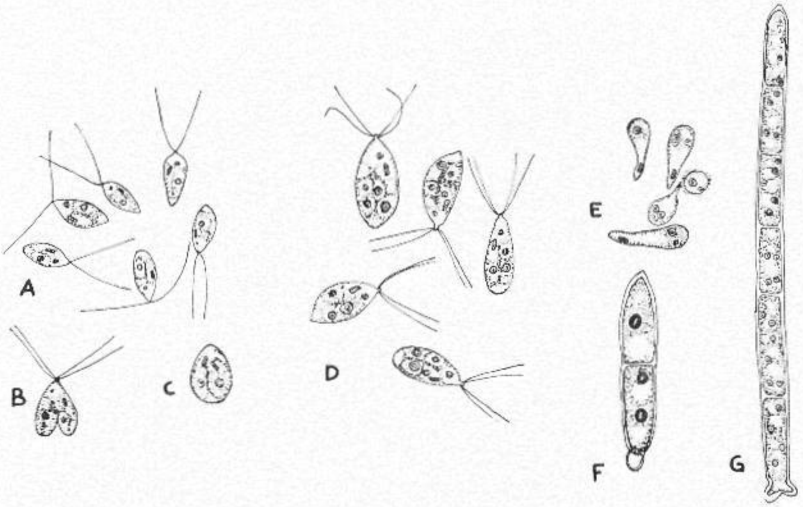


Fig. 2. *Rhizoclonium kochianum*. A: isogametes. — B: a copulating pair. — C: zygote, 20 hours old. — D: zoospores. — E: germinating zoospores. 2 days old. — F—G: development of the zoospores. — A—D ×750, E—F ×500, G ×250.

typical, swollen cells (cfr. Fig. 3 E). Almost all the cells of a filament finally grew into sporangia with 4-ciliate zoospores which forced their way out through an aperture a little above the middle of the sporangium. The zoospores swarmed out in the afternoon at 16—20 o'clock (cfr *Cladophora sericea*, Bliding 1936 p. 533). The swarmers (Fig. 2 D) principally have the structure, common in the family *Cladophoraceae*. Just when they have swarmed out, they have a length of 12.5—16.8 μ, mean length 14.3 μ, and a breadth of 4.3—6.6 μ, mean breadth 5.8 μ. The 4 cilia are proportionally short, about 11—12 μ, the eye-spot is placed at the very front of the well developed chromatophore which has 1—3 pyrenoids.

Zoospores from cells of the same thread were isolated on slides, where they directly germinated and grew up to new plants (Fig. 2 E—G). During the wintermonths the growth of this new generation was rather slow. Zoospores, germinating on the 29th of September, were not fertile threads until 7th—25th of December. Their cells then contained a great number of 2-ciliate swarmers (Fig. 2 A). As in *Cladophora* the sexual swarmers are isogametes with proportionally long cilia, eye-spot, relatively small chromatophore and often indistinct pyrenoid. The length of the gametes was 9.1—10.5 μ and the breadth 4.0—5.1 μ. They had pronounced positive phototaxis, but the copulating pairs (Fig. 2 B)

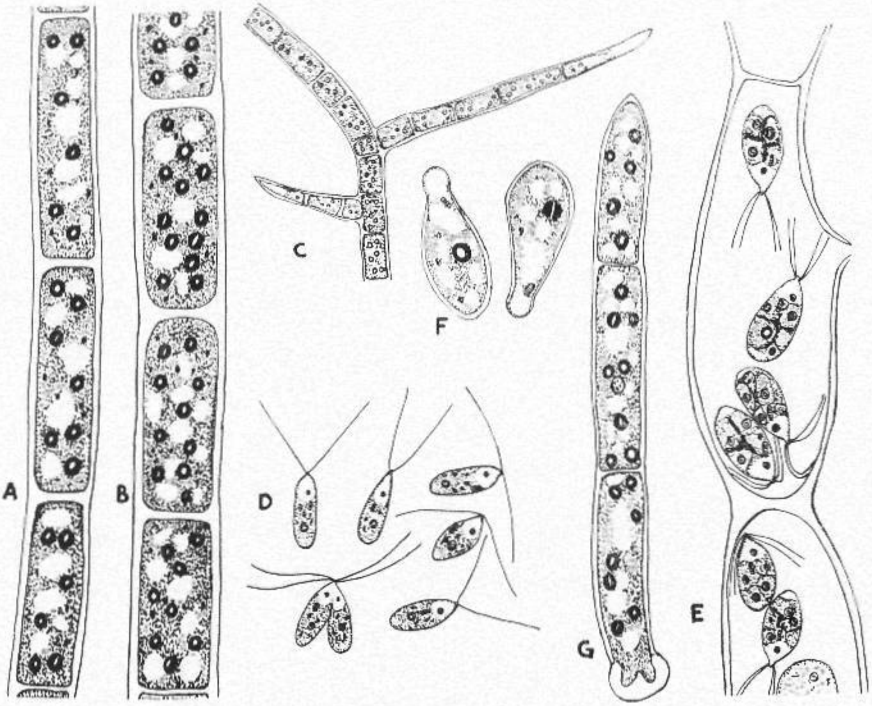


Fig. 3. *Rhizoclonium riparium.* A—B: filaments. — C: rhizoidal branchlets. — D: isogametes and a copulating pair. — E: zoosporangia with some zoospores left. — F: germinating zoospores, 4 days old. — G: young thread, 16 days old, from a zoospore. — A—B ×500, C ×175, D—F ×750, G ×500.

instantly became negative, swimming to the darkest point of the waterdrop, in which the copulation between +- and −-gametes had taken place.

The zygotes (Fig. 2 C) germinated directly and grew up to a new generation, but during that dark winterperiod I failed in my attempt to make the plants develop into fertility.

2. *Rhizoclonium riparium* (Roth) Harv.

This investigation was essentially performed on a material from the Baltic Sea (at Guemåla in Blekinge) and was later checked on living algae from North-Wales (Anglesey, Rhosneigr). Out of the drawings Fig. 3 B, G and two gametes in D represent material of the last-mentioned locality.

Anatomy. — The cells (Fig. 3 A—B) had a breadth of 17—27 μ, mostly about 21 μ, and the measure length: breadth varied from 1.1—4.2. The number of pyrenoids was 3—15, mostly 5—8.

The Swedish as well as the Welsh material had rhizoidal branchlets with 1—5 cells and the top of the ultimate cell tapering and colourless (Fig. 3 C).

Reproduction. — The material, collected in the Baltic in July 1951 was fertile in August and most of it consisted of threads with 4-ciliate swarmers (Fig. 3 E). These zoospores had a length of 14.1—18.0 μ and grew on slides directly into a new generation (Fig. 3 F—G). The first fertile filaments of this new generation were only about 1 month old (26.8—24.9).

The material collected in Wales in July 1953 was fertile at the end of September and had 4-ciliate swarmers, but the new generation from these zoospores needed about 4 wintermonths to be fertile (January 1954).

The reproduction bodies of the cultured generation were isogametes (Fig. 3 D) with a length of 11.5—13.2 μ, distinctly longer than those of *Rhizoclonium kochianum*. The copulation of the isogametes and the development of the zygotes took place as in *Rh. kochianum*.

Summary

As it seemed unlikely that the reports in the literature concerning the reproduction bodies in *Rhizoclonium* were pertinent or had general validity, the author has cultured during some years two species, *Rh. kochianum* Kg=*Rh. implexum* (Dillw.) Kg sensu Koster and *Rh. riparium* (Roth) Harv.

