Botaniska Notiser 1964 · Vol. 117 · Fasc. 3 · Lund

Om några adventiva Polygonum-arter av gruppen Avicularia

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Under arbetet på andra delen av min Nordisk kärlväxtflora har jag också haft att ta ställning till några arter av *Polygonum*-gruppen *Avicularia,* vilka ej tillhöra den ursprungliga eller arkeosynantropa floran inom det nordiska floraområdet men som blivit funna där som sena och mer eller mindre tillfälliga inkomlingar. Jag har nyligen (Hylander 1963) i annat sammanhang nämnt ett par sådana, *P. erectum* L. och *P. achoreum* S. F. Blake, två närbesläktade nordamerikanska arter, av vilka den första blivit samlad en gång i Helsingfors, den andra två gånger vid hamnen i Svendborg.

Större frekvens som adventiva visa några eurasiatiska arter, av vilka dock ingen synes ha blivit bofast, om det också förefaller troligt, att en av dem, *P. patulum,* i vissa fall genom självsådd kunnat hålla sig kvar på en och samma lokal under mer än ett år. Denna art är den som inkomling vanligaste, i Sverige liksom i Danmark, Norge och Finland, men även den är tydligen mycket sen. Den första rapporten från Sverige är uppgiften hos Nordström 1903 om ett fynd av »*P. Bellardi* All.» vid Hälsingborg (mellan Pålsjö och Sofiero) 1900;[1] det äldsta svenska belägg jag sett är från 1903, samlat av F. Ringius vid Östrand i Medelpad. I Danmark blev den först samlad vid Köpenhamn 1895 och omnämns, så vitt jag kunnat finna, i dansk litteratur första gången 1905, i Mortensens & Ostenfelds artlista, även här under namnet *P. Bel-*

[1] Fyndet har av någon anledning ej upptagits hos Weimarck 1963, där arten (som *P. kitaibelianum,* jfr nedan) nämns blott från Simrishamn (O. R. Holmberg 1910) och Malmö (C. Blom 1931). Nordströms beskrivning tyder bestämt på *P. patulum,* och någon anledning att tvivla på fyndet kan jag ej se, trots att något belägg ej tycks finnas bevarat.

lardi. I Raunkiærs flora kom den dock inte in förrän i uppl. 3 (1911), då under det riktiga namnet *P. patulum*. Allionis art *P. Bellardii* anses numera inte alls ha med *P. patulum* att göra utan hänföra sig till någon form av *P. aviculare* coll.; namnet användes dock länge allmänt för *P. patulum* (i vidsträckt mening).

Karakteristiskt för *P. patulum* gentemot kollektivarten *P. aviculare* är att de övre bladen äro förkrympta, så att en stor eller övervägande del av blomknippena synes bilda ett naket, avbrutet ax. Kalken är påfallande brokig genom att flikarna till större delen äro gröna men ha en vanligen bjärt rosafärgad bård; de sluta sig mycket tidigt och äro i spetsen tydligt huvlikt inböjda över frukten, medan de hos *P. aviculare* äro raka eller utsvängda. Frukten påminner i formen om den hos *P. aviculare* ssp. *heterophyllum*, är liksom den vid mognaden matt men med föga eller knappast alls märkbar ytstruktur och mera nötbrun till färgen.

Liknande bladlösa men ofta mera tydligt axlikt sammanflytande blomsamlingar ha också ett par andra formgrupper, som blivit funna adventiva i Norden. Hos den ena äro blommorna påfallande länge öppna med stjärnlikt utbredda flikar, vilka till allra största delen äro kronlikt färgade (vanligen ljust skära, stundom nästan vita); fastän blommorna i regel äro mycket små (liksom frukten), bli blomsamlingarna därför ganska iögonenfallande och växten i blom mycket prydlig. En av de hithörande arterna har också fått namnet *P. pulchellum*, givet 1825 av fransmannen Loiseleur, som beskrev arten från Frankrike. Hos franska författare har den emellertid ofta identifierats med den något tidigare, av Waldstein & Kitaibel 1801 från Ungern beskrivna *P. arenarium*, och i själva verket äro dessa båda arter varandra så utomordentligt lika, att de utan frukt näppeligen låta sig säkert åtskilja. Visserligen anges exempelvis hos Ascherson & Graebner som en väsentlig olikhet, att hos *P. arenarium* de övre blomgrupperna skulle vara tätt sammanträngda, hos *P. pulchellum* ej, men denna karaktär synes mig mycket osäker. Den enda säkra skillnad, jag kan finna mellan dem, ligger i utseendet hos den mogna nöten, som hos *P. arenarium* är alldeles slät och starkt glänsande, hos *P. pulchellum* som ung med antydan till chagrinering, som mogen nästan utan glans. Helt nyligen har C. Blom vid Göteborg funnit en form, som han bestämt till *P. arenarium*, vilket — trots avsaknaden av mogen frukt — synes plausibelt; det är i så fall det första fyndet av denna art i Norden, trots att namnet tidigare figurerat här (se nedan). Däremot blev *P. pulchellum* funnen av Blom vid Göteborg redan 1933 (enligt Blom 1936) och sedan på

samma lokal av densamme 1941, 1947 och 1950; med undantag av fyndet 1947 skulle den funna typen vara var. *graecum* Beck, en grovvuxen och relativt storblommig typ, vars systematiska värde jag ej kan uttala mig om. Till *P. pulchellum* hör också en del av det material, Degelius fann som inkommet med turkisk manganmalm vid Vargön i Västergötland och publicerade som *P. kitaibelianum* (Degelius 1959), och nyligen har jag från Finland mottagit några exemplar, samlade av V. Erkamo vid Viborg och så vitt jag kan se identiska med den nämnda grovvuxna Göteborgstypen fastän ännu blott i blom.

Från Danmark finns mig veterligt ingen uppgift publicerad om *P. pulchellum,* däremot en om *P. arenarium,* nämligen i Wiinstedts rapport (1954) om den adventiva korkfloran vid Pedersborg nära Sorø. Efter vad jag kan se, hör emellertid denna växt, enligt belägget i Köpenhamns-herbariet, ej till *P. arenarium* utan till *P. pulchellum,* och detsamma gäller flera kollekter som ej publicerats men i samma herbarium ligga etiketterade som *P. arenarium,* ja, även en del av det ursprungligen som *P. Bellardii* bestämda Köpenhamns-materialet från 1895. Utom från nämnda lokaler föreligga danska exemplar av *P. pulchellum* från Kolding, Nykøbing F. och Slagelse.

På ett ark, som samlats av S. Andersen på en annan ruderatplats vid Köpenhamn men lämnats obestämt, har denne gjort följande anteckning: »Denne *Polygonum* er nedliggende i Modsætning til den sedvanlige *Polyg. arenarium*». Denna nedliggande växt är *P. pulchellum,* men den upprättväxande art, som Andersen kallar »sedvanlig» *P. arenarium,* är ej den sistnämnda utan en art med mindre iögonenfallande, snart slutna blommor, som något påminna om dem hos *P. patulum* genom flikarnas smala, mer eller mindre rosenröda bård men äro mycket mindre (vanl. 2,5—2,8 mm långa); från både denna och *P. pulchellum* skiljer den sig genom att frukten, som blott är c. 2 mm lång och slutligen mörkt kastanjebrun, är alldeles slät och redan som ung starkt glänsande, därigenom alltså erinrande om *P. arenarium.*

Identifieringen av denna art, som enligt beläggen i Köpenhamns-herbariet blivit samlad åtskilliga gånger i Danmark (vid Århus, Ålborg, Korsør, Roskilde och Köpenhamn), har berett mig stora bekymmer, och jag är inte alldeles tillfreds med den bestämning, jag slutligen måst stanna för, nämligen *P. argyrocoleum* Steud. Denna bestämning hade redan Wiinstedt givit på flera ark av ifrågavarande växt, och det är otvivelaktigt samma art som länge funnits odlad under detta namn i Botaniska trädgården i Köpenhamn och tydligen sedan långt tillbaka även i andra botaniska trädgårdar; i trädgårdsherbariet i Uppsala bota-

niska museum ligger den under detta namn samlad av E. Fries redan 1854 i Uppsala botaniska trädgård, dit den kommit från Botaniska trädgården i Wien.[2] Jag har också i Riksmuseet i Stockholm sett moderna främreasiatiska kollekter av samma växt, som av olika specialister bestämts till *P. argyrocoleum* och till en del, genom sin gracila växt etc., mycket väl stämma överens med det nordiska kultur- resp. adventiv-materialet. Andra exemplar åter avvika genom grövre stjälkar (och till synes mer eller mindre nedliggande växtsätt) och ansluta sig därigenom närmare till det autentiska materialet av *P. argyrocoleum* i Th. Kotschy Pl. alepp. kurd. moss., ed. Hohenacker 1843, vilket samlats av Kotschy »in arena insularum Tigridis pr. Mossul» 12 sept. 1841. Då emellertid blom- och frukttyp i allt väsentligt är densamma i samtliga fall, torde man därför böra räkna även de gracila adventivtyperna till samma art, trots att Kotschys exemplar, i den mån jag sett dem, habituellt verka ganska avvikande; detta kan dock delvis bero på att de samlats så sent, att de flesta bladen fallit av och i stället stipelslidorna framträda så mycket mera med det starka silverskimmer, på vilket artepitetet syftar (argyrocoleum — silverslidad).[3]

Utanför sitt hemland är arten numera också känd som en modern men, som det synes, naturaliserad inkomling på åtskilliga håll i de västra staterna i USA: Arizona och speciellt Californien (se Abrams 1944). Jag har sett exemplar härifrån i Riksmuseet, samlade av *Polygonum*-specialisten Brenckle i lusernfält, och detta är enligt Abrams det vanligaste förekomstsättet. Den kallas av den sistnämnde Persian knotweed, och som dess hemland anges Persien. Utbredningen sträcker sig dock vidare: från Transkaukasien mot SV åtminstone till Syrien och mot Ö till Turkestan. I den mån arten — som fallet tycks vara i USA — kommit in med lusernfrö, är det väl också snarare med turkestansk än med persisk blålusern; den förra hade i slutet av 1800-talet och början av 1900-talet ett visst rykte och importerades speciellt (enligt Whyte, Nilsson-Leissner & Trumble 1953 alltifrån 1898) till USA, där den också gett upphov till en del nya sorter. Även till Europa infördes avsevärda mängder av turkestanskt lusernfrö under nämnda

[2] Av frö från Köpenhamn har den också odlats i Bergianska trädgården under samma namn, enligt ett exemplar (i Riksmuseet) samlat där 1924 av T. Vestergren, som märkligt nog ansett bestämningen »falsk» och bestämt om växten till »*P. aviculare* L. coll.».

[3] Den ursprungliga stavningen är *argyrocoleon,* vilken används även av Abrams, medan Flora URSS och Rechinger (1964) nyttja den latiniserade formen på -um, som jag enligt mina principer (men naturligtvis alldeles lagvidrigt) anammat.

tid, enligt Stebler & Volkart 1908 då dock huvudsakligen för vidare export till USA. Om något fynd av *P. argyrocoleum* i Europa, vare sig i samband med lusernodling eller ej, har jag dock ej kunnat finna någon uppgift; alldeles omöjligt vore det väl eljest ej, att något av de danska fynden skulle kunna sättas i samband med sådan import till Danmark.

För Sveriges vidkommande kan säkerligen ett sådant samband utan vidare uteslutas. *P. argyrocoleum* är ej tidigare nämnd härifrån men föreligger faktiskt i några kollekter från Göteborgs-trakten; det är nämligen denna som åsyftas med flertalet uppgifter för *P. patulum* hos H. Fries 1945 (Göteborg: Marieholm 1930; d:o: Frihamnen 1940; Rödbo: Oxhagen 1928), medan den återstående uppgiften, Bohus' station i Nödinge (i Vg), hänför sig till *P. patulum,* närmare bestämt dess var. *kitaibelianum.* Denna är känd från sistnämnda lokal genom flera andra fynd, hos Fries redovisade under namnet *P. kitaibelianum.* Det är till denna speciella ras som allt av mig sett adventivmaterial av *patulum* coll. från Sverige och Norge hänför sig, och även det allra mesta danska materialet hör hit. Det har nämligen den kalk- och fruktyp, som anges karakterisera *kitaibelianum*: kalken är vid fruktmognaden (3,5—)4 mm lång och omsluter helt nöten, vars längd är c. 2,5—2,8 mm (måttsuppgiften 4—5 mm hos Ascherson & Graebner och i Flora URSS måste bero på ett misstag).[4] Hos en kollekt från Odense och några exemplar från Köpenhamn är emellertid kalken något kortare och låter i spetsen översta delen av nöten tränga fram; i övrigt avvika de ej vare sig i blomtyp eller i vegetativt hänseende det minsta från typisk *kitaibelianum.* Om dessa kortblommiga exemplar motsvara *patulum* s.str., synes det omöjligt att tillskriva *kitaibelianum* mer än på sin höjd rang av varietet. Det är emellertid mycket svårt att vare sig i litteraturen eller herbarierna, där i regel materialet av denna grupp är både dåligt samlat och illa bestämt, bilda sig en säker uppfattning om hur *patulum* s.str. orig. egentligen skall se ut. Det förefaller mig bäst att i fråga om våra adventivformer röra sig med en kollektiv *P. patulum* och, om man så vill, använda namnet var. *kitaibelianum* för de exemplar, som utmärkas av lång, nöten helt omslutande kalk.

För *P. patulum* sträcker sig det naturliga utbredningsområdet (eller det område, där den av gammalt är bofast) över hela södra och sydöstra Europa upp till Österrike och i Ryssland till c. 55° n.br., över

[4] Uppgiften hos A. & G. är desto märkvärdigare som de riktigt nog ange, att frukten hos *kitaibelianum* (=»Rasse A.» av *P. patulum*) är kortare än kalken men uppge den sistnämnda hos kollektivarten som blott 2—2,5 mm lång!

vissa delar av Nordafrika och stora delar av tempererade Asien; för *kitaibelianum* anges som hemland södra Europa och Mindre Asien. Denna stora utbredning gör det svårt att bestämma proveniensen för de enskilda adventivfynden, om man ej direkt kan utpeka, med vilka varor införseln skett. Detta synes över huvud ej vara fallet med några av de nordiska fynden, åtminstone om man bortser från ett par av de äldsta svenska fynden, där arten uppenbarligen kommit in med barlast (så på de av Collinder 1909 nämnda Medelpads-lokalerna: Östrand i Timrå och Eriksdal på Alnön). Flera av fynden vid Göteborg äro emellertid gjorda vid kvarnar, ett par vid ett oljeslageri och ett vid ett duvslag. Även i fråga om *P. pulchellum,* som har en stor utbredning i hela Mediterranområdet, gäller denna osäkerhet; förekomsten på korkavfall vid Sorø är ett undantag.

Utöver de talrika fynden i Göteborgs-trakten, vilka uppräknas hos Fries 1945 och Blom 1961, och de övriga redan omnämnda i Skåne och Medelpad, föreligga av *kitaibelianum* endast få svenska insamlingar, nämligen från Bohuslän (ll.cc.), Västergötland (Vargön och Bygd vid Borås) och ett par från Stockholms-trakten (Villa Plania i Nacka samt Rotebro). Norska exemplar finnas från 6 lokaler (se Lid 1963), danska från Jylland, Fyn, Falster och Sjælland, särskilt en hel rad kollekter från Köpenhamn 1895—1962. I Finland är växten funnen vid Nystad, Åbo, Helsingfors och Vasa.

Summary

On some adventive Polygonum species of the Avicularia group

Three Eurasiatic *Polygonum* species of the *Aviculariа* group have been repeatedly found in the Scandinavian countries as more or less casual adventives. The commonest of these is *P. patulum* M.B. — almost exclusively as var. *kitaibelianum* (Sadl.) A. & G., which is known from Sweden, Norway, Denmark and Finland, while a few Danish finds seem to represent the main form. The first find of *kitaibelianum* in Sweden is from 1900, in Denmark from 1895. More rarely the Mediterranean *P. pulchellum* Lois. and the mainly Persian *P. argyrocoleum* Steud. ex Kunze have been found, the former in Sweden (esp. around Gothenburg) and Denmark, the latter in three Swedish localities near Gothenburg but from fairly numerous places in Denmark.

While *P. argyrocoleum* is known as introduced in western USA, it has, as far as known to the author, not earlier been reported as adventive from Europe, where it has, however, been cultivated in botanic gardens since more than 100 years (it was collected in the Uppsala Botanic Garden by E. Fries in 1854), and is still grown in the Copenhagen Botanic garden. Therefore the Danish botanist K. Wiinstedt could correctly identify part of the material from

Denmark as *P. argyrocoleum*; by the collectors it had been variously interpreted, usually as *P. arenarium*. Until now the Swedish collections have passed as *P. patulum* s.str. (e.g. in H. Fries 1945). From this, as well as from *P. pulchellum*, it differs by its smooth, very glossy fruit; the flowers are similar to those of *P. patulum* but smaller (as is also the fruit). *P. pulchellum* is easily distinguished from the others by almost entirely pink-coloured perigon segments, which remain widely expanded for a rather long time. All three species differ from *P. aviculare* by the reduced upper leaves of the flowering shoots, *P. patulum* var. *kitaibelianum* also by its perigon segments being strongly bent inwards over the fruit.

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BOTANISKA NOTISER 1964 · VOL. 117 · FASC. 3 · LUND

Fimetariella, a New Genus of Coprophilous Pyrenomycetes

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Introduction

The coprophilous Pyrenomycetes and especially the family *Sordariaceae* have in recent years attracted a renewed and growing interest from various mycologists. The tendency of systematic research here — as with regard to many other groups of plants — has been to divide large, heterogenous taxa into smaller but more natural units. The well-known genera *Sordaria* and *Podospora* have been and still are to some extent good examples of such large, unnatural taxa. Thanks to works in the 1950's by above all C. Moreau and R. F. Cain, there has crystallized a more satisfying picture than before of the taxonomy and morphology of these and other genera, as well as a better understanding of imperfectly known species.

My own research on this subject has convinced me, however, that we are still far from the goal, i.e. a "natural" system for the genera of *Sordariaceae*. Many new species and genera with hitherto unknown morphological features remain to be described — only a small part of the world is investigated in respect to coprophilous fungi — and the poorly known species must be restudied. The cytology, ecology, and genetics have been studied in only a few species. To this could be added that the *Sordariaceae* offer several intricate, nomenclatural problems.

Podospora, even in a modern sense, contains in my opinion quite a number of species which must be excluded from the genus, and under the generic name *Sordaria* there are still many species apparently belonging to other genera. The present paper treats of such a "*Sordaria*" species, viz. *S. rabenhorstii* Niessl in Rabh., which is here placed in the new genus *Fimetariella* on account of certain unique spore characters.

Fimetariella Lundq. n. gen.

Typus et adhuc species unica: *Fimetariella rabenhorstii* (Niessl in Rabh.) Lundq.

Saprophyticae, fimicolae. Perithecia sine stromate, vulgo solitaria, obscura, glabra vel hyphis obtecta; peridium membranaceum, brunneum. Paraphyses filiformes. Asci unitunicati, cylindracei, longe stipitati, apparatu apicali indistincto, iodo non caerulescente. Sporae uniseriatae, unicellulares, demum obscure brunneae, ellipsoideae vel ovoideae (obovoideae); uno extremo poro germinali singulo, magno, altero extremo poris 1—3 parvis instructae.

Fimetariella rabenhorstii (Niessl in Rabh.) Lundq. n. comb.

Syn.: *Sordaria Rabenhorstii* Niessl in Rabh., Fungi Eur. Exs. No. 1528, 1872. Hedwigia 11: 180, 1872. — *Hypocopra Rabenhorstii* (Niessl in Rabh.) Sacc., Syll. Fung. 1: 245, 1882. — *Pleurage Rabenhorstii* (Niessl in Rabh.) O.K., Rev. Gen. Plant. 3(3): 505, 1898.

Perithecia 480—550×450—480 µ, non-stromatic, scattered or in small clusters, immersed to semi-immersed, ovoid to subglobose without pronounced neck, black, sometimes white-powdered above, glabrous or covered above with flexuous, hyaline hairs, and below with light-brown hyphae; peridium membranaceous, brown, semi-opaque, composed of mostly angular cells of irregular size and form, 6—14 µ in diam. **Paraphyses** filiform, tapering. **Asci** 120—140×7—13 µ, 4-spored, I—, cylindrical with a long, tapering stipe and a round tip with a barely visible, apical apparatus coloured blue by Lactic Blue. **Spores** 13—19× 7—11 µ, uniseriate, at first hyaline, then yellowish to light brown, finally dark brown, one-celled, ellipsoid or ovoid (obovoid), surrounded by a thick, occasionally transversely incised, gelatinous sheath; germ pores 2—4: a single big pore, circ. 1.5 µ in diam., at one end of the spore, and 1—3 smaller, excentrically placed pores, circ. 0.7 µ in diam. at the opposite end; one or two of the minor pores sometimes located on the side of the spore; upper two spores arranged with their big pore turned downwards, lower two spores with their big pore turned upwards; sometimes second spore from the top directs its big pore upwards, but rarely all four spores alternate in this respect; top spore always orientated with its big pore downwards.