It appeared that both species had a sexual generation (gametophyte) with 2-ciliate isogametes and an asexual generation (sporophyte) with 4-ciliate zoospores.

The isogametes of the first species were 9.1—10.5 μ long and those of *Rh. riparium* were 11.5—13.2 μ; the zoospores had a length of 12.5—16.8 μ and 14.1—18.0 μ respectively.

Literature cited

Bliding, C. 1936. Ueber die Fortpflanzungskörper einiger marinen Chlorophyceen. — Sv. Bot. Tidskr., Bd 30. Uppsala.

Hamel, G. 1931. Chlorophycées des côtes Françaises. — Rev. Algol. Tome 6., Fasc. 1. Paris.

Koster, J. Th. 1955. The genus Rhizoclonium Kütz. in the Netherlands. — Publ. Staz. Zool. Napoli. Vol. 2.

Kylin, H. 1949. Die Chlorophyceen d. schwed. Westküste. — Lunds Univ. Årsskr. N.F. 2, 45. Lund.

Wille, N. 1901. Studien über Chlorophyceen. I—VII. — Vidensk. Skr. I. Math.-Naturv. Klasse, 6. Christiania.

Smärre uppsatser och meddelanden

Dikotomi hos Equisetum arvense och Equisetum silvaticum

Dikotomi eller gaffelgrening, d.v.s. förgrening i två eller flera lika stora grenar, är känd från ett stort antal ormbunksarter. Man kan finna alla övergångar från att endast bladspetsen eller något enstaka segment visar antydan till förgrening till att hela bladskivan är delad ända till basen eller att bladskivan och de flesta segmenten äro upprepat delade, s.k. *cristata*-former (jfr Sylvén 1956, sid. 76 och fig. 2). Hos *Equisetum* är dikotomi betydligt sällsyntare men känd från flertalet arter. Såväl assimilationsskotten som de fertila förekomma dikotomt förgrenade (sällan med mer än två grenar). Förgreningspunkten ligger oftast någon eller några centimeter från skottspetsen. I sällsynta fall kan skottet vara delat nästan till basen. Dikotomt förgrenade former av pteridofyter ha beskrivits under flera olika namn. Dessa formers systematiska värde torde vara obetydligt.

År 1922 fann jag i Målsryd, Toarps sn, Västergötland, en steril *Equisetum silvaticum*, som var nästan fullständigt delad. Endast de fyra nedersta lederna voro odelade, och från en gemensam slida utväxte två lika stora, väl utvecklade grenar (Fig. 1). Jag har inte kunnat finna några liknande *Equisetum*-former i våra offentliga herbarier. Ej heller omnämner H. V. Rosendahl några liknande. Han (Rosendahl 1917, sid. 10) upptar *Equisetum silvaticum* f. *multifurcatum* J. Schmidt, »Stjälk mycket kort, i spetsen uppdelad i intill 15 stjälkliknande, jämnhöga grenar. Västergötland: Toarps s:n, Målsryd vid Ekås (A. O. Olson 1915).» I detta fall är det troligen ej fråga om en verklig förgrening av huvudstammen. Om en *Equisetum* avslites eller skadas på annat sätt, kan ur den översta slidan uppväxa kransgrenar, vilka ej bryta genom slidbasen utan växa rakt upp och ge intryck av att stammen grenat sig i ett antal lika grenar.

Från Tyskland omnämnes flera fall av dikotomi hos steril *Equisetum silvaticum*. Milde (1853, sid. 877) fann i Karlsruhe *Eq. s.* »bei denen der sterile Stengel mehr oder weniger tief in 2—3 ringsum völlig ausgebildete Theile der Länge nach gespaltet war.» Flera exempel anföras av Junge (1909, sid. 159) däribland även individ med »Stengel hinab bis zum untersten astlosen Theile gegabelt.» Hos *Equisetum arvense* har iakttagits dikotomt förgrenade sterila skott. Förgreningarna sträcka sig även här olika långt, från spetsen till den nedersta grenlösa delen (Junge 1909, sid. 182). Vanligen anträffas endast något enstaka grenat exemplar bland de normalt utbildade, men de kunna ibland förekomma talrikt. År 1858 fann Milde (1858, sid. 350) över

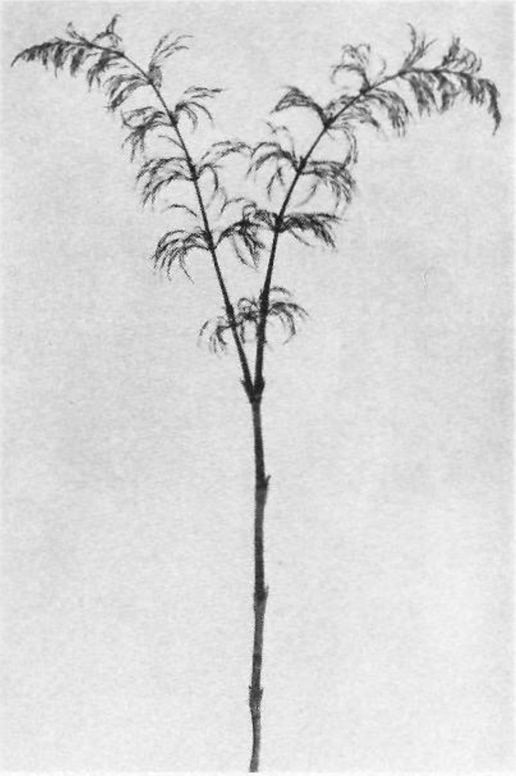


Fig. 1. *Equisetum silvaticum* L. Västergötland: Toarp, Målsryd, 27.5.1922. Leg. Folke Lundberg. — Foto förf.

50 gaffelgrenade exemplar av *Equisetum arvense* i en potatisåker nära Breslau.

Litteraturuppgifter om gaffelgrenade fertila *Equiseta* äro sparsamma. Milde (1854, sid. 100) fann av *Equisetum silvaticum* »eine Menge Pflanzen, deren Aehren in 2 bis 5 Theile der Länge nach, mehr oder weniger tief, einige bis auf den Grund, gespalten waren». Junge (1909, sid. 158) har två uppgifter om *Equisetum silvaticum* med »Sporangienstand mehr oder weniger (bis zum Grunde) zweitheilig». Dikotomi hos sporangieaxen av *Equisetum arvense* omnämnes av Bruhin (1867, sid. 96) från Österrike och av Camus (1887, sid. 85) från Italien. Ett exemplar från Kiel hade två ax utgående från översta slidan (Junge 1909, sid. 182).

Den 28. 4. 1956 insamlades väster om Hjalmar Brantingsplatsen i Göteborg ett exemplar av *Equisetum arvense* med gaffelgrenat ax av min fru. Det är 9,5 cm högt och har fyra slidor, axet är 2 cm långt delat till mitten. Den gemensamma delen har 6—7 sporofyllkransar och de båda grenarna, som äro nästan lika långa och parallella, 7—8 kransar runt om. — Den 8.5.1957 fann hon på samma plats ett annat *Equisetum*-exemplar med axet delat nästan till basen.

FOLKE LUNDBERG

Litteratur

BRUHIN, TH. A. Teratologische Beiträge. — Verh. K. K. zool.-bot. Ges. Wien XVII. 1867.

CAMUS, G. Anomalie e varietà nella flora del Modense (Terza contribuzione). — Atti Soc. Nat. Modena. Rend. Adunanze. Ser III. vol III. 1887.

JUNGE, P. Die Pteridophyten Schleswig-Holsteins . . . — 3. Beih. Jahrb. Hamb. Wiss. Anst. XXVII 1909. Hamburg 1910.

MILDE, J. Ueber *Equisetum silvaticum* L. — Bot. Zeit. 1853.

— Zur Flora von Carlsruhe in Oberschlesien. — Oesterr. Botanisches Wochenblatt. IV. 1854.

— Ueber einige Kryptogamen Schlesiens. — Bot. Zeit. 1858.

ROSENDAHL, H. V.: De svenska *Equisetum*-arterna och deras former. — Ark. bot. Bd 15. N:o 3. 1917.

SYLVÉN, N.: Nya Kullabergsväxter 1955. — Skånes Natur. 1956.

Polypodium vulgare L. var. suprasoriferum Wollaston

E. J. Lowe omnämner en varietet av *Polypodium vulgare,* vilken bär sporgömsamlingar ej blott på undersidan utan även på översidan av bladen. Denna varietet beskriver han på följande sätt: »*Suprasoriferum,* Wollaston, MS.[1] (Fig. 35.) — Found in 1861, near Woolbeding, Sussex, by Mr G. B. Wollaston. The fronds are linear-lanceolate; the lobes denticulate and submarginate. (*Sub* used in the sense of *hardly* or *scarcely,* analogous to *submarginatum* in *Scolopendrium.*) The lower lobes have a tendency to be auricled. Suprasoriferous, as well as on the under side; the name being given by Mr. Wollaston on account of the sori on the upper surface of the frond. The upper sori marginal. A narrow-fronded and distinct variety.» (Lowe 1874, sid. 52). Denna varietet behandlas även av C. T. Druery (1910, sid. 186 och fig. 210 = Lowe's fig. 35). Druery's beskrivning av var. *suprasoriferum* lyder: »subdivisions narrow and irregularly toothed, *à la marginatum*; spore heaps often on the upper surface at the edges, as well as on frond backs». *Marginatum* beskriver han: »the margins are irregulary broken up into pointed teeth, with a minute marginal ridge at the back». (Druery, sid. 182 och fig. 204, 212 = Lowe's fig. 23 resp. 22). Var. *suprasoriferum* skulle alltså skilja sig från andra *Polypodium*-former med oregelbundna primärsegment genom att sori sitta på segmentens kanter och även förskjutits över till segmentens översidor.

Moore (1859 Vol. I, Plate III C) avbildar *Polypodium vulgare* var. *sinuatum* (Willd.) och på hans bild äro några sori kantställda.

En liknande *Polypodium*form förevisades av Beauvisage (1906, sid. XXXIV) vid Société Botaniques i Lyon sammanträde den 12 juni 1906: ». . . deux feuilles de *Polypodium vulgare* portant des sores non seulment à la face inférieure mais encore à la face superieure, on peut même voir leur passage d'une face à l'autre par de petites échanocrures des bords des pinnules».

P. Junge (1909, sid. 122) omnämner från Tyskland såväl *suprasoriferum* som (sid. 132) former med kantställda sori.

---

[1] MS = manuskript, brev.

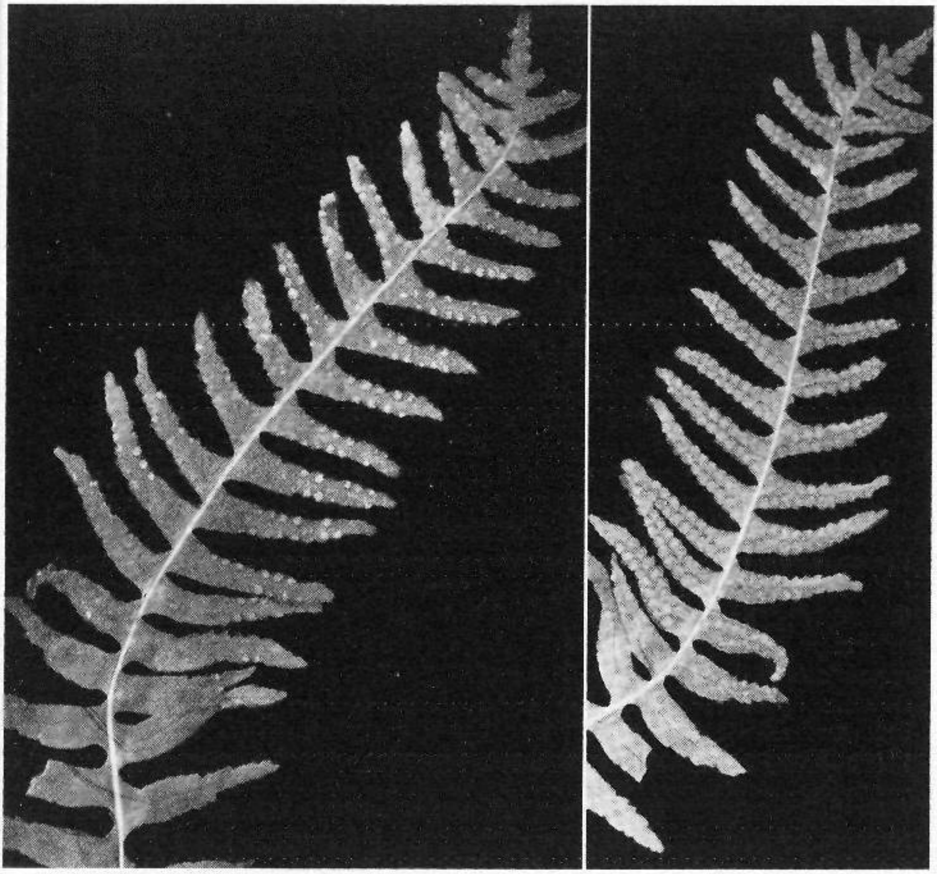


Fig. 1. *Polypodium vulgare* var. *suprasoriferum.* Bohuslän: Bokenäs, Orrvik 18.8. 1939. Leg. Sture Nilsson. Till vänster översida med övervandrade sori, till höger undersida. — Foto T. Nitzelius.

Former, som kunna räknas till var. *suprasoriferum,* ha insamlats i Sverige och Norge. I våra större botaniska museer i Göteborg (G), Lund (L), Stockholm (S) och Uppsala (U) finnas följande:

Skåne: Snogeröd 9.8.1910. Otto R. Holmberg (L, S, U). — Hov, Perstorp i en ekbacke 7.8.1927. Bertil Lindquist (L).
Blekinge: Nättraby juli 1901. Bror Holmberg (G, S). Endast några få sori på översidan.
Bohuslän: Bokenäs, Orrvik 18.8.1939. Sture Nilsson (G). Fig. 1.
Västmanland: Kila, Sätrabrunn juli 1916. H. V. Rosendahl (S).
Uppland: Öregrund 15.8.1926. Carl Pleijel (S). Några få sori på översidan.
Norge: S. Bergenshus, Lervik 8.8.1917. H. V. Rosendahl (S).

Var. *suprasoriferum* och andra, t.ex. var. *marginatum*, med ojämna segmentkanter karakteriseras av att bladskivan av någon (genetiskt betingad) anledning ej tillväxer normalt. Bladvävnaden mellan sekundärnerverna hindras i utvecklingen, vilket har till följd, att segmenten bli smalare och försedda med oregelbundna inbuktningar. Dessa inbuktningar kunna bli så djupa, att de nå in till de framåtriktade tertiärnerverna, vilka bära sori. Tertiärnerverna komma då att sluta i eller nära bladkanten. Sori utvecklas därigenom i eller mycket nära bladkanten i stället för mitt emellan primärnerven och bladkanten och kunna delvis förskjutas till bladets översida.