Czechoslovakia: M o r a v i a, Brno on roe deer dung. Rabenhorst: Fungi Eur. Exs. No. 1528. **Typus.**

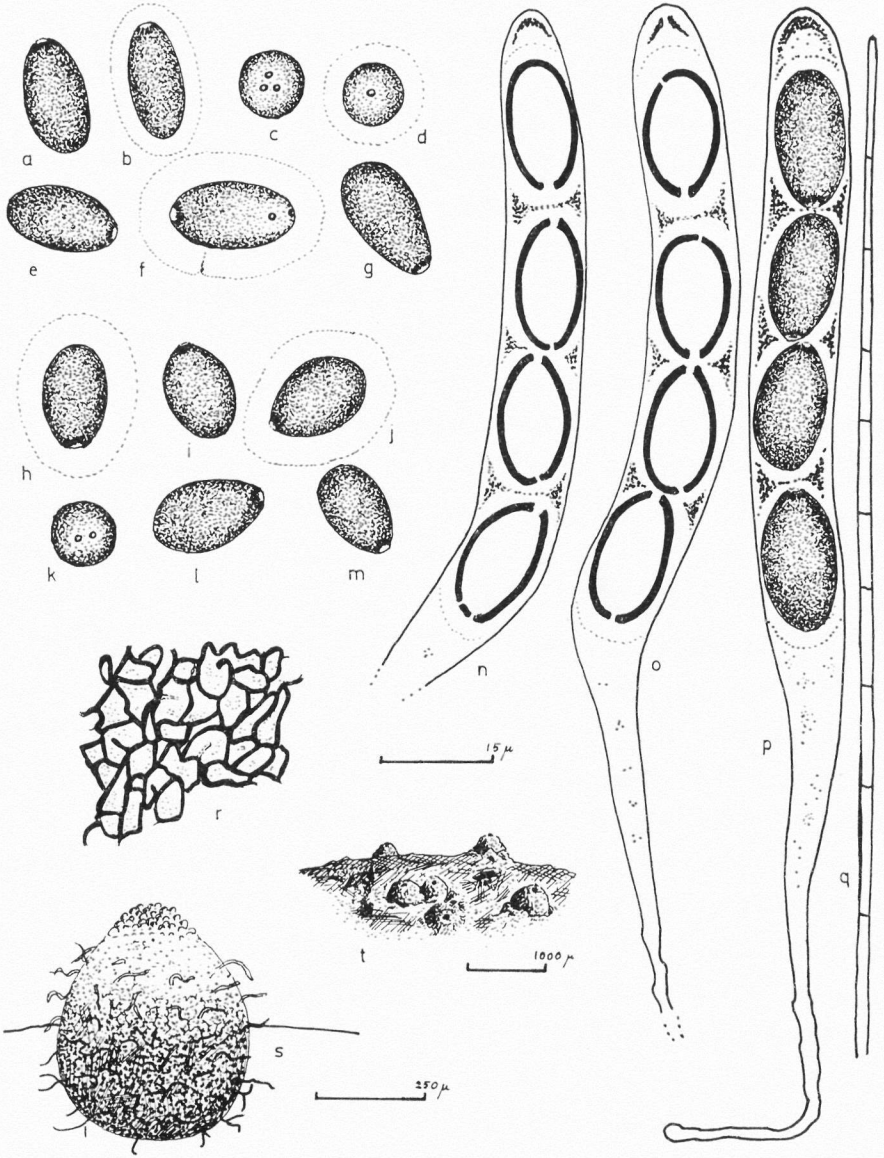

Fig. 1. *Fimetariella rabenhorstii*. *a—g, n—t*. Lundqvist 2183 a. *h—k*. Fungi Eur. Exs. No. 1528. *l, m*. Lojka. *a—m*. Mature spores, five with a gelatinous sheath. *c, d, k*. Three spores viewed from the end showing the minor germ pores. *f*. Spore with an incised sheath and a small, laterally placed pore. *n, o*. Two asci with unripe, olivaceous spores. Optical, longitudinal section showing the germ pores. *p*. Ascus with ripe spores. Stippled portions of the ascus sap are coloured with Lactic Blue. *q*. Paraphysis. *r*. Part of the peridium in horizontal view. *s*. Perithecium. *t*. Six perithecia on the substrate.

Examined specimens

Sweden: Dalarna: Transtrand parish, Fulunäs, on fresh elk dung (*Alces alces*) 6.VI.1960, Lundqvist 2183 a (UPS). — Lappland: Torne Lappmark, Kopparåsen (15 km N.W. of Abisko), on old hare dung (*Lepus timidus*) 9.VIII.1960, Lundqvist 2742 g (UPS).

Belgium: Flandre Occidentale: Blankenberghe, on rabbit dung, leg. Mouton (BR).

Czechoslovakia: Moravia: Brno, on roe deer dung in Spring, leg. Niessl. Rabenhorst: Fungi Eur. Exs. No. 1528, 1872, type coll. (BRSL, M, S, UPS). — Gurein near Brno, on roe deer dung, leg. Niessl, coll. orig. (M). — Gurein near Brno, Kořimska hora, on roe deer dung, VI.1872, leg. Niessl, coll. orig. (M). — Gurein near Brno, on hare dung (*L. timidus*) VI, leg. Niessl (M). — Ratschitz, on hare dung (*L. timidus*), leg. Niessl (M).

Poland: Silesia: Obernigk, on hare dung (*L. timidus*) 30.V.1880, leg. Schröter (BRSL).

Roumania?: "Ungarische Hochalpen",[1] on hare dung (*L. timidus*), comm. Lojka. Herb. Rehm (S).

Abbreviations: BR=Jardin Botanique de l'Etat, Bruxelles. BRSL=Instytut Botaniczny, Wrocław. M=Botanische Staatssammlung, München. S=Naturhistoriska Riksmuseet, Stockholm. UPS=Institute of Systematic Botany, Uppsala.

Reports from literature

Poland: Silesia: Falkenberg, Guschwitz. — Tarnowitz, Neudeck. — Trebnitz, Obernigk, especially on hare dung. Schröter 1894. In Schröter's herbarium there are two collections labelled *Sordaria Rabenhorstii*. Only the one from Obernigk, cited above, is correctly determined. The other is nothing but *Sordaria fimicola* (Rob. ex Desm.) Ces. & DNot., and was collected 14.VII.1881 in Falkenberg. The handwriting is rather illegible, but it seems that the locality is not Guschwitz. The finds from Guschwitz and Neudeck might represent true *F. rabenhorstii,* but they can no longer be checked.

Canada: Ontario: Bruce, Grey, Victoria, and Manitoulin Counties, on rabbit dung (*Lepus americanus*?). Cain 1934.

Apart from Niessl's publication of the type collection it was also cited by Weese 1933, who at the same time reported Niessl's two finds on hare dung. The Belgian find was published by Mouton 1886.

Feltgen (1901) reported *F. rabenhorstii* on hare dung from Baumbusch-

[1] I cannot definitely decide where the "Ungarische Hochalpen" are situated, as they do not exist on any maps consulted by me, but it must be either Roumania or Czechoslovakia, since Hungary at the time of Lojka's botanical travels (1860's and 1870's) comprised large parts of these countries. Lojka visited the Slovakian high mountains as well as the Transsylvanian Alps, and most favoured among the latter was Mt. Retyezát in Hunyad (A. v. Degen: Hugo Lojka. Ein Blatt der Erinnerung. — Magyar Bot. Lapok 31: 61—66, 1932). In case the latter alternative is correct, *F. rabenhorstii* is probably new to Roumania, because it is not mentioned in V. Bontea's list of Roumanian fungi: Ciuperci parazite şi saprofite din Republica Populară Română, p. 1—637, 1953.

Siebenbrunnen in Luxemburg, but according to his description and material it constitutes a species close to *Coniochaeta discospora* (Awd ex Niessl) Cain. It is said to have perithecia with a conical, hairy ostiolum, cylindrical asci, 84—100×10—13 µ with a tapering apex and a short, thick stipe, and brown, broadly ellipsoid, sometimes obliquely monostichous spores, 10—13×5—8 µ. Feltgen has also left a drawing showing the asci to be 8-spored, 95—120×12—15 µ, and the spores 12—15×6—8 µ. On the substrate, which looks like rabbit dung, are found well preserved specimens of the afore-mentioned *Coniochaeta,* remains of *Trichodelitschia bisporula* (Cr.) Munk ex Lundq., and empty ascocarps of a *Sordaria,* possibly *S. macrospora* Awd in Rabh.

All finds of *F. rabenhorstii* listed here have been labelled or reported under the generic name *Sordaria,* except in one case, viz. the one by Mouton, who referred it to *Hypocopra.*

Ecology

Little is known of the ecology of *F. rabenhorstii.* The Swedish specimens were developed in moist chamber (at UPS) at room temperature. On rather fresh elk dung ripening of the spores occurred one week after the substrate was soaked, and on old hare dung ripe spores appeared after about 12 days. I do not know how long time a complete development takes, starting from germinating spores. The species has not been grown on artificial media.

The number of checked finds is too small to give a clear picture of the choice of substrate of *F. rabenhorstii,* but it obviously prefers hare dung. Lojka's, Niessl's, and Schröter's specimens are found on the dung of blue hare, if I am not mistaken. This hare has nowadays a very limited distribution in Central Europe and is mainly restricted to higher altitudes in the Alps. There is also an enclave in Transsylvania in Roumania, where Lojka's find is supposed to have been made (see footnote on p. 241). In the 19th century the blue hare was perhaps not uncommon in the Carpathians and the Czech forests.

It should be noted that Niessl was uncertain of the kind of dung *F. rabenhorstii* was growing on, because on the exsiccata label he writes: ". . . in fimo (caprearum?)", thus indicating the substrate to be goat dung. I have seen a good deal of the type collection, and I am sure that the substrate is roe deer dung. Weese (1933) had the same opinion: "Auf ?Rehkot . . .". In Niessl's herbarium there are two more gatherings of *F. rabenhorstii* on roe deer dung, which must be parts of the type collection distributed in Rabenhorst's exsiccate. On the one dated June 1872 is written on the label "Gurein an Rehkoth? Kořimska hora" (probably a mountain at Gurein), and the envelope contains a handwritten description coinciding with the one on the printed exsiccate label, except that

"Gurein Junio" is added instead of "vere", i.e. Spring. My conclusion is that as these three samples must be parts of one and the same collection, Niessl recognized (with hesitation) the substrate as roe deer dung, but wrote "caprearum" probably by a slip of the pen instead of "capreolino".

The Canadian finds are all stated to have been made on rabbit dung, but they do not refer to the European rabbit (*Oryctolagus cuniculus*), which, as far as I know, is not found in the New World. Bisby, Buller, and Dearness (1929 p. 27), who investigated the fungus flora of Manitoba, declare that the "rabbit" in this province is the varying hare, *Lepus americanus phaeonotus*. It might be the same animal referred to as rabbit by Cain 1934.

I have discussed these things in detail, because the identification of the substrate seems to have been very neglected in the study of coprophilous fungi. Misdeterminations are rather frequent, and when no material has been saved, statements concerning the kind of dung should be accepted with great caution. It is also worth observing that different species of animals in different parts of the world sometimes bear the same colloquial name, as in the case of the European and American rabbit.

I think that coprophilous microfungi are more ecologically specialized than has earlier been supposed. Even species growing on many different types of dung seem to favour one sort. There is also in many cases another tendency, viz. a confinement of the fungi to the dung of animals having a similar habitat. When we know more about *F. rabenhorstii,* it will probably turn out to be a species restricted mainly to the dung of herbivorous forest animals in the Northern boreal and temperate zone.

Some morphological features

The description of *F. rabenhorstii* given here is based on Niessl's, Lojka's, and my specimens. The latter have ellipsoid, somewhat larger spores and larger asci, 15.5—19×8.5—11 μ and 120—140×12—15 μ respectively, whereas Niessl's specimens have more ovoid (obovoid) to broadly fusoid spores, 13—16.5×8.5—10.5 μ, and asci 110—113×11—12 μ. Lojka's specimens agree with Niessl's. The original description is the only one in which the spores are said to be ovoid ("oblongo-ovoideis"). On Swedish material the ovoid or obovoid spore shape is rare and less obvious. Whether the type with larger, ellipsoid spores

constitutes a taxon of its own is not possible for me to decide until I have seen more material. Niessl gives in his diagnosis the figures 12×7 μ and 7 μ for spore size and ascus breadth respectively, so his measures are smaller than mine, but that may be due to differences in optical equipment. On Canadian material Cain has measured the spores to 14—16×8—9 μ, asci to 110—160×10—11 μ, and perithecia to 500—600×300—420 μ. Schröter (1894 p. 285) gives the spore size as 13—17×7—10 μ, and ascus size as 70—80 (pars spor.)×10—12 μ. Schröter's specimens are in an extremely bad state, consisting only of broken perithecia and a few loose, mainly abnormal spores. On the label the spore size is stated to be 13—15×7—9 μ. The normal spores are slightly egg-shaped, and the specimens agree with Niessl's and Lojka's. Mouton's specimens too have spores of this type.

F. rabenhorstii is a species of extraordinary qualities, several of which are unique to the *Sordariaceae* and perhaps even to the *Sphaeriales,* viz. the orientation of the spores in the ascus, the number of germ pores, the variation in number of germ pores, and the different germ pore sizes.

Something must be said here about the terms 'apical' and 'basal' as they are applied to spore morphology. It seems most natural that different parts of a spore are denominated in relation to the orientation of the spore in the ascus. Thus, the apical end of a spore is the one facing the apex of the ascus, provided that all spores in the ascus have a fixed position and are directed in the same way. If, for instance, one spore in an ascus is reversed, it is an exception, and we recognize it as a reversal, i.e. the apical end of the spore is then turned downwards. This is provided, of course, that we are able to distinguish morphologically between the two ends of the spore.

F. rabenhorstii is a special case. The spores have as a rule a fixed orientation. As two of the spores in an ascus have a reversed position in relation to the other two, it is in fact impossible to know which two spores are reversed and which two have a "normal" position. Thus, it is also difficult to apply the terms 'apical' and 'basal', and I have avoided using them. Do all four spores have one big, apical germ pore, and are the upper two spores reversed, or are all spores furnished with one big, basal germ pore, and are the lower two spores reversed? In either case, it seems that the ancestor of the species produced uniformly oriented spores. The change which occurred causing a reversal in orientation of some of the spores in the asci has become fixed in the group. It may be that future genetic studies will provide

an explanation of spore orientation here and give a clue to the evolution of the species.

The reversal of some spores — or different spore orientation — in an ascus as a specific or generic character is a phenomenon that has not earlier been reported in the Ascomycetes, as far as I know. When an irregular spore arrangement is found in other species, it is either a perfect and regular disorder, or a seeming disorder of no systematic significance. Thus, in *Podospora* species with many-spored asci, the mature spores are often irregularly arranged — no doubt as a result of the swelling of the ascus — but at earlier stages of the development they are all directed in the same way, viz. with their pedicel downwards. In species with 4—8-spored asci such conditions are less common, but now and then I have observed reversed top spores in *Podospora* species and on one occasion I saw all spores in a single ascus turned around. However, such things must be regarded as anomalies.

Concerning the other characters mentioned, no species in the *Sordariaceae* has hitherto been described as having spores with more than two germ pores, and in those with two pores they are always of the same size. Besides, no intraspecific variation of germ pore number in *normal* spores is known. Abnormal *Podospora* and *Triangularia* spores, on the other hand, are able to develop a pigmentation of the normally hyaline pedicel, and it is interesting to note that in such cases even a germ pore may appear on the pedicel (Moreau 1959 p. 466). In *Neurospora* species, there may occur abnormal, ovoid spores which have a single germ pore instead of the normal two (Lindegren & Scott 1937 p. 365). Dowding (1933 p. 305) made the observation that spores of *Gelasinospora cerealis* Dowd. mostly germinate from both ends, but sometimes from one end only. She gives no explanation, but either the spores have two germ pores, one of which is not always functional, or two kinds of ellipsoid spores develop in the same ascocarp: some with one germ pore, and some with two. The latter alternative seems unlikely, but *G. cerealis* ought to be investigated in this respect. However, the most probable explanation seems to me to be that the spores with one pore are abnormal, and it is possible that they are connected with the existence of ovoid or apiculate (and certainly abnormal) spores, which Dowding also found in this species (compare Lindegren & Scott, ibid.).

The number and the position of the germ pores are constant, generic characters in fimicolous Pyrenomycetes, but obviously *Fimetariella* and *Gelasinospora* are exceptions, although in the latter genus there is

surely no variation within the species. Some *Gelasinospora* species have spores with two germ pores, others have spores with one pore, the deciding, generic character being the pitted spore wall. Recently Gochenaur and Backus (1963) showed a similar condition to exist in *Neurospora*. *N. terricola* Goch. & Backus is the only *Neurospora* species found having spores with a single germ pore, all the other species have two. The superior, generic character is here the ribbed spore wall. In most other cases, however, when the species of a genus do not agree regarding germ pore number, one is apt to suspect that the genus is not a natural taxon.

This discussion intends to show the exclusive position held by *F. rabenhorstii* concerning some of the germ pore characters, but here an important reservation must be pointed out. I have no real proof that the small pores really are germ pores, or if so, that they actually function at the germination of the spore. As already mentioned these pores are not located on absolutely fixed spots on the spore. Usually they are situated at one end, although slightly excentrically if there are more than one, but exceptionally one or two pores may be placed more laterally on the spore. Now, such instability in the location of germ pores of normal spores is quite unknown in the *Sordariaceae*. The place of the pores is always constant and exact, and, for example, in some *Podospora* species the subapical position of the germ pore is an important, specific character. In *F. rabenhorstii* the big pore is regularly situated at the end of the spore (at the narrow end, if the spore is ovoid or obovoid), and there is no doubt that it constitutes a true germ pore. One could then wonder if the minor pores are nothing but pits in the wall as is found in *Gelasinospora* spores, but I do not think so. When unripe, slightly pigmented spores of *F. rabenhorstii* are observed in high magnification, it is possible to see that the pores break through the whole, outer spore wall.

In case the small pores have no germinative function, the uniqueness of *F. rabenhorstii* is of course strongly diminished, but nevertheless I consider it impossible to place the species in any hitherto described genus.

Relationships

From what has been discussed above, and because of its one-celled, uniseriate, brown spores surrounded by a gelatinous sheath, one might suppose that *Fimetariella* is closely related to *Sordaria* or *Gelasino-*

spora. However, I find it difficult to connect *Fimetariella* here, because of the structure of the apical apparatus of the asci and the occurrence of paraphyses. In the phyletic series consisting of *Sordaria, Gelasinospora, Neurospora,* and a few more genera (perhaps constituting the family *Sordariaceae* sensu stricto) the ascus tips have a thickened ring, and paraphyses are absent. These important characters should be taken into consideration, if we want to establish the taxonomic position of *Fimetariella,* as well as of other genera. Above all, the existence of one-celled, uniseriate, brown spores must be of very dubious systematic significance, as such spore types certainly have evolved independently in different genera in the *Sordariaceae* sensu lat.

The relatives of *Fimetariella* could as well be sought among genera close to *Podospora*. In this and several other genera (some of which are not yet described) the apical ring is not really thickened or there is no visible apical apparatus, and paraphyses usually exist. The occurrence of cylindrical asci with uniseriate, one-celled spores is here a rare phenomenon (the spores are mostly two-celled, furnished with gelatinous caudae), but in a wide sense the *Podospora* series is morphologically a rather diversified assemblage of genera, and for the moment I consider it appropriate to connect *Fimetariella* here. It should be remembered, however, that a final settlement of this question cannot be made until we have more detailed information on *F. rabenhorstii*, e.g. its ascocarp development and cytology. The problem of its taxonomic position will demand a decision only provided that a division of *Sordariaceae* is carried out.

Summary

The new, monotypical, fimicolous Pyrenomycete genus *Fimetariella* Lundq. in the family *Sordariaceae* is described, based on *Sordaria rabenhorstii* Niessl. The type collection is distributed in Rabenhorst's Fungi Eur. Exs. No. 1528, and the new combination is *Fimetariella rabenhorstii* (Niessl in Rabh.) Lundq.