Man kan fråga sig, om detta förhållande är ärftligt betingat eller om det endast är tillfälliga modifikationer. Att en ärftlig disposition föreligger, torde vara säkert. Men kunna även andra faktorer inverka? År 1955 fann jag i Guddehjälm, Ytterby socken i Bohuslän ett bestånd av denna form. Beståndet (en klon) var mycket typiskt *suprasoriferum*. Primärsegmentens kanter voro ojämna, möjligen med undantag för de basala sterila segmenten, och många sori voro synliga på översidan. En del voro nätt och jämnt synliga, men många sutto till hälften på översidan. Några få hade nästan helt vandrat över (Fig. 2). 13 blad insamlades 17.9.1955, och de voro sinsemellan mycket lika. Antalet från översidan synliga sori varierade från 28 till 100. Medeltalet var 61. Fjolårsbladen funnos emellertid kvar, och de voro normala. Bladkanterna voro i stort sett jämna, och jag kunde ej finna några med kantställda eller på översidan synliga sori. År 1956 besökte jag åter platsen, och då voro bladen av samma utseende som år 1955. Antalet på översidan synliga sori var dock något mindre. Det är alltså icke endast ärftliga anlag, som bestämmer utformningen. De yttre förhållanden ha tydligen stor betydelse. Detta stämmer även med det förhållandet, att man i naturen kan finna former med endast några få sori synliga från översidan (se ovan).

Ovanstående gäller *Polypodium vulgare*, men även andra ormbunkar kunna förekomma med liknande former. Detta är i synnerhet fallet med *Scolopendrium vulgare*. Moore (1859, Vol. II, sid. 135) skriver härom: »... although the fructification of *Scolopendrium* is normally dorsal, as the rest of the *Polypodiaceae*, a very curious deviation from this law, occurs in several of the varieties of the common Hart's Tongue Fern, the sori being produced on the upper as well as the lower surface, and sometimes abundantly so. This occasionally happens from the elongation of the normally placed sorus of the underside, which extends to the margin and returns on the upper side when the sori happen to be placed opposite to the marginal crenatures. But it also frequently happens that the sori are placed on the upper side distinctly within the margin, and where there are no corresponding sori beneath. Those varieties which have the margin crenated or lobed, seem most liable to assume this abnormal suprasoriferous condition». Under namn av *Scolopendrium vulgare* var. *fissile* beskriver Lowe (1865, sid. 84) en form från Castle Howard med sori även på bladens översida: »A dwarf Fern, and a very irregular-edged variety, with a beautifully cut margin. Sori small; sometimes supra-soriferous». Från Frankrike noterar Boullu (1895, sid. 57): »*Scolopendrium* a fronde munie de sores sur les deux faces». Som ytterligare exempel kan anföras en form av *Athyrium filix-femina*, insamlad av H. C. Hart nära Dunfanaghy och av

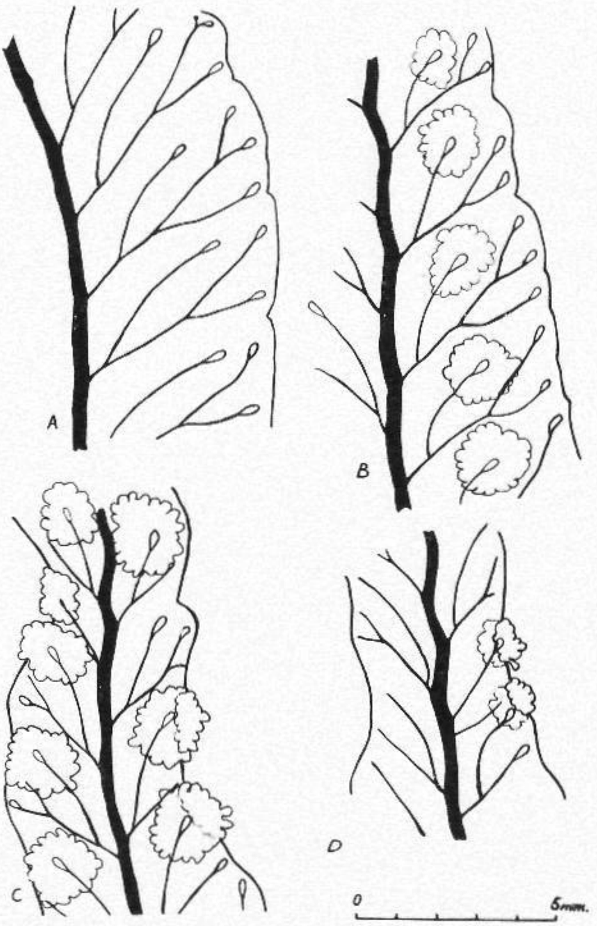


Fig. 2. *Polypodium vulgare* var. *suprasoriferum*. Bohuslän: Ytterby. Guddehjälm. 17.9.1955. Segment från undersidan, med nerver och sori (konturer). Sori på översidan punkterade. Förf. del. — A. Basalt sterilt segment. — B. Nästan normalt fertilt segment. — C. Segment med kantställda och två delvis till översidan förskjutna sori. — D. Segment med två till större delen på översidan belägna sori.

honom (Hart 1880, sid. 336) beskriven på följande sätt: »It bore spores upon the upper as well as the lower surface of the pinnules, frequently upon both faces of the same pinnule, while the fronds were remarkably dissected».

Flera exempel skulle kunna anföras, men dessa må vara tillräckliga. Det framgår, att kanställda och på översidan placerade sori i allmänhet förekomma hos individ med ojämna eller inskurna bladkanter samt att sori alltid även förekomma på undersidan. Dessutom kan man ofta iakttaga sori, som endast delvis vandrat över från undersidan till översidan.

Om de ovan nämnda ormbunkarna äro konstanta, eller om de i likhet med *Polypodium* från Guddehjälm variera från år till år, är ovisst.

Kungälv april 1957.

Folke Lundberg

Litteratur

Beauvisage. Annales de la Société Botanique de Lyon. — Comptes rend. séances. 1906, p. XXXIV.

Boullu. — Ann. Soc. Bot. Lyon. Comptes rend. séances. 1895, p. 57.

Druery, C. T. British Ferns and their Varieties. — London 1910.

Hart, H. C. The Flora of North-Western Donegal. — Journ. Bot. New Ser. Vol. IX. 1880, p. 330—337.

Junge, P. Die Pteridophyten Schleswig-Holsteins . . . — 3. Beih. Jahrb. Hamb. Wiss. Anst. XXVII 1909. Hamburg 1910.

Lowe, E. J. New and Rare Ferns. — London 1865.

— Our Native Ferns, Vol. I. — London 1874.

Moore, Th. Nature-Printed Britsh Ferns. — Vol. I, II. London 1859.

En spontan Rubus chamaemorus-hybrid, den första på den skandinaviska halvön

Vid genomgång av Botaniska Notiser för litteratur om nordliga *Rubus*-arter kom undertecknad på en artikel om en flikbladig *Rubus chamaemorus*-typ, funnen i Storlien, Jämtland, och beskriven av Gunnar Nilsson år 1925. Enligt vad han kunde finna vid jämförelser med olika herbariematerial, var denna typ en *chamaemorus* trots sina flikiga blad (1).

Undertecknad blev intresserad av växten, och vid besök i Storlien den 22/6 1952 hittade jag efter mycket letande den tidigare, omsorgsfullt beskrivna växtlokalen. Plantorna var ej uppkomna ur mossan; där fanns blott små skott och hopvecklade blad nere i densamma. Det hela tycktes, såsom tidigare också meddelats, röra sig om en enda klon. Delplantor medtogs, och på dessa iakttogs endast honblommor med mycket små, rundade, vita kronblad.

Fixeringar gjordes, och det somatiska kromosomtalet konstaterades vara 35, vilket pekar på, att det förmodade hjortronet måste vara en hybrid, troligen mellan *R. chamaemorus* ($2n=56$) och *R. idaeus* ($2n=14$) eller vice versa. Detta antagande grundar sig på det faktum, att den senare arten växte alldeles i närheten, liksom f.ö. även *R. saxatilis* ($2n=28$). På sumpmark 100 m längre ner i dalen blommade hjortronen för fullt vid mitt besök. *R. arcticus*, vars somatiska kromosomtal också är 14, förekommer, såvitt jag vet, inte i denna del av Jämtland, varför det ej är troligt, att den arten ingår i nämnda hybrid. Både *R. arcticus* och *R. chamaemorus* fordrar dessutom fuktig växtplats åtminstone under försommaren, då däremot *R. idaeus* trivs på torr sådan. Hybridens växtplats var säregen — ett klippblock, täckt med någon mylla samt mossa.

Enligt den kände *Rubus*-forskaren, professor A. Vaarama, som brevledes sett vidstående foto av hybriden, kan den dock vara en *R. arcticus*×*chamaemorus*

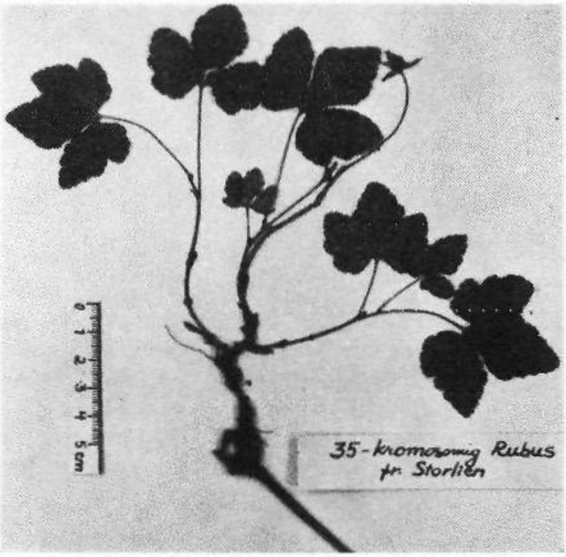


Fig. 1.

Fig. 2.

Fig. 1. The above spontaneous *Rubus chamaemorus* - hybrid with 2n = 35 is the first one, found in the Scandinavian peninsula. It is probably *R. chamaemorus*× *idaeus*, but it could also be *R. chamaemorus*×*arcticus*.
The hybrid was earlier described as *R. chamaemorus* L. *forma* (1).

Fig. 2. 2n = 35, ×3000.

eller vice versa, då frånvaron av *R. arcticus* i nejden inte absolut utesluter en *arcticus*-hybrid. Han skriver också: »Den är verkligen en raritet bland spontana hybrider och den första förekomsten på den skandinaviska halvön». (4)

Tidigare har sålunda inga hjortronhybrider rapporterats från vårt land. Däremot har en dylik, *R. chamaemorus*×*saxatilis* beskrivits år 1925 av W. Tranzschel (3). Han hade funnit den i Ingermanland vid floden Dranischnikowskij år 1915, och han omnämnde även, att en hybrid, *R. chamaemorus*× *arcticus*, setts i Gouv. Novgorod och beskrivits i en rysk artikel 1896.

Själv har jag gjort hundratals korsningar mellan *R. arcticus* och *R. chamaemorus*, men resultatet har blott blivit några få frön, vilka tyvärr aldrig grott.

Vid New Hampshires försöksstation i U.S.A. har man emellertid bevisat, att även *R. chamaemorus* och *R. idaeus* låter korsa sig med varandra: pentaploida plantor har nämligen där uppstått i avkomman (2).

Öjebyn i mars 1957. GUNNY LARSSON

Litteratur

(1) NILSSON, G. En anmärkningsvärd form av Rubus chamaemorus L. — Bot. Not. 1925, Lund 1925.

(2) PIKE, R. B. The breeding behavior of Rubus chamaemorus L. — Thesis, Univ. of New Hampshire. Master of Science, 1952 Nt P 6353 in the Library at Durham. Not published.

(3) TRANZSCHEL, W. Rubus chamaemorus × saxatilis und R. chamaemorus × arcticus. — Memor. Soc. Fauna Flora Fennica. Helsingfors 49, 1925.

(4) VAARAMA, A. Brev i dec. 1956.

Tall med grangren

Våren 1956 fick jag uppgift om en märklig tall, som uppgavs ha en väl utvecklad grangren. Min sagesman och jag gjorde ett besök på platsen, och jag tog trots dunklet nedanstående foto av det förvånande fenomenet. Av bilden torde tydligt framgå, att stammen tillhör en tall och att grenen är en grans.

På en höjd över markytan av 170 cm ansätter en horisontellt växande grangren, som är 185 cm lång (Fig. 1). Vid basen har tallen en omkrets av 78 cm och vid grenens ansättning mäter den 56 cm. Grangrenen börjar med en ansvällning, som är i det närmaste cirkelrund — dess diameter är 21 cm. Ansvällningens höjd är 12 cm. Grenen skjuter inte ut från sockelns centrum utan något asymmetriskt bildande sekant till stammens genomskärningsyta. När grenen lämnar den kupolformiga sockeln, är dess omkrets 18 cm. Det må tillläggas, att gränsen mellan tall- och granbark är mycket distinkt och att någon »sammanblandning» av de två barkelementen icke förekommer.

Skogvaktare Elis Arfvidsson i Hovmantorp känner personligen det här omtalade omaka paret sedan minst tjugo år. När han först såg det, var grangrenen helt liten, vilket väl talar mot »naturlig ympning» genom gnidning mellan tallen och en närstående gran. Något minne av att det då rörde sig om

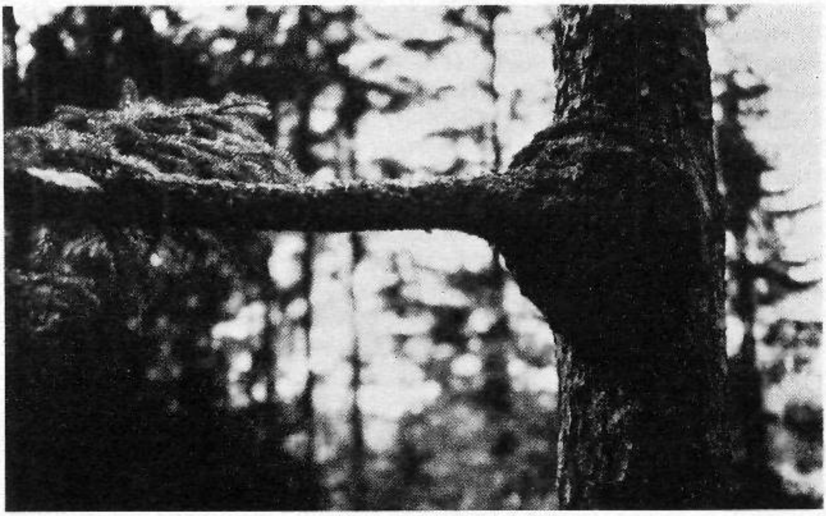


Fig. 1. Tall med grangren.

ett litet träd har inte herr A., vilket i sin tur torde tala mot tanken på att grenen uppstått ur ett i en barkspringa groende frö. Inget rykte är bekant om att någon avsiktligt skulle ha ympat in grenen. Ympteorin är nog trots detta den mest sannolika. Grangrenen besitter en egenhet däri att dess två basala sidogrenar är bakåtriktade (se bilden).