The distribution of the species is given as a list of studied specimens and a compilation of reports in the literature. *F. rabenhorstii* is found in Sweden, Belgium, Czechoslovakia, Poland, and ?Roumania, and has also been reported from Canada. Little is known of the ecology of the species. All finds checked by the author have been made on the dung of herbivorous forest animals, such as hare, rabbit, elk, and roe deer.

Some unique spore characters are found in *F. rabenhorstii*: number of germ pores (more than two), varying germ pore number (2—4), different pore sizes (one big, 1—3 small pores), spore orientation (upper two spores turn their big pore downwards, lower two spores direct it upwards). None of these

characters has been previously reported in the *Sordariaceae*. It should be noted that the species has not yet been kept in culture, and there is no final proof that the minor pores really possess a germinative function. The spore morphology is discussed in detail. The Swedish specimens are found to have slightly larger, more ellipsoid spores and larger asci than other European collections. Canadian specimens seem to agree with Swedish ones in this respect.

The taxonomic position of *Fimetariella* is difficult to establish, as long as its ascocarp development and cytology are unknown. Comparisons are made with *Sordaria* and *Gelasinospora,* with which it has some spore characters in common. However, the lack of a thickened ring in the tip of the ascus, and the existence of paraphyses indicate that the relatives of *Fimetariella* could as well be sought among genera close to *Podospora.*

Acknowledgements

I am much indebted to Dr. R. Santesson, Uppsala, and to Dr. L. Weresub, Ottawa, for critical remarks on my manuscript, and to Dr. H. Smith, Uppsala, for preparing the Latin diagnosis. Mrs. C. Hörner, Uppsala, has kindly corrected the English text.

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BOTANISKA NOTISER 1964 · VOL. 117 · FASC. 3 · LUND

Absorption of Carbon Dioxide by Plant Roots

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Whether or not green plants generally possess the ability to absorb carbon dioxide through a normal root system has long been a subject of debate. The most widely accepted view at present says that plants absorb carbon dioxide through the roots, but only to such a small extent that the loss through root respiration quantitatively exceeds the absorption several times. The possibility of carbonate fertilization is considered very doubtful, if it is not emphatically denied.

In order to enable a choice between the two main opinions on the question, the "positive" and the "negative", some experiments have been planned and carried out. From these some have been selected and are reported below. Common to these selected experiments are some general technical principles:

1. Only *hydroculture* experiments are reported. In some experiments Knop's formula for the nutrient solution, has been used, with the addition of micronutrients (Mn, Zn, Cu, B, Mo) and Fe as chelate with EDTA · Na. In other experiments a formula used on a commercial scale has been used. See table I.

2. All these selected experiments were run as parallel tests. All factors except the CO_2 factor were kept alike. The pH-value was left to regulate itself spontaneously. The difference in pH was not more than 0.2 or 0.3 pH-units at the end of each experiment or in the used solution in those cases where the solution was exchanged during the experiment. With Knop's formula the values were around 5.4 to 5.7 and with the other solution the values were between 5.8 and 6.5. The lower values were regularly obtained in those jars to which more CO_2 was given, and which also showed the higher production of organic material. If any correction of the pH-values should have been made, the means of correction would probably have had a more important influence than the small difference in pH itself, and therefore it was preferred not to make any pH-adjustments.

3. Many factors, such as the chemical composition of the air around the plants, humidity, temperature of the air and solution, wind (when an experiment was executed out of doors), etc. have not been considered or controlled.

Table I. Composition of Nutrient Solution.

Macronutrients		
$Ca(NO_3)_2$ 4 aq	1.181	grams per litre
KNO_3	.303	„ „ „
K_2SO_4	.192	„ „ „
$MgSO_4$ 7 aq	.493	„ „ „
NaH_2PO_4 2 aq	.312	„ „ „
Micronutrients		
Ferro Rexenol Powder, 9 % Fe= 1 ppm Fe	11.11	mg per litre
$MnSO_4$ aq	1.54	„ „ „
$ZnSO_4$ 7 aq	.22	„ „ „
$CuSO_4$ 5 aq	.08	„ „ „
$Na_2B_4O_7$ 10 aq	4.406	„ „ „
$(H_4N)_6Mo_7O_{24}$ 4 aq	.086	„ „ „

4. The illumination in the laboratory has been 6 tubular daylight lamps, each 40 watts. They were about 115 cm long, mounted about 75 cm above the test bench. The total width of the lamp aggregate was about 40 cm.

5. The following apparatus was used in all experiments. The jars were of glass, volume about 1.75 litres, the outside painted with aluminium bronze in order to exclude light and avoid algae in the solution. The lids were made from aluminium or similar light alloy. Foam rubber strips were used between the glass jar and the lid and the plants were mounted practically air tight in foam plastic and rubber tubing in holes in the lid.

Air, with or without CO_2 of different concentration, was bubbled through the solution, intermittently or continuously.

When the experiments were completed the plants were dried at about 105°C. Beans, white mustard and tomatoes have been used, as representing three different plant families. Approximate net weights of beans and white mustard seeds were deducted so that the net weight increase was used for comparison. In experiments with tomatoes the seed weights were considered so small that no deduction for the seeds were made.

In each experiment "A" is the control jar and "B" is the test jar. They were treated alike as far as it was possible to control. The "B" jars always received slightly more CO_2 than the "A" jars. This was the only difference within each pair of jars. The various experiments differed only in how the difference in the CO_2 dose or concentration was accomplished.

The conformity in principle goes so far that it has been considered permissible to make some calculation of the average result, in spite of the fact that different plants have been used and other detail circumstances have been varied.

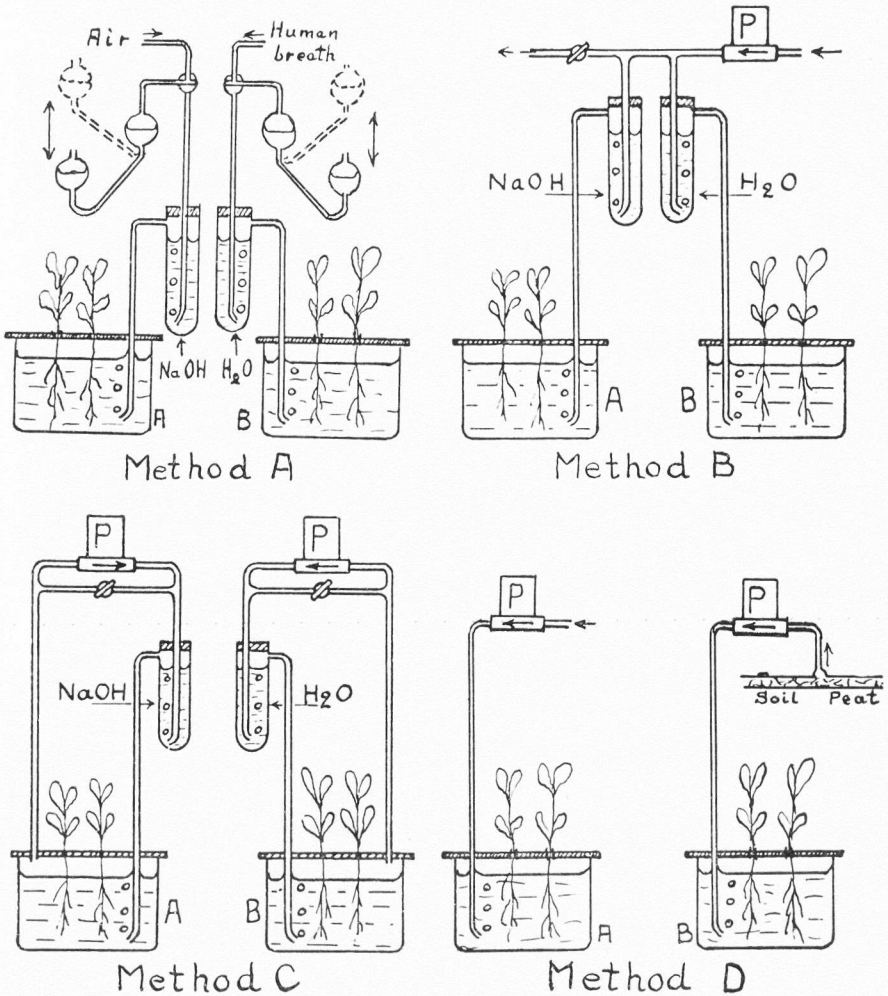

Fig. 1. Methods A—D.

The most important experimental data will be given below. The different technical arrangements are shown in figures 1—2. Only the principles and the most important details are shown. Cotton splash filters are not shown, but were used. See also table II.

Method A. Human breath. (About 5.6 per cent CO_2.)

With niveau flasks 250 ml expelled breath was given to the B-jar two or three times every day. The air for the A-jar was bubbled through alkali to remove its CO_2. See table III.

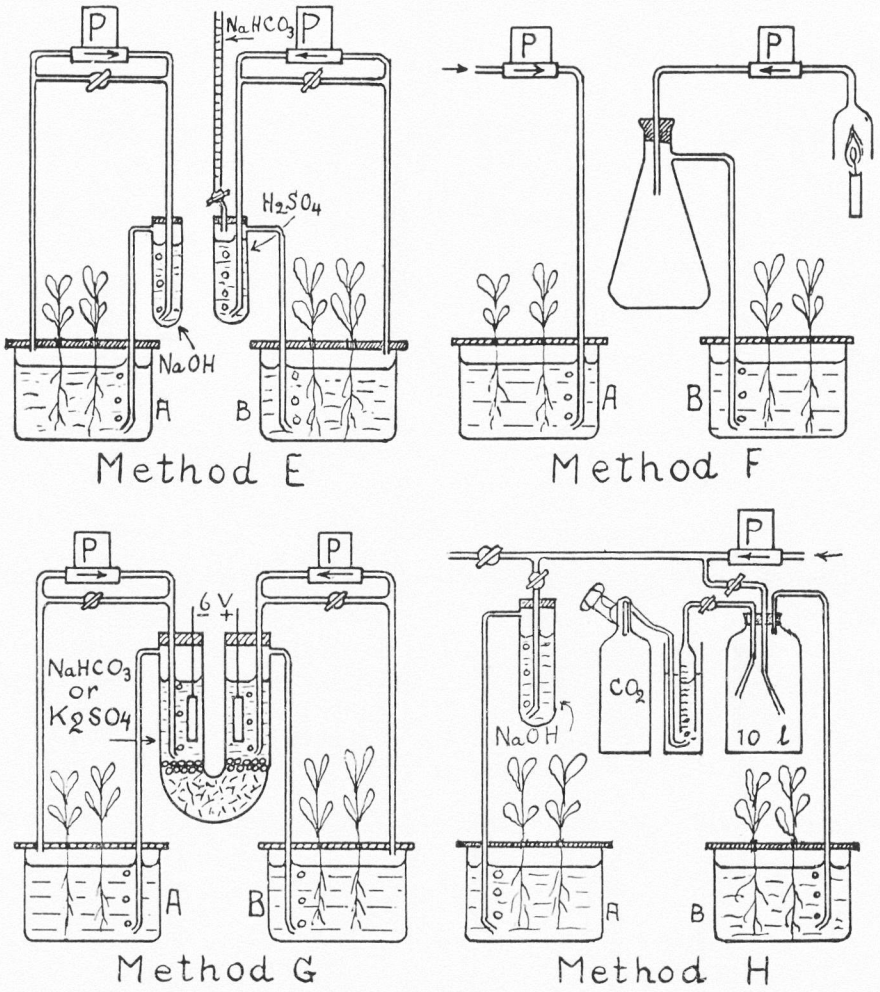

Fig. 2. Methods E—H.

Method B. Normal air contra CO_2-free air.

Instead of intermittently as in method A, the air was bubbled continually, day and night, through the jars. The B-jar received the air *with* its CO_2 content and the A-jar received air which had first been bubbled through alkali. See table IV.

Method C. Removal of root respiration carbon dioxide.
(In the control, A.)

Each jar had a separate pump for circulating an enclosed air volume.

Table II. Different Methods for Accomplishing a Difference in CO_2 Concentration or Dose.

Method called	Source of Difference	Experiments called	Number
A	Human breath	A 1, A 2, A 3	3
B	Normal air contra CO_2-free air	B 1, B 2	2
C	Removal of root respir. CO_2	C 1	1
D	Soil air	D 1	1
E	$NaHCO_3$ dripped into H_2SO_4	E 1	1
F	CO_2 from burning candle	F 1, F 2	2
G	"Stolen" Root respir. CO_2	G 1—G 6	6
H	CO_2 from a Siphon (Sparklet)	H 1, H 2	2
		Total	18

The circulation was controlled with a shunt lead with a regulating valve. The air was drawn off between the nutrient solution and the lid and then returned. In the control, A, the air was deprived of its CO_2 content by bubbling through alkali. In test jar B, the air was allowed to retain its CO_2 content. Its value, which may have increased, was not controlled. See table IV, below.

Method D. Soil air blown through the test jar.

On a wooden bench in a commercial greenhouse, covered with a layer of peat, about 5 cm thick, a plastic cloth, about 0.4 m^2 area, was placed. The edges were pressed down and air was drawn out through a hole in the middle of the cloth. The peat was not completely dry and some oxidation or decay producing CO_2 is supposed to have proceeded. The concentration of CO_2 is not known. See table V.

Method E. Carbon dioxide from a solution of $NaHCO_3$ dripped into H_2SO_4.

The air in each system was enclosed and circulated in the same way as in method C, but the air was bubbled through diluted sulfuric acid instead of water before entering test jar B. Into this sulfuric acid a little (1 ml) of a weak bicarbonate solution was administered two or three times every day. The air was thus circulated continually, but the carbon dioxide was given intermittently. See table V.

Method F. Carbon dioxide from a burning candle.

In control jar A fresh air, with normal content of CO_2, was blown through the solution. In test jar B the combustion gases from a small candle were mixed into the air to be blown into the solution. The candle

Table III. Experiments with Beans.

Exp. A 1. *10 beans each. Out of doors. 29 days. 1957.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	%
Green parts	3.360	4.260	900	26.8
Roots	2.350	3.100	750	31.9
Total	5.710	7.360	1.650	28.9
Less beans	1.700	1.700	—	—
Net increase	4.010	5.660	1.650	**41.2** %

Exp. A 2. *12 beans each. In lab. 23 days. 1960.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	%
Total	3.142	3.350	208	6.6
Less beans	2.280	2.280	—	—
Net increase	862	1.070	208	**32.3** %

Exp. A 3. *4 beans each. In lab. 21 days. 1960.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	%
Total	2.417	2.745	328	13.6
Less beans	509	479	—	—
Net increase	1.908	2.266	358	**18.8** %

was burnt two or three times every day, one minute each time. In order to avoid giving the carbon dioxide in too concentrated form, a flask of about 6 litres volume was included in the air lead, so that the combustion gases were diluted and given each time during a longer period than the candle was burning.

The total reduction of the weight of the candle in Exp. F 1 was 2.54 grams. The difference in net weight increase of the plants was 1.44. These figures may be used for quantitative speculations. See table V.

Method G. Root expiration carbon dioxide is "stolen" from control jar A and given to test jar B.

The arrangement was based on the notion that the plants should not be so sensitive to overdosing, that the spontaneous respiration-CO_2-content from one jar would make the milieu in another jar poisonous. The arrangement will be described more closely.

Between the two jars, A and B, there was a U-tube. Each jar had its own air circulation pump and an enclosed air volume circulating approximately as in methods C and E. Here, as is seen from figure G,

Table IV. Experiments with Beans and Tomatoes.

Exp. B 1. *12 beans each. Out of doors. 25 days. 1958.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	2.802	3.075	273	9.7
Roots	720	775	55	7.3
Total	3.522	3.850	328	9.3
Less beans	2.040	2.040	—	—
Net increase	1.482	1.810	328	**22.1** %

Exp. B 2. *9 tomatoes each. Lab. plant house. 49 days. 1963.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	25.180	34.310	9.130	36.3
Roots	2.616	4.070	1.454	55.7
Total	27.796	38.380	10.584	**38.1** %

Exp. C 1. *11 beans each. In lab. 14 days. 1959.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	2.180	2.230	50	2.3
Roots	660	690	30	4.5
Total	2.840	2.920	80	2.8
Less beans	1.870	1.870	—	—
Net increase	970	1.050	80	**8.2** %

the air streams were both bubbled through a common solution, each air stream confined to its own branch of the U-tube, so that the air streams were not mixed.

The U-tube was partly filled with an electrolyte and had a platinum electrode in each end, between which a low D.C.-voltage was maintained. As electrolytes diluted solutions of $NaHCO_3$ or K_2SO_4 have been used. In the U-bend convection currents have been stopped by glass wool and glass pearls. Electric current and ions could pass from the one side to the other. The low D.C.-voltage made the solution alkaline at the A-end and acid at the B-end of the tube.

Air coming from jar A brought with it some of the root respiration carbon dioxide which was absorbed by the alkaline solution in this end of the tube. The carbon dioxide was then transported, as HCO_3^--ions, electrolytically from the alkaline A-end to the acid B-end of the tube, where it was given over to the circulating air in this section and offered to the solution in jar B.

Table V. Experiments with Tomatoes and White Mustard.

Exp. D 1. *3 tomatoes each. Commercial plant house. 18 days. 1960.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Total	4.080	5.875	1.795	**44.0** %

Exp. E 1. *11 white mustard each. In Lab. 35 days. 1959.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Total	1.230	1.365	135	11.0
Less seeds	440	440	—	—
Net increase	790	925	135	**17.1** %

Exp. F 1. *3 tomatoes each. In lab. 23 days. 1960.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Total	2.062	3.500	1.438	**69.8** %

Exp. F 2. *3 tomatoes each. In lab. 12 days. 1960.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Total	297	390	93	**31.3** %

In this way the root respiration carbon dioxide was "stolen" from jar A and given to jar B. The results obtained seem to confirm that overdosing does not occur under these circumstances. See tables VI—VII.

Method H. Carbon dioxide from a "Sparklet siphon"

One single pump was used, as in method B. The air for control jar A was bubbled through alkali. The air for test jar B was first blown into an empty bottle, about 10 litres volume, continually. Into the same bottle carbon dioxide was blown intermittently, in rather small quantities each time. See table VIII.

In the Exp. H 2 the CO_2 was given in increasing doses, starting with 10 ml the first day and thereafter 10 ml more each day up to the 20th day, when 200 ml was given. During this time there was no visible difference in growth. Overdosing was suspected to be the reason and therefore the CO_2 dose was thereafter kept constant at 200 ml each day, given in portions two or three times every day. The plants in jar B seemed then to grow better, quite obviously. A small accident when the solution was to be changed on the 30th day introduced an

Table VI. Experiments with White Mustard and Beans.

Exp. G 1. *11 white mustard each. $NaHCO_3$ in tube. In lab. 41 days. 1959.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Total	1.389	1.635	247	17.8
Less seeds	440	440	—	—
Net increase	949	1.196	247	**26.1** %

Exp. G 2. *10 beans each. K_2SO_4 in tube. In lab. 30 days. 1959.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	3.595	4.200	605	14.8
Roots	830	1.100	270	32.6
Total	4.425	5.300	875	19.8
Less beans	1.900	1.900	—	—
Net increase	2.525	3.400	875	**34.6** %

Exp. G 3. *10 beans each. $NaHCO_3$ in tube. In lab. 33 days. 1959.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Leaves and pods	2.870	3.685	815	30.2
Stems	1.075	1.270	195	19.1
Total green parts	3.945	4.955	1.010	25.6
Roots	845	1.000	155	18.3
Total plants	4.790	5.950	1.165	24.4
Less beans	1.900	1.900	—	—
Net increase	2.890	4.055	1.165	**40.4** %

"accidental factor" that could have influenced the result, probably increasing the difference, and it was then considered more correct to terminate the experiment earlier than planned. The experiment seemed then to develop about as Exp. B 2, which was run at the same time and in the same locality and the low percentual difference must be considered a result of the early cessation of the experiment.

Discussion

Altogether 18 experiments are reported, with 141 plants in the test jars and 141 plants in the control jars, making a total of 282 plants. The average of the percentage differences in growth, net increase, is 27.7 per cent. The difference in carbon dioxide concentration was arrived at in 8 different ways.

The variation in methods was intended to, and seems to, warrant a certain probability that no unknown or uncontrolled factors have

Table VII. Experiments with Beans and Tomatoes.

Exp. G 4. *3 beans each. $NaHCO_3$ in tube. Lab. plant house. 36 days. 1963.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	7.389	8.316	927	12.5
Roots	1.182	1.371	189	16.0
Total	8.571	9.687	1.116	13.0
Less beans	500	535	—	—
Net increase	8.071	9.152	1.081	**13.4 %**

Exp. G 5. *9 tomatoes each. $NaHCO_3$ in tube. Lab. plant house. 30 days. 1963.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	4.957	6.621	1.664	33.7
Roots	696	988	292	42.0
Total	5.653	7.609	1.956	**34.6 %**

Exp. G 6. *5 beans each. K_2SO_4 in tube. In lab. 26 days. 1960.*

Dry weights	A $-CO_2$	B $+CO_2$ *	Difference mg	Difference %
Green parts	3.654	3.829	175	4.8
Roots	559	736	177	31.4
Total	4.213	4.565	352	8.3
Less beans	519	509	—	—
Net increase	3.694	4.056	362	**9.8 %**

caused the differences observed. The cause must have been the single factor that has been varied, throughout the whole series of experiments, i.e., the concentration of carbon dioxide in the air bubbling through the different jars.

Considering the strong conviction amongst the majority of the leading specialists, it might seem to rash to look upon the results as a definite proof that carbon dioxide is absorbed in the corresponding quantities by or through the root systems. It seems, however, also very difficult to avoid the conclusion that the presence of carbon dioxide in controlled, small doses or low concentrations is beneficial for the growth of plants under those circumstances prevailing in the reported experiments. It seems, therefore, as if the possibility of direct absorption through the roots must be considered an acceptable working hypothesis, strongly supported by the observed facts, until another, satisfying explanation be offered.

There is no doubt that carbon dioxide in stronger concentrations acts as a poison. There seems to be some kind of a toxic concentration

Table VIII. Experiments with Beans and Tomatoes.

Exp. H 1. *4 beans each. Lab. plant house. 29 days. 1963.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	7.338	8.049	711	9.7
Roots	1.249	1.295	46	3.8
Total	8.578	9.344	757	8.8
Less beans	1.335	1.392	—	—
Net increase	7.232	7.952	720	**10.0** %

Exp. H 2. *11 tomatoes each. Lab. plant house. 30 days. 1963.*

Dry weights	A $-CO_2$	B $+CO_2$	Difference mg	Difference %
Green parts	3.571	3.991	240	6.4
Roots	495	537	42	8.5
Total	4.246	4.528	282	**6.6** %

level that must not be exceeded. It does not seem possible to define that level, because too many factors are involved which influence it. Kind of plant, bulk and development of the green assimilation appa-

Table IX. Summary of the Results of the Reported Experiments.

Method	Exp. No.	Time Days	Plants in each jar	Net increase A $-CO_2$	Net increase B $+CO_2$	Difference mg	Difference %
A	A 1	29	10 beans	4.010	5.660	1.650	41.2
	A 2	23	12 beans	862	1.070	208	32.3
	A 3	21	4 beans	1.908	2.266	358	18.8
B	B 1	25	12 beans	1.482	1.810	328	22.1
	B 2	49	9 tomatoes	27.796	38.380	10.584	38.1
C	C 1	14	11 beans	970	1.050	80	8.2
D	D 1	18	3 tomatoes	4.080	5.875	1.795	44.0
E	E 1	35	11 mustard	790	925	135	17.1
F	F 1	22	3 tomatoes	2.062	3.500	1.438	69.8
	F 2	12	3 tomatoes	297	390	93	31.3
G	G 1	41	11 mustard	949	1.196	247	26.1
	G 2	30	10 beans	2.525	3.400	875	34.6
	G 3	33	10 beans	2.890	4.055	1.165	40.4
	G 4	36	3 beans	8.071	9.152	1.081	13.4
	G 5	30	9 tomatoes	5.653	7.609	1.956	34.6
	G 6	26	5 beans	3.694	4.056	362	9.8
H	H 1	29	4 beans	7.232	7.952	720	10.0
	H 2	30	11 tomatoes	4.246	4.528	282	6.6
8 methods		18 expts.	141 plants	79.517	102.874	23.357	498.4

Average or percentage figures $= \frac{498.4}{18} = \mathbf{27.7}$ %.

$\frac{\text{Total difference}}{\text{Total control}} = \frac{23.357}{79.517} = \mathbf{29.4}$ %.

ratus, the character of the root system, light intensity, amongst other factors, complicate the question. If the critical level is not surpassed, there seems to exist a possibility of stimulating growth in hydroculture, which might be exploited advantageously where hydroculture itself is the right agricultural method.

Acknowledgements

Finally, I wish to express my best thanks to Prof. Harry Lundin, head of the Institute of Food Chemistry at the Royal Institute of Technology, Stockholm, who has, in spite of overcrowded localities, with the utmost readiness and kindness, made it possible for me to perform these investigations within the Institute during 3 1/2 years, 1957—1960, and has also placed the equipment and material facilities of the Institute at my disposal.

During 1963 Prof. Torsten Hemberg of the Institute of Physiological Botany of the University of Stockholm has given me a chance to repeat some of my earlier experiments within the Institute's premises and has shown a stimulating interest in my work, its special problems and the technical details, which is highly appreciated and for which I also express my gratitude.

Abstract

The ability of plant roots to absorb carbon dioxide, when given in low concentrations or small doses in water culture has been studied.

In order to avoid or compensate for influence from unknown or uncontrolled factors, a difference in the supply of CO_2 has been accomplished according to 8 different methods.

Each experiment has been made as a comparison between the growth in two jars, given more or less carbon dioxide. All other factors have been kept alike. The difference in net dry weight increase has been measured, after drying at about 105°C.

Eighteen experiments with 141 plants in the test jars and 141 plants in the control jars have been performed, altogether 242 plants. Beans, tomatoes and white mustard have been used.

The average of the percentage figures, showing the average gain obtained from the CO_2-quantities given, has been 27.7 per cent.

The possibility of direct absorption through the roots must be considered an acceptable working hypothesis, strongly supported by the observed facts, until another, satisfying explanation is offered.

Literature

For further literature references, see items No 1—3 below.

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is supplemented by a list of 45 literature references. It also contains several quotations from the literature referred to.)

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BOTANISKA NOTISER 1964 · VOL. 117 · FASC. 3 · LUND

Polyploidy in Cotoneaster

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Abstract

Chromosome numbers in 49 species, varieties and cultivars of *Cotoneaster* were counted and the results compared with earlier work. Especially that of Mrs. Sax was criticized, who, after studying polyploidy and apomixis in *Cotoneaster,* came to the conclusion that the majority of species were triploid. The author's countings proved that *Cotoneaster* species are diploid or tetraploid. Triploidy was only found in varieties and cultivars. The triploid types always showed a reduced fertility.

Some closely related species which have confused several authors could be arranged in polyploid series, thus showing the proper relationships.

A short description of the material used is given.

Introduction

The investigation of Moffett (1931) made it probable that the basic chromosome number of the genus *Cotoneaster* does not deviate from that of other members of the *Pomoideae.* It was established to be 17. This was concluded after counting the chromosomes in 6 species; one of which, *C. procumbens,* proved to be a diploid, 2n=34; one, *C. congesta* (*syn. C. microphylla var. glacialis*), proved to be a triploid, 2n=51 and *C. bullata, C. integerrima, C. rotundifolia* and *C. microphylla,* they were tetraploid, 2n=68.

An extensive study on polyploidy and apomixis in *Cotoneaster* was published by Sax (1954). In all, 59 species and varieties were found by her to be diploid, triploid or tetraploid. This seemed to be in accordance with the results of Moffett, as besides a diploid and four tetraploids, a triploid species are mentioned by him. But, in the study of Sax no fewer than 43 types were found to be triploids and among these 24 are considered as true species. Such an abundance of triploid species in a genus is remarkable, but the occurrence of apomixis should made this acceptable.

The apomixis is a guarantee for propagating plants true from seed, so the communication of Sax, which gave ample information on this phenomenon in *Cotoneaster,* was reviewed by Boom (1955) in the Boomkwekerij, a Dutch nursery weekly. At that time Broertjes (1956) studied, at the Experiment Station at Boskoop, some artificial crosses in the genus *Cotoneaster* and had counted the chromosomes in *C. acutifolia* (*C. lucida*), *C. adpressa praecox, C. franchetii sterneana, C. horizontalis, C. racemiflora,*[1] *C. dammeri radicans* and *C. salicifolia var. flocccosa.*

The former five types were shown to have 68 chromosomes, the latter two 34, contrary to Sax, who found *C. lucida, C. adpressa praecox* and *C. horizontalis* to be triploids. Broertjes counted the chromosomes in sectioned root tips, while Sax only used pollen-mother-cells to determine whether the species was diploid, triploid or tetraploid.

In the case of polyploidy the latter method is not always reliable, as uni-, bi-, tri- and quadrivalents are not easily recognized in small and crowded cells, as in the case of *Cotoneaster.*

The discrepancy in the results of Sax and Broertjes has lead to an investigation of some more *Cotoneaster* species and varieties. The results of this study, which was started in 1956, are described hereafter.

Material and Method

Of as many species and varieties as were available at Wageningen and Boskoop and also of material from some other sources, cuttings were made in late summer. To this end young thriving shoots, which were somewhat lignified at the base were rooted in sand under mist and afterwards potted, at which time root-tips were taken. After the plants had been potted root-tips were available for several months when kept in the greenhouse, or next spring when brought outside.

The root-tips were worked into squash-preparations stained with orcein, or paraffin sections were made, cut at 18 μ, mounted and stained on slides following Smith's method of Gram staining with crystal violet.

The plants of which the chromosomes had been counted were planted outside and after some years branches with flowers and fruits were pressed. This pressed material was compared with the original descriptions and with the material present in the collection Boom of the Leyden herbarium and of that of the Wageningen arboretum.

[1] Mentioned by Broertjes as *C. multiflora calocarpa.*

Results

This chapter discusses the chromosome numbers determined in our material, the proper nomenclature of the collected plants and the deviation of our results from those obtained by Sax.

Table I shows the results of our own counts together with the determinations of Sax (1954), as far as our material concerns, the counts of Broertjes (1956) and of Moffett (1931), as far as they concern our material. Seventeen triploids of Sax are involved in this comparison. In one of these we have counted 34 chromosomes, viz. in *C. adpressa,* and in the others we counted 68 chromosomes, the tetraploid number. Four counts among these latter are in accordance with Moffett or Broertjes. Moffett counted 68 chromosomes in *C. bullata* and Broertjes determined *C. adpressa* var. *praecox, C. horizontalis* and *C. lucida* (mentioned by him as *C. acutifolia*) to be tetraploid. In *C. conspicua,* 2n=34, *C. dammeri* 2n=34, *C. franchetii* 2n=68 our counts are in accordance with those of Sax. We agree with Broertjes concerning the numbers of *C. dammeri* var. *radicans* 2n=34 and *C. sterniana* 2n=68. Finally 68 chromosomes have been counted by Moffett in *C. rotundifolia* which agrees with our results, but it is not certain that his plant was *C. rotundifolia* Lindley, as *C. disticha* Lange can be encountered as *C. rotundifolia,* which we actually did in Boskoop recently. Apart from the above species, the following can be regarded as erroneously determined triploids by Sax: *C. adpressa* var. *praecox, C. ambigua, C. dielsiana, C. divaricata, C. horizontalis* var. *perpusilla, C. lucida, C. foveolata, C. obscura, C. salicifolia* var. *rugosa, C. simonsii, C. tomentosa, C. wardii* and *C. zabelii* var. *miniata.*

Eleven species and nine varieties determined by Sax to be triploid still need re-examination. *C. microphylla* was determined to be tetraploid, contrary to Sax who found the diploid number.

We are well aware that Sax's material in the Arnold Arboretum has a better chance to go under the proper name than ours. So we took the trouble to verify the nomenclature of our plants as far as possible; nevertheless we are not convinced that any mistake is excluded. A review of the species and varieties studied by us may follow.

C. adpressa Bois, *C. adpressa* var. *praecox* Bois et Berthault, *C. adpressa praecox* cv. 'Boer', and *C. adpressa* cv. 'Little gem' Boom. Of this species we have 4 types, which have come to us from different sources. The *C. adpressa* has been obtained from the Wageningen arboretum and from Moerheim nurseries. The two plants closely re-

Table I. Chromosome numbers of different Cotoneaster species and varieties.

No.	Name and origin	The author's count	Sax's count	Moffett's count	Broertjes's count
	C. adpressa Bois		triploid		
57019	from Moerheim nurseries	34			
1464	from Arboretum Wageningen	34			
	C. adpressa Bois, var. *praecox* Bois et Berthault		triploid		68
56002	from Schiphorst nurseries as *C. praecox*	68			
	C. a. praecox cv. 'Boer'				
932	from Exp. Sta. Boskoop as *C. pr.* 'Boer'	68			
	C. adpressa Bois, cv. 'Little Gem' Boom				
9288	from Arb. Wageningen	51			
	C. ambigua Rehder et Wilson		triploid		
1458	from Arb. Wageningen	68			
	C. bullata Bois		triploid	68	
1459	from Arb. Wageningen	68			
	C. conspicua Marquand		diploid		
9286	from Arb. Wageningen as *C. c.* var. *decora*	34			
	C. dammeri Schneider		diploid		
1486	from. Arb. Wageningen	34			
	C. dammeri var. *radicans* Dammer				34
10615	from Arb. Wageningen	34			
	C. dielsiana Pritzel		triploid		
1497	from Arb. Wageningen	68			
8324	from Arb. Wageningen as *C. froebelii*	68	triploid		
	C. divaricata Rehder et Wilson		triploid		
9285	from Arb. Wageningen	68			
	C. franchetii Bois		tetraploid		
57026	from Moerheim nurseries	68			
	C. franchetii cv. 'Gloire de Versailles'				
935	from Exp. Sta. Boskoop	68			
	C. frigida Wallich		diploid		
8921	from Arb. Wageningen	34			
	C. harroviana Wilson				
13081	from Arb. Wageningen	68			
	C. horizontalis Decaisne		triploid		
934	from Exp. Sta. Boskoop	68			
1462	from Arb. Wageningen	68			
	C. horizontalis var. *perpusilla* Schneider		triploid		
13077	from Arb. Wageningen	68			
	C. hor. var. *wilsonii* (Havemeyer ex) Wilson				
9284	from Arb. Wageningen	68			
	C. lucida Schlechtendal		triploid		
1456	from Arb. Wageningen	68			
57020	from Moerheim nurseries as *C. acutifolia*	68			
3966	from Arb. Wageningen as *C. foveolata*	68			68
	C. microphylla Lindley		diploid	68	
8910	from Arb. Wageningen	68			
	C. multiflora Bunge		tetraploid		
8416A	from Arb. Wageningen as *C. orbicularis*	68			
	C. foveolata Rehder et Wilson		triploid		
1481	from Arb. Wageningen as *C. moupinensis*	68			
	C. obscura Rehder et Wilson		triploid		
1501	from Arb. Wageningen as *C. obscura*	68			

No.	Name and origin	The author's count	Sax's count	Moffett's count	Broertjes's count
	C. obscura Rehder et Wilson				
1507	from Arb. Wageningen as *C. obscura*	68			
	C. racemiflora var. *royleana* Dippel				
8416	from Arb. Wageningen as *C. orbicularis*	68			
	C. rotundifolia Lindley		triploid	68?	
1483	from Arb. Wageningen	68			
8913	from Arb. Wageningen as *C. rot.* var. *lanata*	68			
	C. rotundifolia cv. 'Ruby' Boom				
57021	from Moerheim nurseries as *C. rubens*	68			
	C. salicifolia Franchet				
9277	from Arb. Wageningen	34			
8912	from Arb. Wageningen as *C. henryana*	34			
	C. salicifolia var. *floccosa* Rehder et Wilson				34
942	from Exp. Sta. Boskoop	34			
	C. salicifolia var. *rugosa* Rehder et Wilson		triploid		
9281	from Arb. Wageningen	68			
	C. simonsii Baker		triploid		
952	from Exp. Sta. Boskoop	68			
	C. sterniana (Turrill) Boom				
57003	from Lombarts nurseries as *C. franchetii sterniana*	68			68
950	from Exp. Sta. Boskoop as *C. wardii*	68			
	C. tomentosa Lindley		triploid		
1469	from Arb. Wageningen	68			
	C. watereri Exell (x) cv. 'Watereri'				
11030	from Arb. Wageningen	34			
	C. wardii W. W. Smith		triploid		
56005	from Moerheim nurseries	68			
	C. zabelii Schneider var. *miniata* Rehder et Wilson		triploid		
13350	from Arb. Wageningen	68			

semble one another and are slow growing, which contrasts very much with the robust *C. adpressa praecox*. They bear fruits with seeds regularly. The species is diploid, 2n=34. Its origin is the Western part of China, where it is reported by Wilson to grow in rocky places in alpine regions at an altitude of ±3000 m, in Western Szech'uan near Tachienlu, on the eastern slopes of the immense plateau of Thibet which are open to the mild climate of the red basin. The *C. adpressa* var. *praecox* and the cultivar 'Boer' are both *tetraploid,* 2n=68. The former reached Europe via Regel and Kesselring at St. Peterburg who received seeds collected by Sokalski in the Nanshan range. These mountains are situated about 10° North of Tachienlu and are exposed to the north. Boom (1957) and Flinck and Hylmö (1962, p. 34) prefer to give this type the rank of a species, because it comes true from seed. However, while comparing the barren habitat of *C. adpressa* var. *praecox*

with the mild one of *C. adpressa* (diploid), the former can be regarded as an ecotype of the latter. They are very similar, except for the sturdier growth of the variety. Therefore, we should like to accept it as a tetraploid form of *C. adpressa* and to maintain the varietal name of Bois and Berthault. *C. adpressa* cv. 'Little Gem' is a triploid. This character places it between the diploid and the tetraploid. It is of interest that our plant is completely sterile. However, we are informed that old plants may occasionally bear some fruits. This triploid character is of another type than that mentioned by Sax, which is accompanied by fertility based on apomixis.

C. ambigua Rehder et Wilson. Our plant no. 1458 of the Wageningen arboretum was originally provided by the Botanic Gardens at Edinburgh. It is, according to Rehder and Wilson (1913), a species between *C. acutifolia* Turcz. and *C. moupinensis* Franch. The persistent brown hairs on the branchlets and on the veins of the leaves, and the elliptic ovate leaves made us decide that we had the mentioned species before us. The fruits of our plant are black. This species is *tetraploid*, 2n=68, contrary to Sax's determination.

C. bullata Bois. It is not known from where the Wageningen arboretum obtained this plant, but there is not the slightest doubt it is *C. bullata*. The large rugose leaves and the red berries stand for this. Moffett's count and ours agree. The species is a tetraploid; 2n=68.

C. conspicua Marquand. The Wageningen arboretum received its plant from Mr. F. G. Grootendorst at Boskoop as *C. conspicua* var. *decora* Russell. The plant in the arboretum has grown about one and a quarter m. in height. The branches are spreading at right angles from the stem but are not prostrate. Russell (1938) distinguished a form distributed in the United States as var. *decora* because of its prostrate habit and the fact that Cpt. Kingdom Ward mentioned erect and prostrate forms growing together in their original habitat. Part of the original seeds, collected by Ward in 1924, were sent to the U.S. Dept. of Agr. in 1925. From these seeds a plant of prostrate habit was raised. A Californian nurseryman obtained 2 cuttings in 1929 and named the plant *C. decora*. So it seems that the variety has spread from this source. But the plant in the Wageningen arboretum received as a *decora*-type proves to have lost the prostrate habit after several years of cultivation. Thus it seems advisable to investigate more material of this variety, propagated by cuttings and from seed, in order to establish if this '*decora*' character is persistent. We omitted the varietal name of our

material and determined *C. conspicua* to be a diploid. This determination is in accordance with that of Sax; 2n=34.

C. dammeri Schneider and *C. dammeri* var. *radicans* Dammer. Both creeping forms, which cannot be mutually confused, nor with any other *Cotoneaster* species. In both types 34 chromosomes were counted, which accords with the determinations of Sax (the species) and Broertjes (the variety).

C. dielsiana Pritzel. We have brought together under this name two plants from the Wageningen arboretum one of which was received as *C. froebelii* Hort., and one as *C. dielsiana* Pritzel.

This *C. froebelii* was procured by Messrs. Vilmorin, as seed, from trees grown at Les Barres. *C. dielsiana* is a very characteristic plant, in general feature coming close to *C. wardii, C. franchetii* and *C. sterniana.* Its particular habit, so well described by Whitchurch (1933), distinguishes it unmistakebly from the others, especially by "the 2 or 3 vigorous growths, which branch freely towards the top in a sort of umbrella". Both our plants have that particular characteristic; the umbrella consists of numerous distichously placed side branches, slightly turned and bent over. We counted 68 chromosomes in both plants. It is likely that the seeds, procured by Messrs. Vilmorin, who first anounced *C. froebelii* Hort., have been harvested from the type and so we have to conclude that *C. froebelii* Hort. cannot be more than a variation in *C. dielsiana,* and does not come true from seeds.