Den egendomliga tallen finns att beskåda c:a en km norr om stora landsvägen Växjö—Kalmar vid en skogsväg, som från den förra tar av mot norr strax öster om östra nedfarten till Hovmantorps samhälle.

Curt Mossberg

Botaniska Notiser 1957 · Vol. 110 · Fasc. 2 · Lund

Litteratur

Olaus Bromelius: Chloris Gothica. — Facsimile-tryck utg. av Axel Liljedahl. Göteborg 1956. Numrerad uppl., skinnband kr. 90: —.

Att den sällsynta och svåråtkomliga boken Chloris Gothica av Olaus Bromelius, ursprungligen tryckt 1694, på initiativ av framl. apotekare Axel Liljedahl blivit tillgänglig i en facsimile-upplaga, är mycket värdefullt med hänsyn till dess historiska värde. Olaus Bromelius, stadsläkare i Göteborg, var en av de förlinnéanska botanisterna i Sverige; han avled 1707, samma år som Linné föddes. Hans bok Chloris Gothica erinrar något om O. Rudbecks Hortus Botanicus av 1685 i uppställning och nomenklatur, men under det att den senare i stor utsträckning ägnar sig åt trädgårdsväxter, många av Rudbeck nyinförda, är Bromelius' bok en förteckning över vilda växter, förekommande i Göteborgstrakten, samt åkerbruksväxter. Nomenklaturen är också fylligare, såväl den latinska, som upptar många citat från andra författare, vilket underlättar identifieringen av växterna, som även den svenska. Särskilt för kännedomen om äldre svenska namn har boken stort intresse. Många av de upptagna namnen äro utan tvivel folknamn, ofta träffande, ibland drastiska, såsom lejonfot (*Alchemilla*), grodesallat (*Potamogeton*), koskälla (*Anemone pulsatilla*), kalvelortar (*Rubus caesius*), prästepungar (*Ranunculus ficaria*), bondenejlikor (*Agrostemma githago*), fuglenäste (*Daucus carota*). Andra äro mera att betrakta som skrivbordsprodukter, såsom de omständliga: Det större Karborre-gräs med Näät omkring Hufwudet, Store Hunde Fioler med rundachtige Blad.

Även för kännedomen om äldre tiders flora är boken av värde, då den ger en förteckning över de vilda växterna i ett begränsat område. För många arter ges här de äldsta förekomstuppgifterna för Sverige, eller åtminstone för Västsverige. Bl.a. upptagas några arter, som numera äro mycket sällsynta eller försvunna i trakten, såsom *Osmunda regalis* och *Lithospermum officinale*. Vidare får man veta, att en del av människan i relativt sen tid införda arter på denna tid förekommo i Göteborgstrakten, såsom *Acorus calamus* och *Inula helenium*. Bland åkerbruksväxterna lägger man märke till *Hordeum nudum*, himmelskorn eller skallöst korn. Med himmelkorn betecknades tidigare en *Triticum*-art, *T. dicoccum* eller *spelta*, medan namnet hos Linné och senare författare överförts till en korntyp med löst omslutande agnar. Bromelius avser tydligen också det senare; även på hans tid hade namnets ursprungliga betydelse råkat i glömska, sedan de ålderdomliga vetearterna försvunnit i odling.

Också en hel del kryptogamer upptagas av Bromelius, bl.a. en del svampar. Dessa indelas i tre grupper, giftsvampar, omfattande de flesta arterna, vidare på träd växande svampar, samt ätliga eller mindre giftiga svampar. Till den senare gruppen räknas endast två slag, dock inte kantareller och champinjoner utan murklor och riskor. Murklorna voro tydligen i äldre tid viktiga matsvampar; de omtalas ju t.ex. också flerestädes i Linnés resor (»murklor såg man plockas av bondtöserna, som voro både sköna och stora»).

I ett bifogat litet häfte, som sammanställts av Maja Kjellin, lämnas biografiska upplysningar om Olaus Bromelius, efter A. Liljedahls anteckningar, och vidare även några biografiska data om Liljedahl. Man skulle nog ha önskat en mera utförlig kommentar, särskilt i fråga om en del svårtolkade växtnamn. Kanhända hade Liljedahl också planerat en sådan men ej hunnit fullborda arbetet.

Bromelius' bok är givetvis av speciellt värde för Göteborgsbotanister men även för andra har den sitt intresse genom de bidrag den lämnar till botanikens äldre historia i Sverige.

H. HJELMQVIST

G. Huber-Pestalozzi: Das Phytoplankton des Süsswassers, Systematik und Biologie I—IV. — Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

För de forskare, som vid seklets början ville ägna sig åt det just inledda och tjusande studiet av sötvattnens fytoplankton, var det ett rätt besvärligt portgångsföre. Dessa nya biotoper uppvisade massor av former och det gällde att urskilja i vad mån de kunde sammanhänga med vad som var känt från våta biotoper, varvid litteraturkällorna måste sökas på de mest skilda håll, även i den zoologiska litteraturen på grund av fytoplanktonets heterogena innehåll. Nya former beskrevos med stor flit men ofta ofullständigt utredda. Paschers Süsswasserflora, av vilken flera delar utkommo strax före det första världskriget betydde en utomordentlig hjälp i rättan tid och ha i hög grad gynnat forskningen, men numera äro dess delar ofullständiga och omoderna (speciellt klorofycéer och krysofycéer, desmidiéerna ha ännu icke utkommit); endast volvokaler, blågrönalger och diatoméer ha utkommit i starkt utvidgade upplagor.

Den taxonomiska forskningen av de planktiska algerna har sen dess i fyra decennier fortsatt i växande tempo ehuru ej alltid med den noggrannhet och exakthet, som krävers för att ekologiska slutsatser skola kunna dragas vid jämförelser av olika forskares resultat. Det är därför en lika tacknämlig som omfattande uppgift, som den schweiziske fytoplanktonforskaren Gottfried Huber-Pestalozzi påtog sig i och med utgivandet av del I av ovannämnda arbete år 1938, redan 1941—42 följda av del II.

Stort upplagda verk med blott en författare äro utsatta för risken att bli oavslutade och limnologerna frågade sig under krigets allt mer omfattande brand, om resterande delar skulle se dagen; särskilt kanske var man orolig för de kvalitativt så viktiga klorofycéerna och desmidiéerna. År 1950 utkom emellertid del III och 1955 den digra del IV. Detta år meddelade förläggaren undert., att den då 77-årige förf. i det närmaste slutfört manuskriptet till del V, vilken nu torde vara säkerställd. Även om en projekterad supplementdel ej skulle bringas till utförande, har förf. skapat en bibel för alla fytoplanktologer och åt sig själv ett monumentum aere perennius.

Del I behandlar planktonbegreppet, svävförmågan och formtyperna, fytoplanktonets ursprung, allmänna sammansättning, cyklomorfos, migration och utbredning, sjötyper i anslutning till planktonassociationer, skiktning m.m. på de första 122 sidorna. Därefter följer en taxonomisk del om cyanofycéer samt mera framträdande bakterier och svampar på 225 sidor med 66 planscher, upptagande 285 nummer av figurer, vardera i regel med flera (upp till 15) bilder. Pris 64 DM.

Del II: 1 behandlar krysofycéer, färglösa flagellater och heterokonter på 350 sidor och 107 plancher med talrika bilder, sammanfattade i 443 figurer. Pris 82 DM.

Del II: 2 behandlar diatoméerna och är till väsentlig del författad av Fr. Hustedt, som även står för ett stort antal nya former och flertalet bilder. Ett kapitel om kiselsyrans kretslopp ingår även. Denna del omfattar 175 sidor med 202 figurer på 71 planscher. Pris 49 DM.

Del III behandlar kryptofycéer, kloromonader och peridinéer (*Dinophyceae*) på 310 sidor och 350 figurer (1415 detaljbilder). Pris 68 DM.

Del IV behandlar euglenofycéerna på 564 sidor och 1265 figurer. De 114 planscherna äro här sammanförda till slutet av volymen. Förf. har i denna del utvidgat sitt område vida utöver de egentliga plankterna och åstadkommit en tacknämlig sammanfattning av alla funna arter, t.ex. 233 arter av *Trachelomonas*!

Varje volym är försedd med rätt utförligt sakregister, delarna I—III även med auktorregister. De citerade auktorsnamnen ha i regel blott det avsedda arbetets årtal bifogat, detta med tanke på den sammanfattande litteraturförteckningen i supplementbandet. I del IV har för säkerhets skull denna anordning frångåtts, så att bandet innehåller lista på citerad litteratur.

Under den mer än två decennier varande utarbetningen har den projekterade omfattningen väsentligt utökats dels på grund av den allt mer intensifierade forskningen, dels genom en vidgad uppfattning av fytoplankton till att omfatta icke-sessila alger överhuvud. Härigenom har särskilt del III och IV kommit att bli en värdefull handbok i de färgade flagellaternas, speciellt euglenofycéernas taxonomi och biologi, vilken förut saknats.

Förlaget, som specialiserat sig på limnologisk litteratur, har givit verket en synnerligen vederhäftig, klar och redig typografisk utstyrsel. Den relativt begränsade publik, som verket kan påräkna, har dock medfört, att prisläget, cirka 500 kr, torde tvinga många enskilda fykologer att nödgas avstå från ett privat förvärv. De angivna priserna avse häftade exemplar, maskinbundna originalklotband kosta blott c. 3 DM mer, men med tanke på den intensiva användning, som banden bli utsatta för, torde det i längden bli billigast och trevligast att låta inbindningen ske här.

För varje fytolimnolog är verket ett absolut oumbärligt hjälpmedel. De högre taxa presenteras med värdefulla översikter av morfologi och utvecklingshistoria, och bestämningen av formerna ledes genom noggranna bestämningsnycklar fram till klara diagnoser och konfirmeras av det ytterst rika illustrationsmaterialet; de besiffrade 2655 figurerna innehålla ungefär det tredubbla antalet detaljbilder. Av största värde äro även de uppgifter om ekologi och korologi, som förf. hopbragt ur den lika omfattande som splittrade litteraturen.

Värdet av ett sådant hjälpmedel kan ej överskattas; den ökade intensiteten inom den limnologiska forskningen måste till mycket stor del tillskrivas den stimulans, som Huber-Pestalozzis verk utövat. Verket betecknar ett stordåd, skapat av intelligens, vetenskaplig noggrannhet och kärlek till uppgiften, det senare framgår ej minst av den omständigheten, att förf. vid sidan av sin gärning såsom läkare (han är med. såväl som fil. dr.) haft energi och möjlighet att genomföra sin uppgift på ett så glänsande sätt.

EINAR TEILING

Carolus N. Linnaeus. Örtabok 1725. Utgiven av Svenska Läkaresällskapet till Linnéjubileet 1957 genom Telemak Fredbärj. — Almqvist & Wiksell, Stockholm (Pris 25 kronor).

Att Linnélitteraturen skulle berikas till 250-årsdagen av Linnés födelse var väntat. Men att det även skulle komma ut ett förut icke publicerat arbete av Linné och därtill det första kända av hans hand, var nog en överraskning för de flesta. Så har emellertid skett och detta till glädje för alla Linnévänner. Det rör sig om en anteckningsbok, som Linné fört under sina skolår i Växjö. Den är daterad 1725, således när Linné var 18 år. Någon titel har den inte, men utgivaren kallar den för *Örtabok*. En titel som väl täcker innehållet, ty detta står helt på de gamla örtaböckernas nivå och är rikt bemängt med fabler, vidskepelse och övertro. Härför kan dock icke Linné lastas, då så gott som alltsammans är citat, avskrifter, som skolynglingen Linnaeus gjort efter en rad böcker, som mer eller mindre kan stämplas som örtaböcker och som han själv skaffat eller lånat av sina lärare. För honom representerade dessa böcker högsta visdom, vilken han med ungdomlig iver och kunskapstörst tillägnade sig. För oss förefaller det underligt att denna från antiken och medeltiden härstammande örtabokslärdom ännu då var gångbar och att även lärarna satte sådana böcker i lärjungarnas händer. Men det visar också vilka stora svårigheter och vilket motstånd Linné måste ha mött, när han insåg ohållbarheten i de gamla föreställningarna och började arbeta för en förnuftig och på saklighet grundad läkemedelslära.

Boken, som är på mer än 300 sidor, innehåller omkring 170 växter, namngivna på svenska och latin och åtföljda av de nämnda citaten, som huvudsakligen beröra växternas användning som läkemedel. Utgivaren har kompletterat detta med bilder över de olika växterna. Det är träsnitt hämtade från några av de böcker, som Linné avskrivit. I boken omtalas också kaffe och te och deras användbarhet i medicinen. Ett kapitel har titeln varia och innehåller vad som hörer till läkarens och apotekarens yrken. Alltsammans är kommenterat i utförliga och sakrika noter. I förekommande fall har latinsk text översatts till svenska. Några av anteckningsbokens sidor återgives i faksimile. De visa, att utgivaren måste ha nedlagt ett stort och tålamodsprövande arbete för att kunna tolka och återgiva boken. Härför är man honom stor tack skyldig. Liksom man är tacksam mot Svenska Läkaresällskapet, som möjliggjort att denna örtabok kommit ut. Den berikar på ett mycket påtagligt sätt vår vetskap om skolynglingen Carolus Linnaeus och berättar om den tid och den miljö han växte upp i.

AXEL TÖRJE

BOTANISKA NOTISER 1957 · VOL. 110 · FASC. 2 · LUND

Notiser

Ny professor. Till professor och föreståndare för avdelningen för marklära vid Statens skogsforskningsinstitut har från den 1 april 1957 utnämnts 1:e assistenten vid institutet, docent C. O. Tamm.

Forskararvode. Laborator Albert Levan, Lund, har av Statens naturvetenskapliga forskningsråd tilldelats ett forskararvode motsvarande professorslön för ett år från den 1 juli 1957, under förutsättning att han erhåller tjänstledighet från laboraturen.

Docentförordnande. Fil. dr O. Hedberg har förordnats till docent i systematisk botanik vid Uppsala universitet.

Hedersdoktorer. Med anledning av 250-årsminnet av Linnés födelse har den 31 maj 1957 följande botaniska forskare promoverats till hedersdoktorer vid Uppsala universitets matematisk-naturvetenskapliga fakultet: Dr H. H. Allan, Wellington, Nya Zealand, dr J. Braun-Blanquet, Montpellier, med. lic. Harald Fries, Göteborg, professor Roger Heim, Paris, dr Johannes Iversen, Charlottenlund, professor Harald Lindberg, Helsingfors, professor Rolf Nordhagen, Oslo, dr J. Ramsbottom, London, professor Johanna Westerdijk, Baarn. Till medicine hedersdoktorer promoverades de kända Linnéforskarna med. lic. Telemak Fredbärj och f.d. 1:e bibliotekarie A. H. Uggla, och till filosofie hedersdoktor i humanistiska fakulteten Linné-kännaren biskop E. Malmeström. — Vid Lantbrukshögskolan blev samtidigt till agronomie hedersdoktorer promoverade professor J. Clausen, Stanford, U.S.A., professor H. Kihara, Yokohama, och professor G. Turesson. — Slutligen har professor J. A. Nannfeldt, Uppsala, kreerats till hedersdoktor vid universitetet i Caen, Frankrike.