C. divaricata Rehder et Wilson. The Wageningen arboretum has obtained their specimen from the experiment station at Boskoop. Being near to *C. simonsii* in characters, as Rehder and Wilson state, the habit is entirely different. Our specimen has numerous fine arching branches with leaves somewhat smaller than those of *C. simonsii*; these have a wavy margin, as in *C. adpressa,* though not so pronounced. They are lustrous and have when young a delicate red hue. In autumn they become lively red. The fruits are bright red and borne in profusion. The shrub has a globular shape. *C. divaricata* proved to have 68 chromosomes. Originating in the same country as *C. adpressa,* viz. Szech'uan and that part of Hupeh which borders on it, and having some characters with this species in common, out of a cross between them a plant like *C. adpressa praecox* could have emerged. Our determination is not in accordance with Sax's, who found the triploid number.

C. foveolata Rehder et Wilson. Our plant No. 1481 was obtained from the Wageningen arboretum as *C. moupinensis* Franchet. However, it differs from that species in flower and fruit characters. According to

Rehder and Wilson (1913) the fruits of *C. moupinensis* should have 3—5, generally 4—5 stones and in his original description Franchet (1885) states emphatically that the flowers besides being pink, have 5 styles and never 2. We examined 50 fruits of our plant, 34 had two stones, 15 had 3 stones and 1 had one stone. The flowers examined had 2 or 3 styles, the petals were white with a pink hue. The fruits were black and subglobose; we could discern some shallow pits on the back of the stones. This lead us to the conclusion that we had *C. foveolata* before us. Our determination of 68 chromosomes deviates from that of Sax, who found this species to be triploid.

Both *C. franchetti* Bois and the variation cv. 'Gloire de Versailles' proved to be tetraploid plants. Our plant, representing the species, has been obtained from Moerheim nurseries and is doubtless genuine. It is less vigorous than *C. sterniana,* which comes nearest to it in relation and habit. Numerous branches are shooting up from the ground making a dense bush not very conspicuous among other plants. The fruits are weakly coloured and have an orange red hue. The cultivar 'Gloire de Versailles' is somewhat coarser and, as far as our experience goes, has fewer basal branches; its berries are more red and bigger.

C. frigida Wallich. This species has been determined diploid by Sax but she has put a question-mark behind the name. We counted 34 chromosomes in leaf-preparations from the plant present under this name in the Wageningen arboretum, but we are not quite certain that our plant is not a hybrid of this species because of the spreading branches and of the leaves which look too rigid. However, there can be no question as to the chromosome number of *C. frigida* as all the hybrids of this species examined by us are diploid.

C. harroviana Wils. We are not able to give a description of the plant we got our material from, because both the plant from the arboretum and ours have been lost. Contrary to Sax we counted 68 chromosomes.

C. horizontalis Decaisne, *C. horizontalis* var. *perpusilla* Schneider and *C. horizontalis* var. *wilsonii* (Havemeyer ex) Wilson.

We obtained the species from the Experiment Station at Boskoop and the varieties from the Wageningen arboretum. The species is so widely used and for such special purposes that it can hardly be confused with others. With its fanlike spreading branches, it grows best against a wall, for which purpose it is very much planted in our country. Our plant proved to be *tetraploid*; 2n=68. Broertjes came to the same conclusion. After a cross of *C. salicifolia* var. *floccosa* and *C. horizontalis*

in which the former was the seed parent, Broertjes obtained hybrids which were triploid. They were in habit between both parents and answered the purpose of the cross, which was to produce a hardy and fast growing plant, which would cover a slope or a wall in a short time. Berries are very scarce on the hybrids. In 1955 all the fruits on 40 seedlings and their cuttings were harvested. There were about 1500 fruits, thus averaging 38 fruits on a plant. The plant we obtained of the variety *perpusilla* is slow growing and has more rounded leaves. It serves other purposes than the species. It is more suited to the rock garden. The variety *wilsonii* on the other hand is a more robust grower and has not so dense a ramification as the species; the leaves are bigger and in autumn they have the same dark red colour as those of the species. Both varieties are *tetraploid*. This is a very clear case of a misinterpretation by Sax, who called *C. horizontalis* a triploid.

C. lucida Schlechtendal. Three plants, obtained under different names from the Wageningen arboretum and from Moerheim nurseries, did not differ from each other, thus we were obliged to regard them as one species. The arboretum procured a *C. lucida* and a *C. foveolata* and Moerheim sent a *C. acutifolia*. *C. lucida* was originally described by Lindley as *C. acutifolia,* but this name goes now for another species described by Turczaninov in 1832. So we could recognize the *acutifolia* plant as *C. lucida,* and it was clear to us that the name *foveolata* was erroneously given to a *C. lucida*. Our plants are best characterized by their stiff upward growth, smooth, shining dark green leaves and their black berries having 2—3 stones. In all these plants we counted the *tetraploid* number; 2n=68.

Cotoneaster microphylla Lindley. Our material has been obtained from the Wageningen arboretum. The plant is a rather slow growing one; it has small coriaceous leaves, the blades of which fit very good with the description of Lindley, who called them oblong-cuneate. At the top they are somewhat rounded but at the petiole they form a sharp angle. Especially beneath but also sparingly above long, straight hairs are present which give the margins a ciliated appearance. These two characters distinguish the plant very well from the closely allied *C. rotundifolia*. Our plant has originally been provided by the well-known Boskoop nursery Felix and Dijkhuis. It proved to be a tetraploid; we counted 68 chromosomes. Compared with other *Cotoneasters* the chromosomes are very small. Our count deviates from that of Sax who found the diploid number, but it is in accordance with Moffett's.

Cotoneaster multiflora Bunge. We received our material from the

Wageningen arboretum. It is a bush of very graceful habit with many long dark red drooping twigs, carrying an abundance of lively red berries. The berries of our plant are about 8 mm across, so it does not seem to be the variety *C. m. calocarpa* which has berries up to 12 mm. We counted 68 chromosomes in our plant. It has to be mentioned that we have received two different plants under no. 8416 as *C. orbicularis* one of these now labelled 8416 a was *Cotoneaster multiflora*. Our count accords with the determinations of Sax.

C. obscura Rehder et Wilson. The Wageningen arboretum has two plants of this name, which, though they have been obtained from different sources, do not differ. We counted 68 chromosomes in both. The plants agree very well with the description of Rehder and Wilson (1931), except that the fruits usually contain 4 stones; only exceptionally 3 stones were seen. The colour of the fruit is dark red. The variety *cornifolia* is distinct from the species by the number of stones, which is usually 5, and the purple black colour of the fruit. Though the enhanced number of the stones points in the direction of this variety, the colour of its fruit weakens the argument. We are not quite convinced that we have the proper name, but we think to have no right to change it to *C. obscura* var. *cornifolia*.

C. racemiflora var. *royleana* Dippel. Labelled as *C. orbicularis* we received material of 2 plants from the Wageningen arboretum, one of which proved to belong to the above mentioned variety of *C. racemiflora*. It is a relatively weak growing plant, with almost round leaves, grey felted, especially when young. We counted 68 chromosomes, which is the same number as Broertjes (1956) found for the species. The *Cotoneaster* generally planted in Boskoop as *C. multiflora calocarpa* has proved to be *C. racemiflora* so we have to read Broertjes's determination in this sense.

C. rotundifolia Lindley and *C. rotundifolia* cv. 'Ruby' Boom. Three plants, 2 from the Wageningen arboretum and 1 from Moerheim nurseries, will be discussed. Under No. 1483 we received a plant, supplied to the arboretum by Messrs. Copijn & Sons, at Groenekan, as *C. rotundifolia*. Lindley has at first described this plant as *C. microphylla uva-ursi* but afterwards it has been recognized by him to be a distinct species and following Wallich he named it *C. rotundifolia*. It originates from the Himalaya and is an evergreen species with coriaceous dark green, broad oval emarginate and mucronate leaves. It belongs to the section *Chaenopetalum*. The white flowers stand solitary or in corymbs of 2 to 3 flowers, have purple anthers and contrast well with the dark green

leaves. The relatively big fruits are red. The plant No. 8913 obtained as *C. rotundifolia* var. *lanata* Schneider does not differ from No. 1483, especially the elliptic to elliptic oblong leaves, with a tomentum beneath have not been observed, We consider this plant, which has been procured by Messrs. de Bie van Aalst at Zundert, not as the variety mentioned and not to differ from the species. The third plant discussed here was at our request sent by Moerheim nurseries as *C. rubens*. When this plant came to flower it was at once clear, that it could not be a *C. rubens* because it had the habit of flowering of the *Chaenopetalum*-section, to which *C. rubens* does not belong. It was afterwards found that in the nurseries this type generally went under the name *C. rubens* and in connection with this Boom (1959) gave a description of this variation under the name of *C. microphylla* cv. 'Ruby'. In general appearance, in growth, in the form of the leaves and by having commonly 2 to 3 flowers in the corymb it comes nearer to *C. rotundifolia*. It differs in being smaller in all characters, by its free flowering and its crimson fruits. So we have treated it as a variation of *C. rotundifolia*. In all three plants we have counted 68 chromosomes. *C. rotundifolia* is treated as a triploid by Sax.

C. salicifolia Franchet, *C. salicifolia* var. *floccosa* Rehder et Wilson and *C. salicifolia* var. *rugosa* Rehder et Wilson.

C. salicifolia is a species that is widely used in our modern gardens, evergreen in not too severe winters and carrying a profusion of bright red berries during the autumn. The dark leaves are elliptic to lanceolate and the fruits are well exposed by numerous and somewhat drooping branches. This character renders it suitable for planting in large groups for urban decoration. This species is very variable. Stapf (1923) reviews *C. salicifolia,* varieties and related species. He brings *C. salicifolia* var. *floccosa* to the species and takes *C. henryana* Rehder et Wilson and *C. rugosa* Pritzel together as one species. From a taxonomic point of view it seems justified to cancel the *C. salicifolia* var. *floccosa*; however, it has already become a well established variation in horticulture and it will not be easy to get rid of it.

As regards the *C. rugosa* and *C. henryana,* I should not advise to bring them under the same heading, as the former has proved to be tetraploid and the latter is probably diploid, because *C. henryana* is known to be one of the parents of *C.*×*watereri* Exell (1938). This hybrid has proved to be diploid and we can regard the determinations by Sax of *C. henryana* as being a diploid as correct. It is not very likely that *C. rugosa* has been involved in any of the *C. frigida* hybrids. Last

summer I collected some cuttings of *C. frigida*×*C. salicifolia* hybrids in various nurseries at Boskoop viz. *C.*×*watereri* 'Herbstfeuer', *C.*× *watereri* 'Exburiensis', *C.*×*watereri* 'Cornubia', *C. watereri* 'Pendula' and *C.*×*watereri* 'Aldenhamensis'; after they had been rooted and they were examined all proved to be *diploid*. This was expected because these types are especially valued for their production of fruits. The *C. henryana* from the Wageningen arboretum is only a large-leaved type of *C. salicifolia*. How far *C. henryana* has to be treated as a separate species, I will not discuss, but it seems proper to me to read in Exell's (1938) and Boom's (1959) communications with respect to *C.*×*watereri*, *C. henryana* instead of *C. rugosa*. Now that *C. rugosa* is established to be a tetraploid it can be regarded as a tetraploid form of *C. salicifolia*. Broertjes (1956), crossed *C. salicifolia* with *C. horizontalis* and obtained sterile hybrids (triploids). When taking *C. salicifolia* var. *rugosa* instead to cross with *C. horizontalis* one has a good chance to get tetraploid hybrids and fertile plants.

Cotoneaster simonsii Baker, from the Khasia mountains, was brought to Europe more than a century ago. It was mentioned, according to Veendorp (1931), in the records of the Leyden Hortus in 1860, and procured by Messrs. Low, nurseries in England. This species is still much used. It is conspicuous by its oblique-growing stiff branches, its rather small, round acuminate leaves and its brilliant, red berries. We obtained our plant from the Experiment Station at Boskoop. It is a *tetraploid*; 2n=68.

C. sterniana (Turrill) Boom. In the nurseries of this country, this species has been known for some time as *C. wardii,* until Boom (1957) drew the attention to the difference between *C. wardii* of Sir William Wright Smith and the species in question. It belongs to a group of *Cotoneaster* species which resemble each other so much that they can be arranged in a series with *C. franchetii* at one end, *C. wardii* at the other and *C. sterniana* and *C. dielsiana* between them. Going from *C. franchetii* to *C. wardii* the fruits become brighter red, the leaves more hairy and rugose and the basal shoots less numerous. All the species in this series are *tetraploid*. *C. sterniana* is second in this row. It is taller than *C. franchetii* and forms a dense bush of fine branches, carrying in early autumn many clusters of orange red fruits on short stalks. It grows so fast that it is less suited for small gardens, as it easily overgrows the neighbouring plants.

C. tomentosa Lindley. The plant in the Wageningen arboretum, from which we obtained our material, was procured by the Botanical Gar-

dens at Dublin. This bush has an erect habit, oval leaves, that are rounded at the top and the base, hairy above and woolly beneath. The fruits are red and usually have 4 stones. The calyx is very woolly. Its closest relative, *C. integerrima* Med., mostly has 2 stones in the fruits and a glabrous calyx. Therefore, we are convinced that our plant belongs to *C. tomentosa*. It is tetraploid, 2n=68.

C. wardii W. W. Smith. We have already reported on the confusion in the nomenclature of *C. wardii* and *C. sterniana*, and indicated that only from the Moerheim nurseries the genuine *C. wardii* could be obtained. Our plant has been procured by these nurseries. It is characterized by the long-stalked inflorescences and by its rugose leaves. We counted 68 chromosomes.

C. zabelii var. *miniata* Rehder et Wilson. This variety is distinguished from the species by its elliptic leaves, which become yellow in autumn. Our plant has this yellow colour too, but it is partly covered by a red colour, which makes it very attractive. The brilliant coloured berries — to us of the best coloured in the genus — are most conspicuous when the leaves are still green. The fruit has two stones. On quick growing twigs the emarginate leaves show very clearly their shining edge. Our plant proved to be a tetraploid, 2n=68.

Last summer we obtained from Boskoop, partly from the Experiment Station, partly from some nurseries, various rooted cuttings, which we were able to use for chromosome counts. A list of the species and varieties examined is given here, but we like to emphasize that we are not quite certain that we have got all the plants with their proper names.

	2n
Cotoneaster acuminata	68
Cotoneaster horizontalis cv. 'Saxatilis'	50
Cotoneaster microphylla var. cochleata	68
Cotoneaster salicifolia cv. 'Avondrood'	34
Cotoneaster salicifolia cv. 'Parkteppich'	34
Cotoneaster salicifolia cv. 'Perkeo'	34
Cotoneaster salicifolia cv. 'Saldam'	34
Cotoneaster×Sabrina	68
Cotoneaster×Skogholm	34
Cotoneaster×watereri 'Aldenhamensis'	34
Cotoneaster×watereri 'Cornubia'	34
Cotoneaster×watereri 'Exburiensis'	34
Cotoneaster×watereri 'Herbstfeuer'	34
Cotoneaster×watereri 'Pendula'	34

These names and numbers are given for notice. We like to point to the aneuploid *C. horizontalis* cv. 'Saxatilis', a hypo-triploid and we draw attention to the fact that this type is known to be almost sterile.

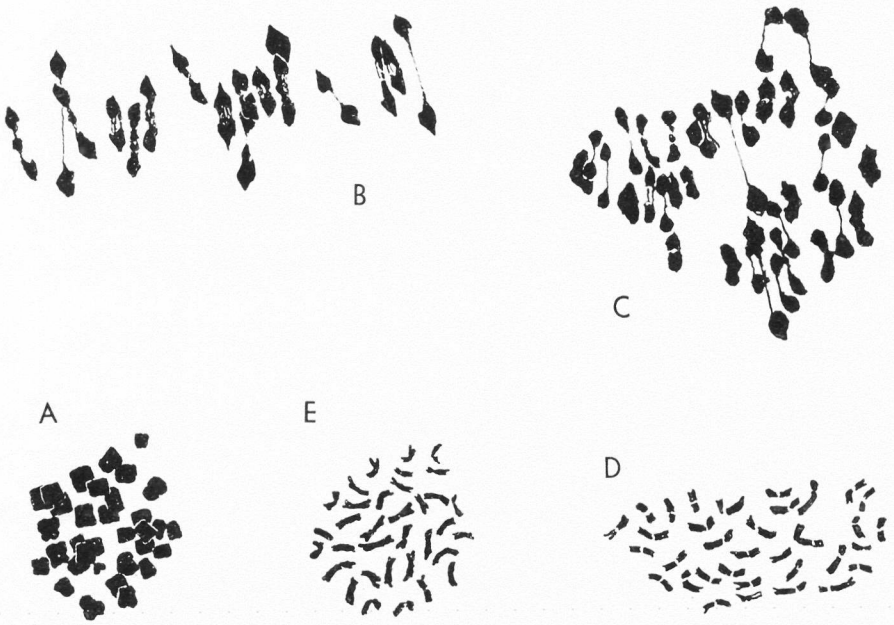

Fig. 1 A. *Cotoneaster adpressa praecox*: meiosis in an anther, metaphase I; section. B. *Cotoneaster dammeri* var. *radicans*: meiosis in an anther, metaphase I; smearpreparation, 17 bivalents. C. *Cotoneaster adpressa* var. *praecox*; meiosis in an anther, metaphase I; smearpreparation, 34 bivalents. D. *Cotoneaster frigida*: mitosis in a young leaf; squashpreparation, 34 chr. E. *Cotoneaster salicifolia*: mitosis in a root tip; squashpreparation, 34 chr.

Discussion and Conclusion

Looking at the results mentioned in the last chapter we regret not to have been able to investigate more species of the genus. Our original plan of work was to study mainly those species which had been determined by Sax to be *triploid* and so we gave most attention to these types. Of the evergreen species cuttings of growing shoots were rooted in autumn and of the decidious ones wood-cuttings were made in winter. Of these last types we have lost many, which have only partly been replaced. Further several plants proved to have been incorrectly named and lack of time caused us to give up looking for new ones, and in some cases where we later obtained some material it became clear to us that there was so much confusion in the nomenclature, that premature results could better not be published. However, our investigation has clearly shown that most *Cotoneaster* species are *diploid*

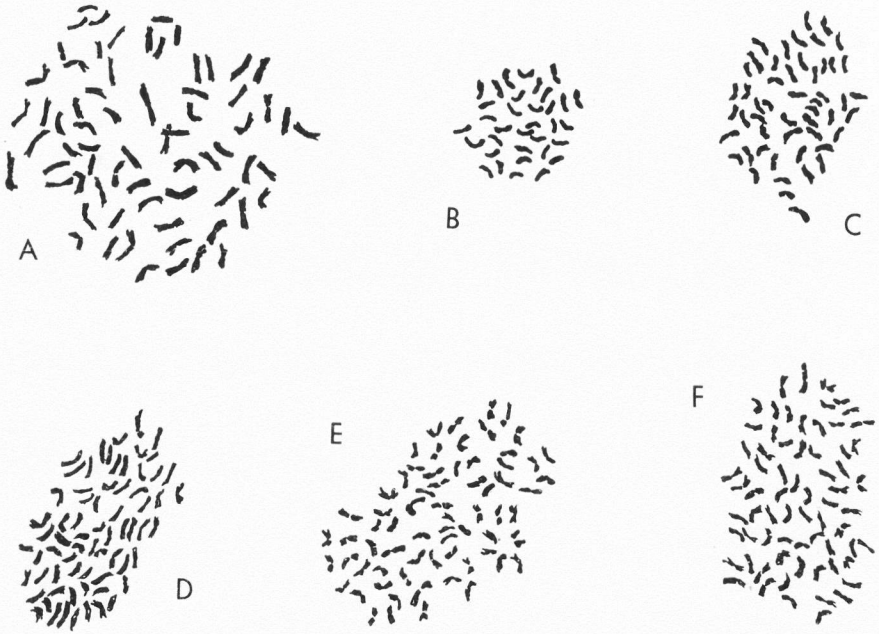

Fig. 2 A. *Cotoneaster salicifolia* var. *rugosa*: mitosis in a root tip; squashpreparation, 68 chr. B. *Cotoneaster adpressa*: mitosis in a root tip; section, 34 chr. C. *Cotoneaster adpressa* cv. 'Little Gem': mitosis in a root tip; section, 51 chr. D. *Cotoneaster adpressa* var. *praecox*: mitosis in a root tip; squashpreparation, 68 chr. E. *Cotoneaster horizontalis*: mitosis in a root tip; section, 68 chr. F. *Cotoneaster simonsii*: mitosis in a root tip; section, 68 chr.

or *tetraploid*. If triploidy will be found it is not likely to occur in a pure species. The triploids we could trace so far were sterile plants and of hybrid nature. As to the investigations into the chromosome numbers of *Cotoneaster* we must confess that we have had the easiest part. It was clear to us from the beginning that the study of the meiosis alone could not give convincing results. After we had made some preparations of flower buds it was evident that the meiotic divisions are very misleading, especially in sections it is hardly possible to make an analysis. Fig. 1 A gives the results of an analysis of M_I plate in a section of *C. adpressa* var. *praecox* and fig. 1 B and C have been drawn from smear preparations. Fig. 1 B shows 17 bivalents in M_I of *C. dammeri* and fig. 1 C 34 bivalents, some of them questionable, of *C. adpressa* var. *praecox*. The large number of bivalents in *C. adpressa* var. *praecox* are an indication of their hybrid nature as suggested on p. 268. In most

anaphase plates of our meiotic preparations we saw many laggards. This is in contrast with our drawings. But in the few divisions suitable for analysis they were practically absent. However, in fig. 1 A at least one univalent or a third chromosome attached to a bivalent can be seen. Several times no more than 25—30 elements could be counted. Such conditions can easily be misinterpreted and we do not wonder that Mrs. Sax could not always get the correct number.

On the other hand in almost every preparation made of a healthy root tip one or more plates enabling a reliable analysis were found. In fig. 1 D, a division in a young leaf of *C. frigida* is drawn at a magnification of 2500 times; fig. 1 E and 2 A are drawn from root-tip squashes at the same enlargement. They represent *C. salicifolia* and *C. salicifolia* var. *rugosa*. Figs. 2 B, C and D show the series diploid, triploid and tetraploid in *C. adpressa, C. adpressa* 'Little Gem' and *C. adpressa* var. *praecox*. The first two are drawn from sections of root-tips, the last one is from a root-tip squash; all three have been drawn at a magnification of 2500 times as was also done in figs. 2 E and F, being drawings of root-tip sections of respectively *C. horizontalis* and *C. simonsii,* both tetraploids.

These drawings demonstrate that there is a slight difference between some chromosomes in a plate. Generally speaking they are of long and of medium size. In a diploid plate there are always four, at the most eight chromosomes clearly longer than the others. The small ones do not differ much in size except probably two. The obvious difference in size of the chromosomes of the various figures, comes to the credit of the preparation method; sectioning of the material always results in a shrinkage of the cells and the chromosomes. Smear and squash preparations have a swelling effect.

It startled us very much that there is still such a confusion in the nomenclature of the *Cotoneaster* and it was very discouraging to discover the names of so much material to be incorrect. Though we might expect the material in the nurseries to be well named, we realize that new introductions can easily be confounded when several of them have been acquired together and the characters are insufficiently known. When afterwards the official collections are completed via such sources, there is a good chance that the mistakes are obscured and the use of the wrong names will increase. We should be glad if this investigation would be an impetus to those who are responsible for our collections of plants, not to spare any effort to get them true to name.

In conclusion we wish to express our sincere thanks to our co-workers in the cyto-genetic department, to the director of the Wageningen arboretum, Prof. Dr. A. J. Venema, and the director of the Experimental Station at Boskoop, Ir. G. Dorsman, for the material they have provided; to. Ir. C. Broertjes and to Ir. F. Schneider for the information concerning the hybridization work at the Experimental Station at Boskoop; to Dr. B. K. Boom for his guidance during the taxonomical study of the material and to Dr. O. Banga, who encouraged and enabled us to carry out this investigation.

Note. From a personal communication of Dr. Hylmö I learned that our No. 1481 is a nova microspecies, a Wilson collect, very common in culture; see page 268, *C. foveolata.*

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BOTANISKA NOTISER 1964 · VOL. 117 · FASC. 3 · LUND

Miscellaneous Notes on Algal Taxonomy and Nomenclature, I.

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The following notes refer to taxonomical and nomenclatural problems detected during preliminary work for the forthcoming '*Flora of British Marine Algae*' and the '*Revised Checklist of British Marine Algae*' (Parke and Dixon, 1964).

Kuetzingiella holmesii (Batt.) Russell comb. nov.

Ectocarpus holmesii was described by Batters (1888) on the basis of material collected at Minehead, Torquay and Berwick-on-Tweed by E. M. Holmes and himself. Numerous specimens from the three localities are now preserved in the herbarium of the British Museum (Natural History), whilst further examples have been located in other herbaria (e.g. Rijksherbarium, Leiden). Batters clearly had a considerable quantity of material at the time he drew up the description.

The thalli of *Ectocarpus holmesii* are composed of a matted layer of prostrate filaments on which are borne numerous short erect filaments, 3—4 mm. in length, which are simple or sparsely branched. Batters described the sporangia as being borne laterally on these erect filaments, either as sessile or shortly pedicellate structures, and this has been confirmed by examination of part of the original material. A further distinctive feature of the taxon is the presence of discoid chromatophores.

Hamel (1931) divided the species of *Ectocarpus sensu lato* into ten morphologically distinct groups, in one of which, the '*Ectocarpi terminales*', the thalli are composed of short tufts or turf-like growths,

with the primary filaments forming a creeping horizontal layer. Hamel referred *E. holmesii* to this group, together with *E. terminalis, E. battersii, E. zanardinii* and *E. bornetii*. Of these species, *E. zanardinii* and *E. bornetii* were later transferred to *Streblonema* by Hamel (1939), whilst *E. terminalis* has been shown subsequently (Kuckuck, 1960) to be nothing more than a phase in the development of *Spongonema tomentosum*. Finally, *E. battersii* has been made the type species of the new genus *Kuetzingiella*[1] by Kornmann (in Kuckuck, 1956).

E. holmesii, the only species remaining of the group '*Ectocarpi terminales*' designated by Hamel, is distinguished by its habit, the presence of discoid chromatophores and the narrow diameter of the filaments. There are, however, several similarities between this species and *Kuetzingiella battersii,* the only point of difference being that the plurilocular sporangia of *Ectocarpus holmesii* are never produced on the prostrate filaments. The difference is not of critical importance in that the production of plurilocular sporangia on the basal system occurs in ectocarpoid species other than those referable to *Kuetzingiella* whilst in *K. battersii* itself the formation of plurilocular sporangia on the prostrate filaments diminishes with time following the growth of the erect filaments and the formation on these of plurilocular sporangia. The similarities are sufficient to warrant the transfer of *Ectocarpus holmesii* to *Kuetzingiella*: —

Kuetzingiella holmesii (Batters) Russell, comb. nov.=*Ectocarpus holmesii* Batters, In, J. Linn. Soc. (Bot.), 24: 450 (1888).

Pylaiella or *Pilayella?*

The two orthographic variants *Pylaiella* and *Pilayella* have been used as the name of a genus of the Phaeophyta. Bory (1823) published the original description of the genus under the name *Pilayella,* but subsequently Leman (1826) changed the spelling to *Pylaiella* stating "l'orthographie du nom du botaniste . . . auquel il est dedie, M. Bachelot de la Pylaie, nous oblige a changer en celui de *Pylaiella*". The two alternative versions were used indiscriminately by later workers, Ruprecht (1851) being one of the few to indicate the reasons for his use of *Pylaiella* rather than *Pilayella.* To make matters more complicated Gaillon (1828) used yet another variant, *Pylayella,* although this does

[1] The use of the diacritic 'ü' in the original orthography (*Kützingiella*) is incorrect and must be transcribed in accordance with Art. 73 of the *International Code of Botanical Nomenclature* (Lanjouw et al., 1961).

not appear to have been adopted by any other worker. De Toni (1895) adopted *Pylaiella* and since that time this version has been accepted almost consistently, Newton (1931) being one of the few authors to use the original orthography.

The person to whom the generic name is dedicated himself used two variants of his name, Pylaie appearing on some publications (Pylaie, 1825; 1829) and Pilaye on others (Pilaye, 1826). Furthermore the latinization of the name to *Pilayella* by Bory is perfectly acceptable according to Art. 73 of the *International Code of Botanical Nomenclature* (Lanjouw et al., 1961) and there is no reason for the alteration proposed initially by Leman. *Pilayella* is therefore the correct spelling to be used.

Sauvageaugloia and *Stilopsis*

Problems of priority and citation in the Rhodophyta resulting from the misquotation of *nomina nuda* have been discussed previously (Dixon, 1962, 1964). The present study of these two genera of the Phaeophyta falls into the same category.

The generic name *Sauvageaugloia* was coined by Hamel (1939), who stated that *Mesogloia griffithsiana* Grev. ex Harv. in Hook., being sufficiently distinct from other species of *Mesogloia,* warranted separation as a distinct genus to which the name *Sauvageaugloia* should be applied in honour of the phycological contributions of Camille Sauvageau. Unfortunately no formal description was given and the information presented is not sufficient to validate the generic name. The first formal description was published in the following year by Kylin (1940), so that the correct authorities for genus and species are *Sauvageaugloia* Hamel ex Kylin and *S. griffithsiana* (Grev. ex Harv. in Hook.) Hamel ex Kylin respectively.

Similarly the generic name *Stilopsis* was used by Kuckuck as a manuscript name and listed by Nienburg in his posthumous account of Kuckuck's unpublished work (Kuckuck, 1930) but the information is presented in such a way as to invalidate the name. Hamel (1935, 1937) in his discussion of the Spermatochnaceae presents information and a key to the genera which are sufficient to validate the generic name, so that the correct authorities for genus and species are *Stilopsis* Kuck. ex Hamel and *S. lejolisii* (Thur. in Le Jol.) Kuck. ex Hamel, respectively.

Ascocyclus

Despite the various discussions of taxonomic problems in this genus, there are still several outstanding nomenclatural points requiring clarification.

Myrionema orbiculare was described by J. Agardh (1848) on the basis of material from the Mediterranean, whilst Magnus (1875) later collected a brown algae in the North Sea which he identified, somewhat reluctantly, with Agardh's species. Magnus commented that his material was sufficiently distinct from the species of *Myrionema* then known to justify generic separation and he proposed the generic name *Ascocyclus* with sufficient information to validate the name. Various dates of publication (1872; 1874) have been cited for the description of *Ascocyclus* but the evidence is that Magnus's paper did not appear until 1875. Magnus refers consistently to the alga from the North Sea as *Myrionema orbiculare* so that all subsequent authors have erred in crediting him with the nomenclatural transfer of that species to *Ascocyclus*. De Toni (1895) appears to be the first author to validate the transfer of *Myrionema orbiculare* so that the authority for *Ascocyclus orbiculare* is "(J. Ag.) De Toni".

It is now accepted that the plants from the Mediterranean and the North Sea are taxonomically distinct and that the binomial *A. orbiculare* must be retained for the former. The North Sea plant was renamed *A. magnusii* by Sauvageau (1927) although Waern (1952), claiming erroneously that the epithet is incorrect, changed this to *magni*. Alteration of the epithet from *magnusii* to the genitive form *magni* would be correct only if the name *Magnus* was a latin name or the latinization of a non-latin name. It is neither and the original epithet must be retained.

A nomenclatural study of *Ectocarpus confervoides*

Ectocarpus is as confused, both taxonomically and nomenclaturally, as any genus of the Phaeophyta. The present study is concerned with *E. confervoides* (Roth) Lyngb. and certain other species currently regarded (cf. Parke, 1953) as being conspecific with it, viz. *E. siliculosus* and *E. arctus*.

Ectocarpus siliculosus (Dillw.) Lyngb. was described originally by Dillwyn (1809) as *Conferva siliculosa*. The latter is, however, a superfluous, and illegitimate, name because of the citation in the original description of the synonym *Ceramium confervoides* Roth. The latter is the basionym of *Ectocarpus confervoides* (Roth) Le Jol. By Art 7, Note 4 of the *International Code of Botanical Nomenclature* (Lanjouw et al., 1961), *Conferva siliculosa* Dillw. must be typified by the type of *Ceramium confervoides* Roth. But the latter, in its turn, is also a super-

fluous, and illegitimate, name, because of the citation in its original description of the synonym *Conferva littoralis* L. This is the basionym of *Pilayella littoralis* (L.) Kjellm. Thus, by the Art. 7, Note 4 cited above, *Ceramium confervoides* must be typified by the type of *Conferva littoralis* L., as must also *Conferva siliculosa* for the reasons stated above. Thus *Conferva siliculosa* and *Ceramium confervoides* as to type are therefore both synonyms of the alga now known as *Pilayella litoralis,* and neither epithet is acceptable in the genus *Ectocarpus.*

It would appear that the oldest epithet available for the taxon now known as *Ectocarpus confervoides* is *E. arctus* Kützing. This entity was described (Kützing, 1843) on the basis of material collected at Spalato (=Split, Jugoslavia). The description of *E. arctus* contains a reference to "E. draparnaldioides Kg. Actien 1836" but this binomial is a *nomen nudum* and it does not therefore invalidate *E. arctus.*

Acknowledgements

We are indebted to Mr. R. Ross for assistance with nomenclatural matters; to Professor N. A. Burges and Mr. J. S. Colman for reading the manuscript; and to the Directors of the Rijksherbarium, Leiden, and the British Museum (Natural History), for permission to examine material.

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Botaniska Notiser 1964 · Vol. 117 · Fasc. 3 · Lund

Schisandra Michaux — Its Embryology and Systematic Position

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Among the Ranales, the genus *Schisandra* presents many problems and peculiarities in its morphology (see Bailey & Nast, 1948; Lemesle, 1955). Despite this no comprehensive study of this genus has ever been made and the controversies with regard to its systematic position still exist.

The embryological data on this genus are meagre. Wodehouse (1935, 1936) described the pollen grains of *Schisandra* and *Kadsura* as hexacolpate with a triradiate mark. He also proposed a hypothesis according to which these pollen grains are supposed to have given rise to those of higher angiosperms having three or more furrows. Erdtman (1952) recorded some abnormal pollen grains and denied any homology between the fern spores and the schisandraceous pollen grains. Recently Hayashi (1960) has given a brief account of the anther wall, microsporogenesis and pollen of *Schisandra nigra* and *Kadsura japonica*. Yoshida (1962) has studied the development of the female gametophyte in *Schisandra chinensis*. The present work deals with the embryology of *Schisandra grandiflora* Hook. f. & Thomson.

Material and methods

Buds, flowers and fruits of *Schisandra grandiflora* were obtained from some localities in the eastern and western Himalayas of India (see Tab. 1).

Mostly formalin-acetic-alcohol was used as fixative, but for the study of microsporogenesis Carnoy's fluid proved better. Dehydration and embedding were done in the usual way. Before sectioning the imbedded material was soaked in water for about a month. The sections were

Tab. 1. Source of material.

Particulars	Locality and Altitude	Date of collection	Collector/s
Mature fruits	Rambara; 9,500 ft	September, 1957	M. A. Rau
Male and Female flowers	Rambara; 9,500 ft	June, 1958	H. Singh and S. Jalan
Young fruits	Mundali; 8,000 ft	August, 1959	H. Singh and S. Jalan
Floral buds	Rambara; 9,500 ft	May, 1961	S. Jalan
Pollinated flowers	Jumnotri; 8,000 ft	June, 1961	M. A. Rau

cut at 7—15 microns in thickness and stained with safranin-fast green and Heidenhain's haematoxylin-fast green combinations. The pollen grains were examined after mounting them in glycerine jelly containing basic fuchsin. The microsporogenesis was studied mainly by acetocarmine smears.

External morphology

Schisandra grandiflora is a woody, deciduous, dioecious, and sinistrorsely climbing shrub inhabiting steep slopes and shady places. In any particular locality the male plants are often more numerous than the female.

The flowers are solitary and are borne in the axils of leaves (Fig. 1 A). They are globose, actinomorphic, and fragrant but may be white, pinkish-white, yellow or reddish-yellow. Each flower is about 3 cm in diameter with a 3—6 cm long pedicel. The perianth comprises 9 or 10 opaque and apparently eglandular tepals arranged alternately in three, triseriate whorls. They differ in size and are more or less suborbicular and pronouncedly concave in shape (Fig. 1 M, N).

In male flowers (Fig. 1 D, E) the torus is short, cylindrical, fleshy and bears 25—30 stamens (Fig. 1 L). Each stamen is differentiated into a filament and anther (Fig. 1 K). The filaments are fleshy and basally adnate with the receptacle (Fig. 1 L). Their length varies even in the same flower. Usually the lower stamens have longer filaments, but those near the tip of the receptacle are almost sessile (Fig. 1 L). The thecae are large, widely separated, protuberant and oblong to elliptical with latrorse or extrorse dehiscence. Staminodes with different degrees

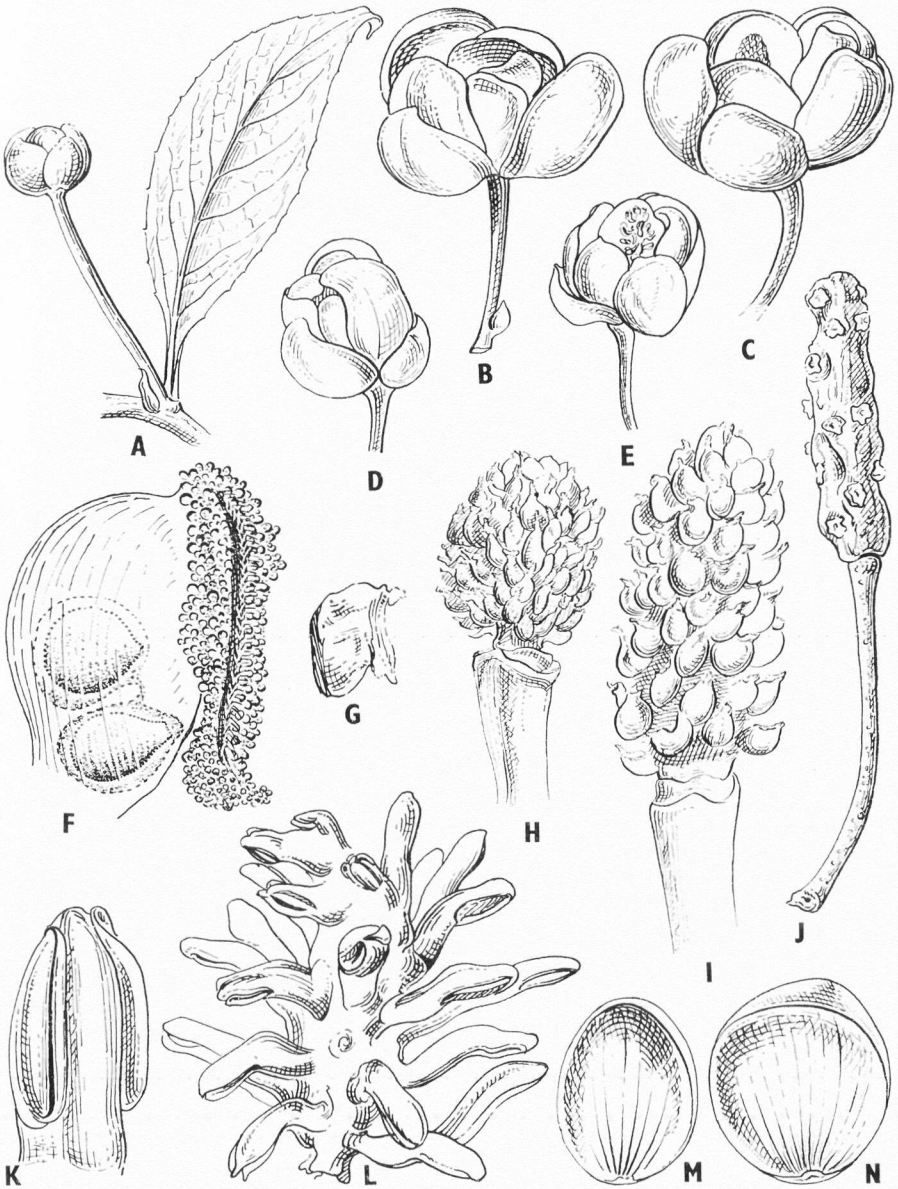

Fig. 1. — *Schisandra*. — Fig. A. Solitary flower borne in the axil of a leaf. — Fig. B, C. Female flowers; in Fig. B a small bract is seen at the base of the pedicel. — Fig. D. E. Young and old male flowers. — Fig. F, G. Whole mounts of carpel showing two ovules and the papillose stigmatic crests. — Fig. H, I. Gynoecia at anthesis and post-anthesis stages respectively. — Fig. J. Receptacle after removing the carpels; the scars are spirally arranged. — Fig. K. Stamen. — Fig. L. Male flower without perianth lobes. — Fig. M, N. Perianth lobes enlarged. — Fig. A—E, J ×1, F ×39, G ×15, H, I, L ×5, K ×19, M—N ×2.