Doktorsdisputationer. Följande doktorsavhandlingar har ventilerats vid Uppsala universitet: den 27/4 O. Hedberg: Afroalpine vascular plants, 18/5 O. Rune: Studier över floran på serpentinbergarter i norra Fennoskandien och nordöstra Nordamerika, 22/5 Maj-Britt Florin: Insjöstudier i Mellansverige, 25/5 L. Holm: Études taxonomiques sur les Pléosporacées. — Vid Lunds universitet försvarade den 13/5 N. O. Bosemark: Studies on accessory chromosomes in grasses, 18/5 H. Rufelt: Studies on the geotropism of wheat roots och 20/5 A. Almestrand: Growth and metabolism of isolated cereal roots. — Vid Stockholms högskola ventilerades den 20/5 D. v. Wettstein, Genetics and the submicroscopic cytology of plastids. — Vid Lantbrukshögskolan den 25/5 S. Bingefors: Studies on breeding red clover for resistance to stem nematodes.

Forskningsanslag. Fysiografiska sällskapet i Lund har vid sammanträde den 13/3 utdelat ett anslag å 3.000 kr. till prof. G. Ehrensvärd för inköp av ett mikroskop, speciellt ägnat för studier av mögelsvamparnas morfologi och utveckling.

Vidare utdelades ur sällskapets Nilsson-Ehle-fond 2.000 kr. till prof. G. Ehrensvärd för genetiskt-biokemiska arbeten rörande släktet *Penicillium*, 2.000 kr. till fil. kand. S. Ellerström för undersökning av konkurrensförhållandena hos olika kromosomraser av timotej i blandbestånd, 800 kr. till fil. lic. S. Fröst för undersökning av accessoriska kromosomer hos *Plantago serraria*, 350 kr. till fil. mag. L. O. Hall för bearbetning av japanskt vetematerial, 1.000 kr. till fil. kand. G. Holm för undersökning av alleliförhållandena hos klorofyllmutanter av korn, 2.300 kr. till fil. kand. G. Ising för fortsatta undersökningar av heterozygotigradens roll för heterosisfenomenet hos diploida och tetraploida korntyper, 2.500 kr. till fil. lic. A. Lundqvist för fortsatt undersökning av inavelseffekter hos råg, 2.300 kr. till fil. kand. S. Malmborn för evolutionsgenetiska undersökningar över diploida kornsorter med särskild hänsyn till cellstorleken och därav beroende egenskaper, 1.800 kr. till doc. N. Nybom för cytogenetiska arbeten inom släktet *Rubus*, 2.300 kr. till fil. kand. E. Vigfússon för fortsatta undersökningar angående luxurierande solrosors uppkomst. — Stiftelsen Lars Hiertas minne har vid sitt ord. vårsammanträde utdelat bl.a. följande anslag: Till fil. lic. Kerstin Gezelius, Uppsala, 700 kr. för bildmaterial till uppsatsen: »Morphology and fine structure of the slime mold Dictyostelium discoideum», till fil. dr B. Halden, Stockholm, 800 kr. för geologisk-växtekologisk undersökning av Våckelberget i Dalarna, till doc. T. Norlindh, Lund, 1.460 kr. för embryologiska och cytologiska undersökningar av vissa arter inom *Calendula*-gruppen. Vidare har från Hierta-Retzius' stipendiefond utdelats 1.700 kr. till docenterna O. Gelin och L. Ehrenberg för undersökning av genbetingad variation i strålningskänsligheten hos ärt, 3.000 kr. till fil. lic. B. Pettersson för färdigställande av en avhandling om valda problem i gotländsk vegetation och flora samt 1.000 kr. till lektor S. Rönnerstrand för en undersökning av rödalgernas oxidassystem. — Statens naturvetenskapliga forskningsråd har den 3 april 1957 offentliggjort, att följande anslag utdelats för botanisk forskning: Till doc. Irma Andersson-Kottö 4.968 kr. för genetiskt-kemiska undersökningar av aminosyrebildningen i normalstam och mutanter av *Neurospora*, till lektor C. Bliding 5.890 kr. för undersökning av anatomi, fortplantning och livscykel inom släktena *Enteromorpha*, *Cladophora* m.fl. samt för utarbetande av en monografi över *Enteromorpha*, till doc. I. Ekdahl 7.800 kr. för studier över rot- och rothårstillväxten hos några kulturväxter, till prof. H. Erdtman 17.420 kr. för fortsatta studier över barrträdens kemiska beståndsdelar och deras taxonomiska betydelse, till laborator G. Fåhraeus 9.360 kr. för undersökning av oxidaser hos svampar, till fil. lic. A. Gustavsson 2.286 kr. för undersökningar av oosporer och mycelium hos arter av släktet *Peronospora*, till doc. H. Runemark 5.800 kr. för detaljinventering av floran på Cycladerna, till laborator G. Samuelsson 7.000 kr. för isolering och konstitutionsbestämning av peptider i *Viscum album*, till prof. H. Weimarck 3.048 kr. för cytologiska undersökningar, till prof. E. Åkerberg och doc. A. Hagberg 10.000 kr. för undersökning av fotosyntesen hos växtmaterial av varierande genetisk konstitution. — Från Längmanska kulturfonden har utdelats 1.500 kr. till lektor V. Gillner för illustrationer och tabeller till en avhandling »Strandängsvegetation vid Sveriges västkust», 1.500 kr. till fil. lic. B. Pettersson för illustrationer till en doktorsavhandling över valda problem i Gotlands flora och vegetation samt 2.000 kr. till Skaraborgs läns naturskyddsförening för en vetenskaplig beskrivning av länets naturreservat jämte historik över föreningens verksamhet.

Ett erbjudande att förvärva underlagskartor för biologiskt inventeringsarbete. På initiativ av Riksmuseet och Stockholms Högskola har AB Kartografiska institutet framställt en underlagskarta över Sverige, speciellt lämpad för inprickning av växt- och djurfynd. Kartan är gjord i skalan 1 : 2 miljoner (1 cm = 2 mil). Kustkonturer och viktigare vattendrag tryckas i svart, medan de finare kartdetaljer som skola medge fyndens exakta inprickning framträda i blått. När en fyndkarta skall reproduceras bortfiltreras blåtrycket vid klicheringen, så att endast kartans huvuddrag komma att framträda. Den publicerade bilden blir därigenom synnerligen överskådlig.

För att göra det möjligt för såväl fackmän som amatörer, sysselsatta med arbeten av inventeringsnatur, att till lågt pris anskaffa en dylik förstklassig underlagskarta, har Statens naturvetenskapliga forskningsråd bekostat hela grundarbetet med ritning, klichering och uppsättning av kartan. Den kan därigenom erhållas för endast 25 öre per exemplar (omfattande två hälfter, södra och norra Sverige, vardera i storlek ca 32×45 cm; halvorna säljas *ej* separat) förutsatt att beställningen göres i samband med förestående tryckning samt omfattar jämna hundratal exemplar. För mindre beställningar blir priset något högre.

Beställningar måste vara kartredaktör Olof Hedbom, AB Kartografiska institutet, Vasagatan 16, Stockholm C, tillhanda senast den 31 juli 1957. Kartredaktör Hedbom står också till tjänst med vidare upplysningar för den som så önskar.