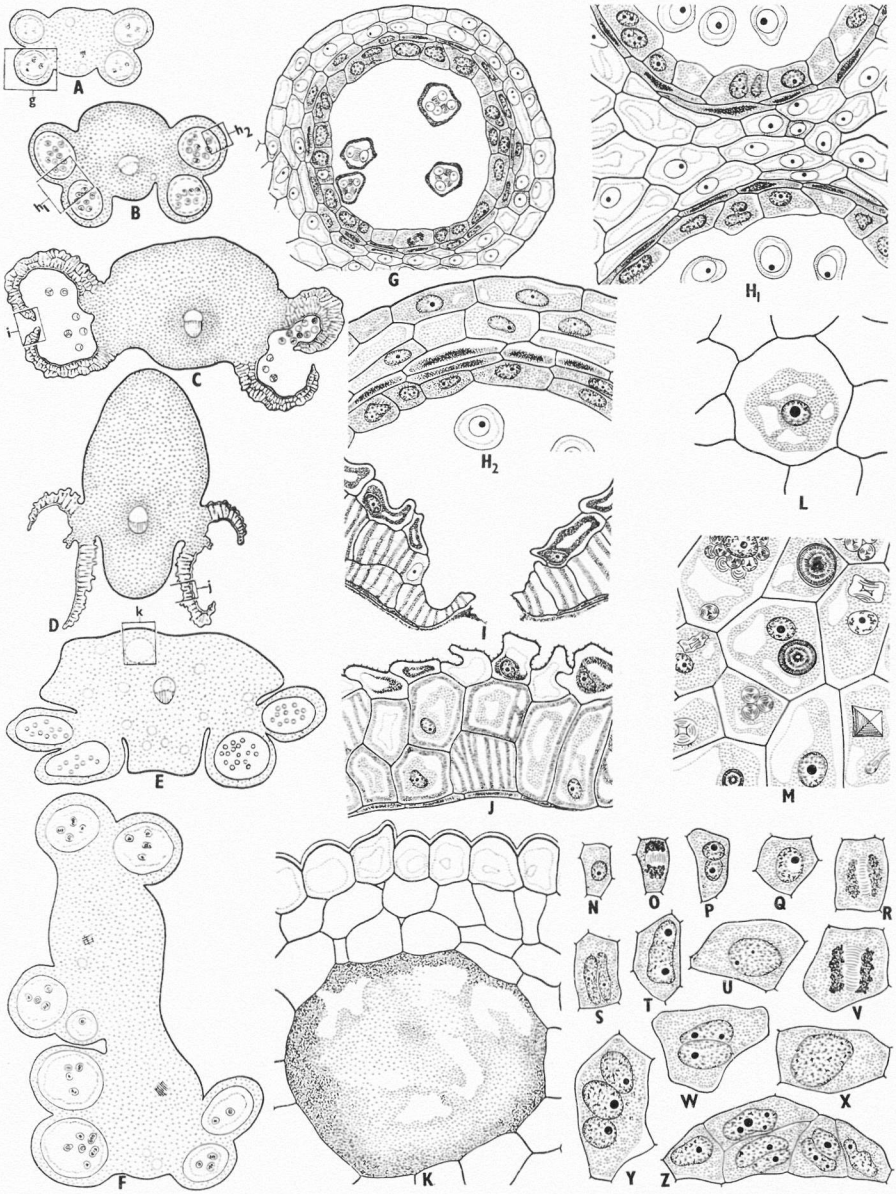

Fig. 2. — *Schisandra*. — (Fig. A—D, F—J, L—Z are of *S. grandiflora* and E, K of *S. neglecta*). Fig. A—C. Transections of the anthers at the microspore tetrad, 1-, and 2-celled stages of the pollen grains. — Fig. D. Transection of a dehisced anther. — Fig. E. Ethereal oil cells in connective region of anther. — Fig. F. Abnormal stamen bearing eight anther locules. — Fig. G. Anther locule g from Fig. A enlarged to show wall layers. — Fig. H_1, H_2. Enlargements of portions h_1, h_2 from

of reduction in vascular strand and sporangia may also occur. Sometimes the stamens may fuse throughout their length; figure 2 F shows transections of one such abnormal stamen at the level of the anthers.

The female flowers (Fig. 1 B, C) are larger than the males (Fig. 1 D, E), and their outer perianth lobes are more highly coloured and fragrant. There are numerous, free, minute and sessile carpels arranged spirally on the receptacle (Fig. 1 H—J). The ovary is superior, and contains two ovules lodged separately in two chambers (Fig. 1 F, G). Along the ventral side the two margins of the carpel lie close to each other and form a prominent papillose stigmatic crest which is distally projected into a non-vascularized pseudostyle (Fig. 1 F, G).

After fertilization almost all the carpels mature into berries (Fig. 8 A—D). However, sometimes a few abort. The receptacular axis elongates from 3—30 cm and becomes fleshy and swollen (Fig. 1 J). Each berry is dark-purple, globose, and about 2 cm in diameter (Fig. 8 E, F). The pericarp is soft and pulpy at maturity. There are two seeds (Fig. 7 A) imbedded in the pulp.

Microsporangium

A hypodermal, multicelled archesporium differentiates at four corners of the young anther. Its cells divide transversely to form the parietal cells and the microspore mother cells. The former undergo periclinal divisions and produce 5 or 6 wall layers (Fig. 2 A, G).

The epidermis consists of rectangular cells (Fig. 2 B, H_2) which become papillate and filled with tannin as the anther matures (Fig. 2 C, D, I, J). The endothecium is hypodermal and irregularly 2-layered (Fig. 2 H_2, J). Prior to dehiscence it develops vertically oriented fibrous thickenings (Fig. 2 I, J). The middle layers (2 or 3) start degenerating soon after the completion of reduction divisions in the microspore mother cells (Fig. 2 G, H_1, H_2). The tapetum is of the secretory type and irregularly 2-layered (Fig. 2 G). Its cells are densely cytoplasmic and initially uninucleate but later become polyploid due to repeated nuclear divisions and fusions (Fig. 2 N—Z). Ethereal oil cells are pre-

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Fig. B showing degeneration of middle layers. — Fig. I. Portion i from Fig. C magnified to show fibrous thickenings in endothecium. — Fig. J. Magnified view of portion j in Fig. D showing 2-layered endothecium and cuticular projections on the epidermis. — Fig. K. Portion k from Fig. E enlarged to show ethereal oil cell. — Fig. L. Ethereal oil cell in surface view. — Fig. M. Crystals in cells of connective. — Fig. N—Z. Tapetal cells showing nuclear divisions and fusions. — Fig. A—D, F ×36, E ×41, G—M ×330, N—Z ×411.

sent in the connective tissue (Fig. 2 E, K, L). In *Schisandra neglecta* crystalliferous parenchyma cells were also observed (Fig. 2 M).

All the wall layers, except the epidermis and fibrous endothecium, degenerate during maturation of the anther. Prior to dehiscence, the partition wall between the two locules of the same anther lobe breaks down leaving only a few deformed epidermal and endothecial cells which open apart and the pollen grains are discharged.

Microsporogenesis and male gametophyte

The pollen mother cells are polygonal initially, but become more or less rounded and enclosed in a thick gelatinous wall as the meiosis begins (Fig. 3 A, B). The reduction divisions are simultaneous, and decussate or tetrahedral tetrads are formed (Fig. 3 C—E). A young microspore shows a centrally situated nucleus and dense cytoplasm (Fig. 3 F). As it develops, the exine, intine and the germ furrows differentiate, and the nucleus divides to produce the vegetative and generative cells (Fig. 3 G—I). The mature pollen is thus 2-celled. It germinates by a rupture of the three furrows at the convergent pole (Fig. 3 Q). Sometimes abnormal microspores showing two large isodiametric nuclei instead of the generative and vegetative cells (Fig. 3 J, K) were also observed.

The mature pollen grain is oblate-spheroidal and shows six — three long and three short — meridionally arranged furrows. The longer furrows meet and fuse at one of the poles (called 'distal' by Erdtman) forming a 'triradiate' mark while the short furrows do not fuse and are disposed alternately in relation to the former (Fig. 3 N—P). Both the short and long furrows are alike in structure. The exine is thick and reticulate while the intine is thin (Fig. 3 I). Frequently the pollen grains showed parasyncolpate and synrugoidate patterns of the furrows. In the former the longer furrows bifurcate near one of the poles and the branches eventually fuse enclosing a blank island (Fig. 3 M). The synrugoidate grains contain only five furrows — one short and four long — the latter fuse pairwise at one of the poles with the former (Fig. 3 L). Similar atypical grains were also noticed by Erdtman (1952) in *Schisandra chinensis* as abnormalities. However, present work indicates that they are quite common and occur to the extent of 30—35 per cent in *Schisandra grandiflora*.

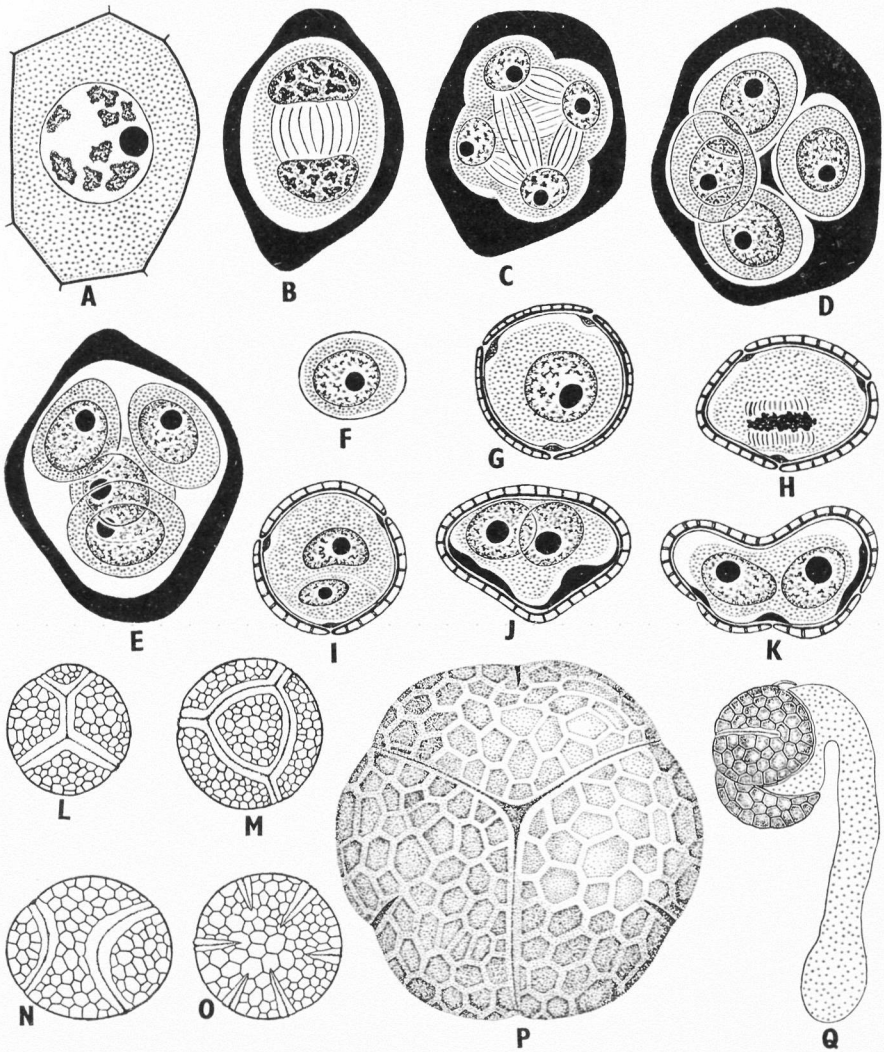

Fig. 3. — *Schisandra*. — Fig. A. Microspore mother cell. — Fig. B, C. Same, meiosis I and II. — Fig. D, E. Decussate and tetrahedral microspore tetrads. — Fig. F, G. Young and mature uninucleate microspores. — Fig. H. Division of microspore nucleus. — Fig. I. Two-celled pollen grain. — Fig. J, K. Abnormal 2-nucleate pollen grains. — Fig. L, M. Pollen grains in polar view showing syn-rugoidate and parasyncolpate patterns of furrows. — Fig. N. Pollen grains with two furrows in lateral view. — Fig. O. Same, in polar view showing blank pole and alternately arranged shorter and longer furrows. — Fig. P. Pollen grain with a triradiate mark formed by the meeting of three furrows; the exine is reticulate. — Fig. Q. Germinated pollen grain showing pollen tube emerging from the convergent pole. — Fig. P ×1740, otherwise ×585.

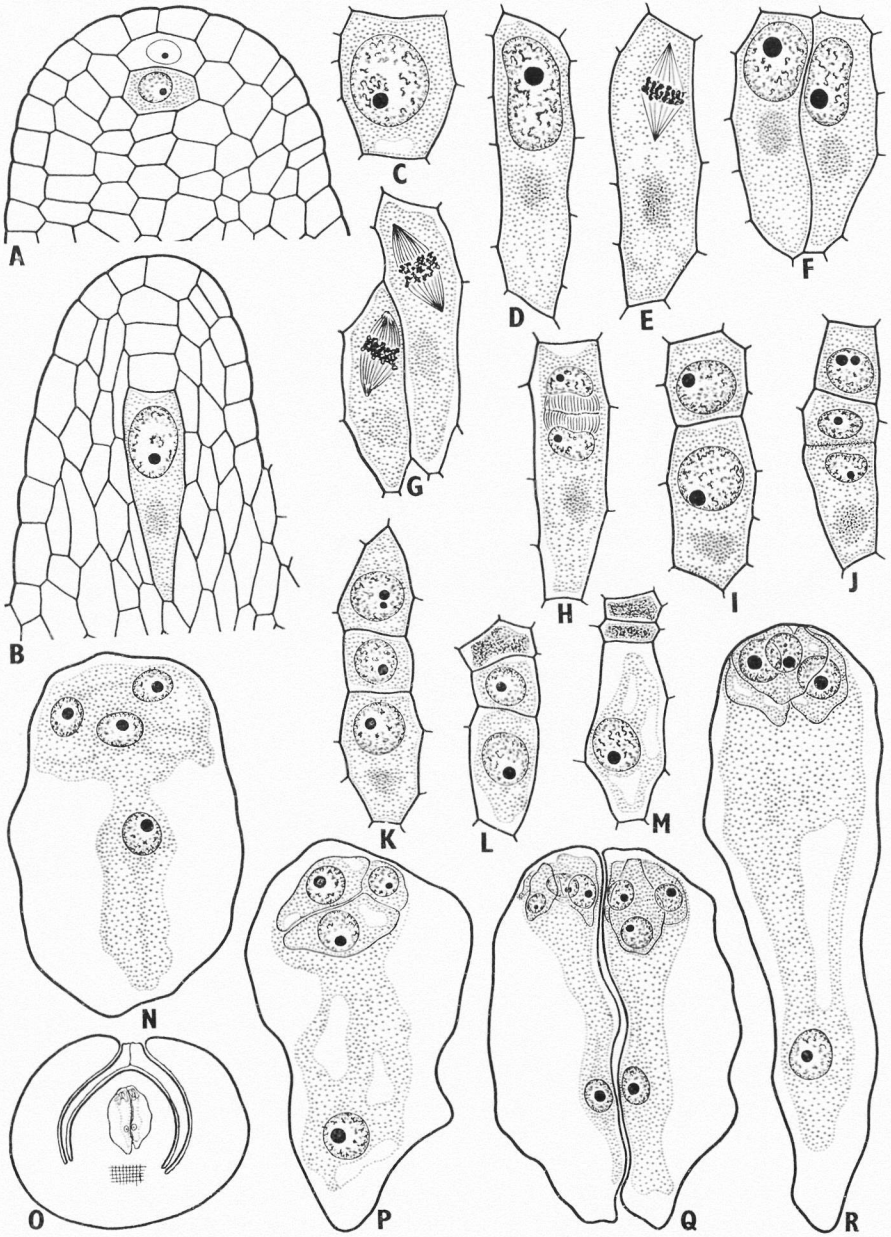

Fig. 4. — *Schisandra.* — Fig. A. Longisection through nucellus showing primary parietal cell and sporogenous cell. — Fig. B, C. Megaspore mother cells. — Fig. D. Same, showing densely staining cytoplasmic body in the chalazal portion. — Fig. E. Meiosis I. — Fig. F, G. Two megaspore mother cells lying side by side; both in

Megasporangium

The ovular primordium arises as a conical outgrowth and gradually becomes anatropous. The initials of the integuments appear more or less simultaneously after the differentiation of the archesporium. Sometimes the inner integument may arise earlier than the outer. At the mature embryo sac stage the outer integument consists of 6 or 7 layers while the inner has only 3 layers of cells. Both the integuments envelop the nucellus and organize the micropyle (Fig. 7 C).

Megasporogenesis and female gametophyte

The hypodermal archesporial cell divides periclinally forming the parietal and the sporogenous cells (Fig. 4 A). The former by further divisions, produces 3 or 4 parietal cells and as a result the megaspore mother cell becomes deep-seated (Fig. 4 B). At the time of meiosis the megaspore mother cell may be much elongated with a large nucleus in the micropylar portion and a deeply staining, somewhat rounded, cytoplasmic body in the chalazal portion (Fig. 4 C, D). This body usually occupies a basal position in the chalazal megaspore (Fig. 4 E—K), and disappears as soon as the non-functioning megaspores begin to degenerate (Fig. 4 L).

The first meiosis (Fig. 4 E, H) results in two dyad cells, of which the lower one is invariably larger (Fig. 4 I). The second meiosis follows shortly but involves only the lower dyad cell so that a linear triad of megaspores is produced (Fig. 4 J, K). Of these the chalazal megaspore develops further and the upper two degenerate (Fig. 4 L, M). The nucleus of the functioning megaspore undergoes three successive divisions to form an 8-nucleate embryo sac of the Polygonum type (Fig. 4 M, N, P). The mature embryo sac is long with a broad micropylar end and a narrower chalazal end (Fig. 4 R). It shows two vacuolated synergids, an egg cell and two polar nuclei. The latter fuse in the centre to form the secondary nucleus (Fig. 4 R). The three antipodal cells degenerate immediately after their inception. Multiple megaspore mother cells were also observed. In Fig. 4 F, G two megaspore mother cells are lying side by side while Fig. 4 O, Q shows twin embryo sacs.

division in Fig. G. — Fig. H—L. Stages leading to formation of dyads and triads of megaspores. — Fig. M. Functioning megaspore, degenerated upper dyad cell and the middle non-functioning megaspore. — Fig. N. Four-nucleate embryo sac. — Fig. O, Q. Ovule with twin embryo sacs. — Fig. P, R. Young and mature female gametophytes. — Fig. A, B ×412, C—N, P—R ×513, O ×112.

Fertilization and endosperm

The pollen grains are monosiphonous and they germinate on the papillose stigmatic crest. The pollen tube enters through the micropyle and reaches the egg destroying one or both the synergids.

The endosperm is *ab initio* Cellular. The primary endosperm nucleus divides transversely to form a large micropylar and a small chalazal chamber (Fig. 5 A, B). Next the chalazal chamber divides vertically and transversely to form 4- or 6-celled endosperm (Fig. 5 C, D). Subsequent divisions are irregular. Figure 5 E—G, K represents endosperm at the 1-, 3-, 4- and 16-celled stages of the proembryo. The cells of the endosperm during earlier stages are polygonal, uninucleate and thinly cytoplasmic (Fig. 5 H, I). As the development proceeds (Fig. 7 D, E) they fill up the entire seed and form a compact tissue (Figs. 5 L, 7 F). The cells of the mature endosperm have thick walls and contain food materials like starch grains and oil globules (Fig. 5 J).

Embryo

The first division of the zygote is transverse resulting in a terminal cell, *ca*, and a basal cell, *cb* (Fig. 6 A, B). However, there is much variation in the subsequent behaviour of these two daughter cells. The divisions in *ca* may precede those of *cb* (Fig. 6 D, E, N, O) or vice versa (Fig. 6 G—I). Usually *ca* divides by a vertical wall to form two juxtaposed cells (Fig. 6 J, L) whereas *cb* divides transversely resulting in two superposed cells *m* and *ci* (Fig. 6 G—M). Thus, a ⊥-shaped, 4-celled proembryo is formed (Fig. 6 K, L). Sometimes the zygote may divide by a vertical wall (Fig. 6 C) and the resulting daughter cells transversely to form a cruciform 4-celled proembryo (Fig. 6 F). Occasionally the terminal cell *ca* divides obliquely (Fig. 6 E, M).

The two juxtaposed cells derived from the terminal cell divide by a vertical wall to form the quadrant. This undergoes a transverse division to delimit the tiers *l* and *l'* (Fig. 6 N). Finally a longitudinal division results in the formation of an octant (Fig. 6 O, P). From this stage onwards the divisions are irregular and result in globular and heart-shaped embryos (Fig. 6 Q, R).

The derivatives of the basal cell divide irregularly. The tier *m* contributes to the formation of the hypophyseal region, while the tier *ci* forms a short suspensor which is absorbed during the growth of the embryo.

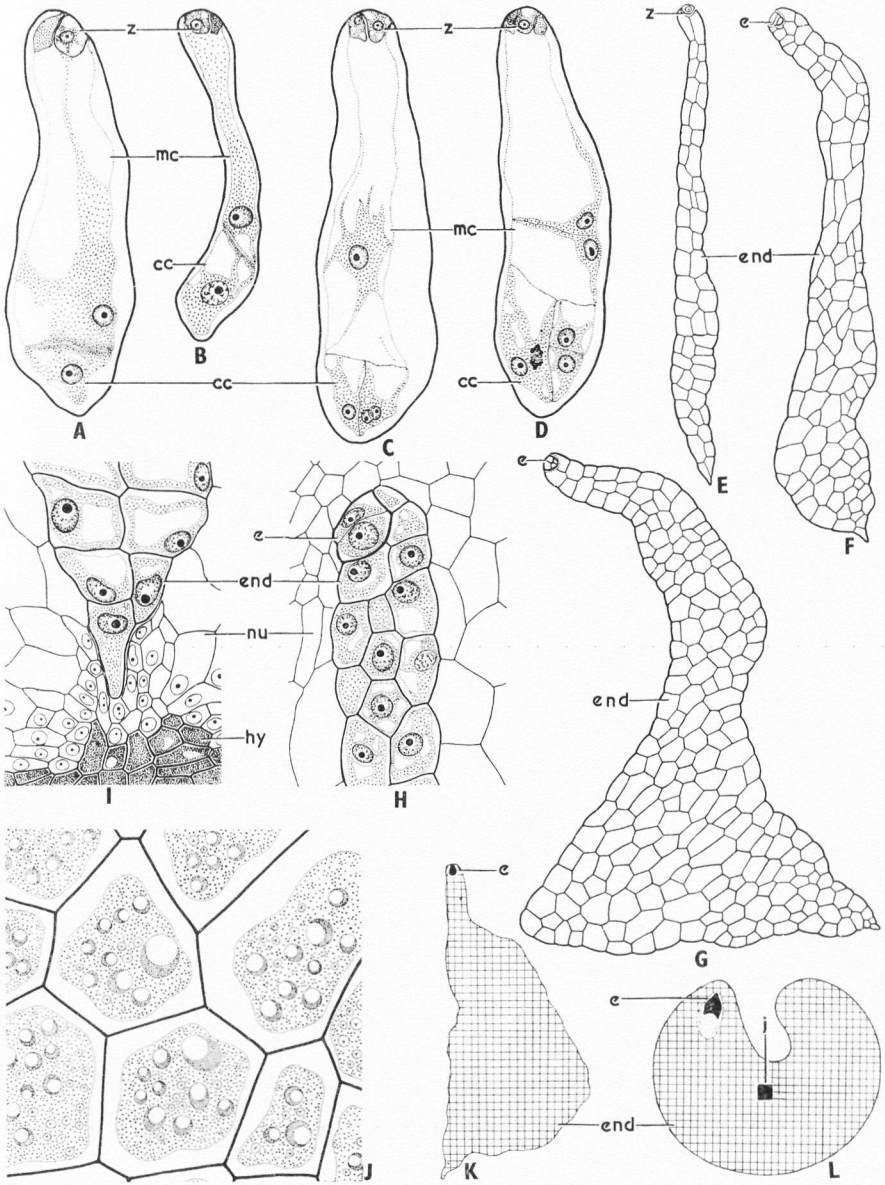

Fig. 5. — *Schisandra.* — (*cc*, chalazal chamber; *e*, embryo; *end*, endosperm; *hy*, hypostase; *mc*, micropylar chamber; *nu*, nucellus; *z*, zygote). Fig. A—D. Early stages in the development of cellular endosperm. — Fig. E—G. Endosperm at the zygote, 3-celled, and 4-celled stages of the proembryo. — Fig. H, I. Magnified view of micropylar and chalazal portions of the endosperm. — Fig. J. Magnified view of portion marked j in Fig. L to show mature endosperm cells containing fat globules. — Fig. K. Whole mount of endosperm at globular stage of embryo. — Fig. L. Longisection through a mature seed after removing testa. — Fig. A—D ×202, E—G ×132, H—J ×277, K ×57, L ×15.

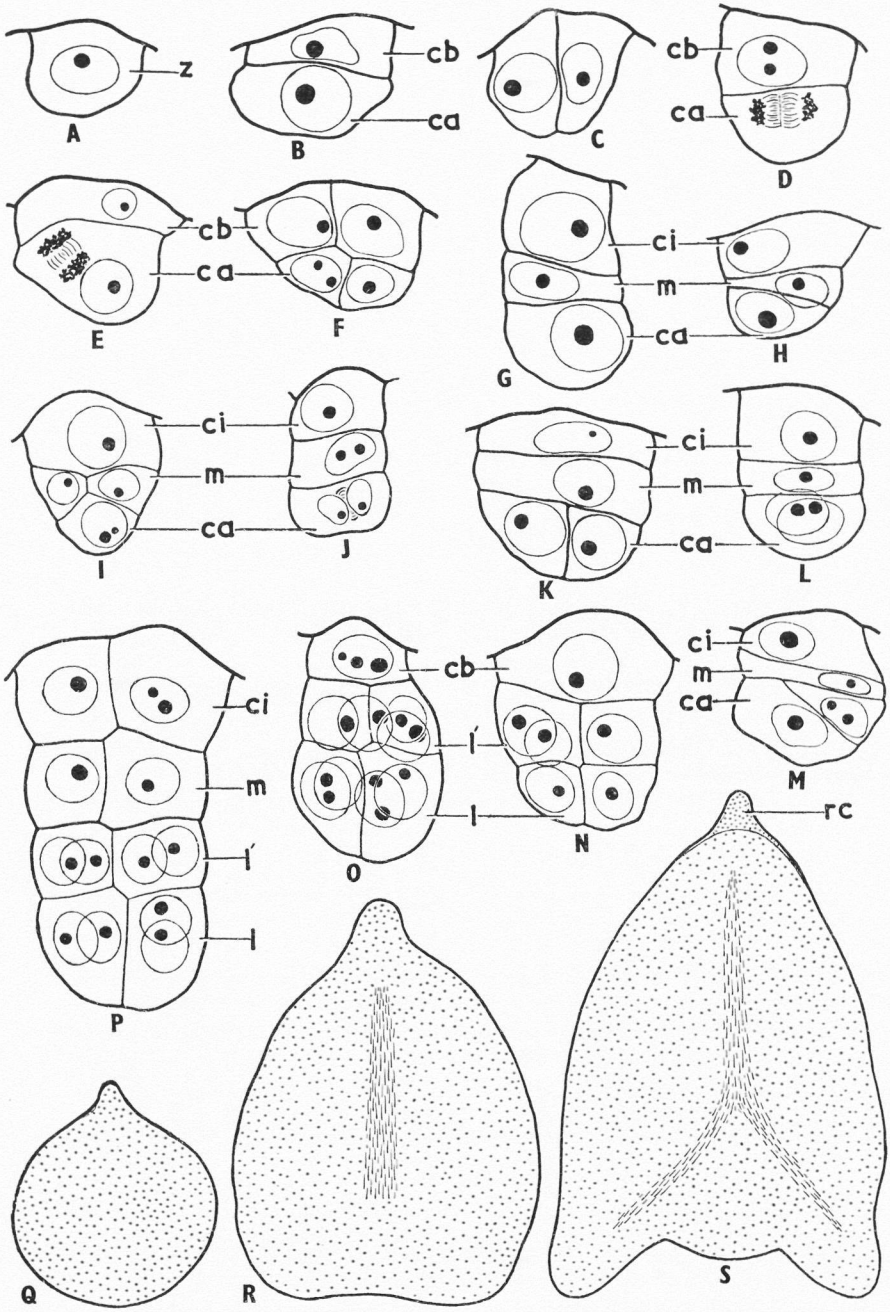

Fig. 6. — *Schisandra.* — (*rc*, root cap; *z*, zygote). Fig. A. Zygote. — Fig. B, C. Two-celled proembryos. — Fig. D, E, G, H. Three-celled proembryos. — Fig. F, I—M. Four-celled proembryos. — Fig. N—P. Stages leading to the formation of octant proembryo. — Fig. Q—S. Globular, heart-shaped, and mature embryos. — Fig. A—P ×640, Q—S ×169.

The mature embryo is dicotyledonous and is embedded in the massive endosperm (Fig. 7 F). The cotyledons are small, the hypocotyl is feebly developed and the radicle is incipient (Fig. 6 S).

Seed and testa

The seeds are small and reniform with flattened lateral sides (Fig. 7 B). They are greyish-brown with a smooth surface. The hilum is lateral.

At the mature embryo sac stage, the outer integument is 6- or 7-layered (Fig. 7 C, H), except in the micropylar region and on the funicular side where it may be 10 or 11 layers thick. The cells of the outer epidermal layer are longer than broad whereas the inner epidermal cells are smaller and cubical (Fig. 7 H). The ground tissue between the two epidermal layers consists of pentagonal or hexagonal cells. The inner integument is 2- or 3-layered (Fig. 7 H) except in the micropylar region where it forms a thick lip.

After fertilization both the integuments undergo marked changes. These are first seen in the outer epidermal cells of the outer integument which elongates (Fig. 7 D, E, I, J) and become thick-walled to form a stony layer of macrosclereids (Fig. 7 G, K). Each macrosclereid is rod-like with a small lumen and asymmetrically lignified and pitted walls (Fig. 7 M, N). The cells of the 2 or 3 subepidermal layers develop into thick-walled and irregularly-shaped brachysclereids (Fig. 7 K, L). In contrast to the cells of the outer epidermis they elongate horizontally and show simple, unbranched pits and a large lumen (Fig. 7 L). Beneath the epidermal and subepidermal layers of sclereids, one or two layers remain thin-walled and become compressed (Fig. 7 I, K). Their cells are uninucleate and show vacuolated cytoplasm. The cells of the inner epidermis become considerably enlarged and a few of them develop thick walls and simple pits (Fig. 7 J, K).

The inner integument undergoes little differentiation. At first all the three wall layers are composed of cubical or rectangular cells (Fig. 7 H) but at maturity the cells become radially elongated and crushed leaving a thin, degenerated strip close to the outer integument (Fig. 7 I—K). At the micropylar end both the outer and inner integuments lie close to each other (Fig. 7 F). Their cells develop thick, pitted walls similar to those of the surface layer. The cells of the nucellar tip elongate and form a cap-like structure which protrudes into the micropyle (Fig. 7 O).

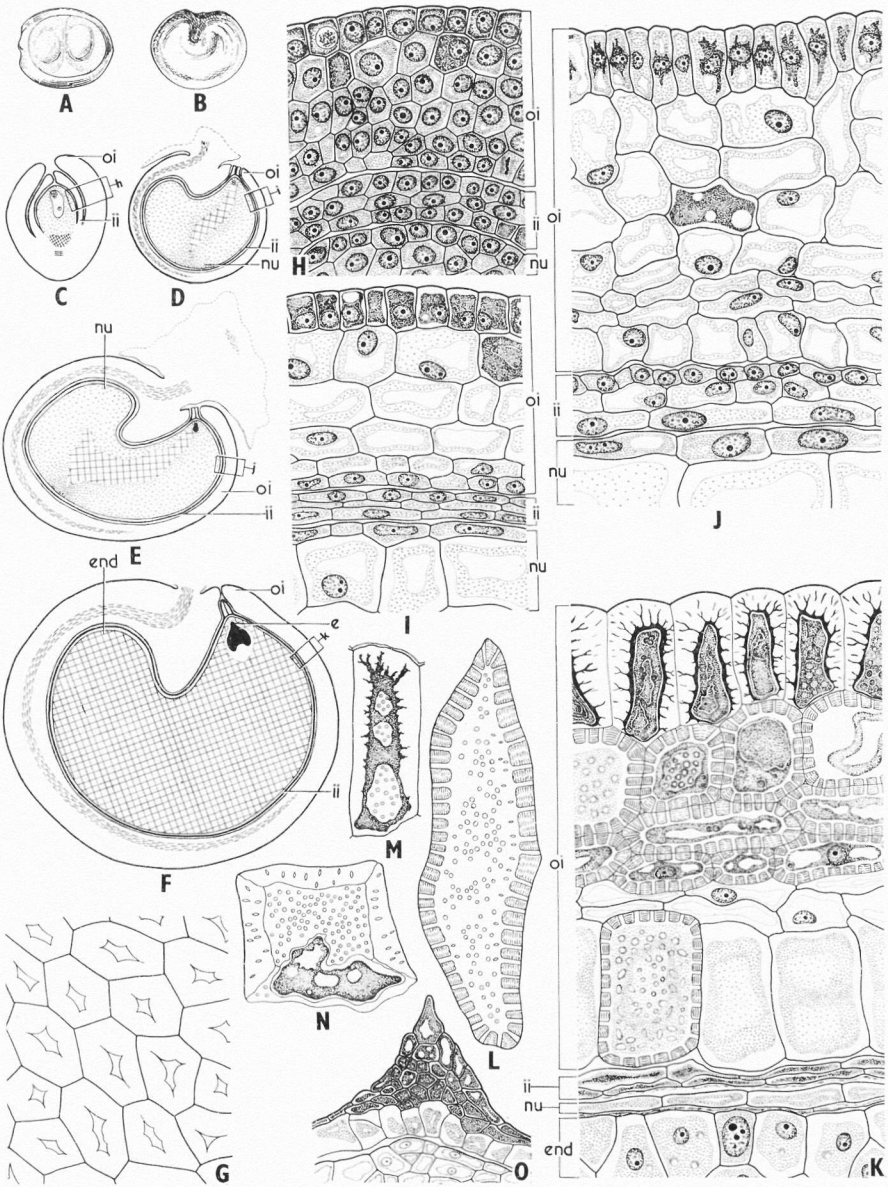

Fig. 7. — *Schisandra.* — (*e,* embryo; *end,* endosperm; *ii,* inner integument; *nu,* nucellus; *oi,* outer integument). Fig. A. Ripe fruit with a portion of the wall removed to show two seeds. — Fig. B. Mature seed. — Fig. C—F. Longisection of ovules at various stages of development. — Fig. G. Portion of testa in surface view. — Fig. H. Portion h from Fig. C enlarged to show testa at the mature embryo sac stage. — Fig. I, J. Portions i and j enlarged from Fig. D and E to show compression

Pericarp

During prefertilization stages (Fig. 8 G, H) the ovary wall is made up of 10—12 layers of parenchymatous cells (Fig. 8 J, K). The epidermal cells are small and rectangular while those belonging to the subepidermal layers are large and polyhedral (Fig. 8 J, K). A large number of ethereal oil cells are present in the outer epidermis (Fig. 8 N, O).

After fertilization (Fig. 8 I) the number of subepidermal layers increases to 14 or 15 due to periclinal divisions in their cells (Fig. 8 L) and these later enlarge tangentially and radially (Fig. 8 L, M). At some places intercellular spaces also develop between them. The cells of 1 or 2 layers situated above the inner epidermis elongate to about ten times their original length (Fig. 8 M).

Concomitant with the above changes in the epidermal and subepidermal layers of the pericarp, the edges of the ventral stigmatic crest fuse (Fig. 8 G—I) and the carpel becomes spheroidal (Fig. 8 E, F). The ovary loses its tough and hard texture and becomes swollen, fleshy and succulent.

Discussion

Male gametophyte: In *Schisandra grandiflora* the anther wall comprises the epidermis, a fibrous endothecium, one or two ephemeral middle layers and an irregularly 2-layered secretory tapetum. The latter originates from the parietal cells and not the sporogenous cells. Hayashi (1960) noted that in *S. nigra* and *Kadsura japonica* ". . . the tapetal cells are uninucleate at first but soon become binucleate". On the contrary, in *S. grandiflora* the tapetal cells are consistently multinucleate.

Both tetrahedral and decussate types of microspore tetrads are formed. However, Hayashi (1960) records only tetrahedral tetrads in *S. nigra* and *K. japonica*. The quadripartition of the pollen mother cells in *Schisandra* and *Kadsura* occur by cell-plate formation rather than by furrowing as reported in the Magnoliaceae (Padmanabhan, 1960 a).

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of the cells of the inner integument and enlargement of the cells of the outer integument. — Fig. K. Magnified view of portion marked k in Fig. F showing sclerified cells in the mature testa. — Fig. L—N. Isolated sclereids from outer integument. — Fig. O. Portion of nucellus from the micropylar region showing the nucellar cap. — Fig. A ×2, B ×6, C ×36, D, E ×33, F ×5, G—K ×321, L—N ×342, O ×136.

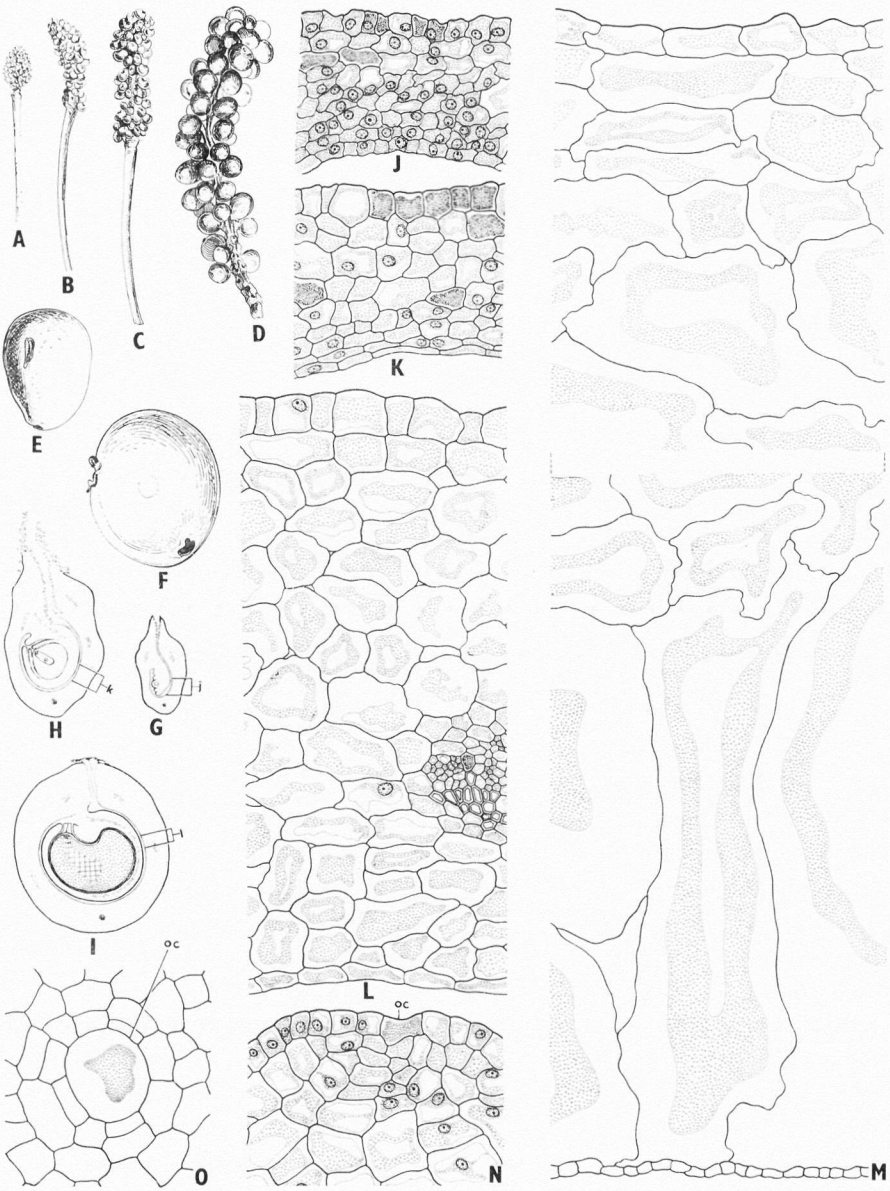

Fig. 8. — *Schisandra.* — (*oc,* oil cell). Fig. A—D. Gynoecia at various stages of postfertilization leading to the development of fruit. — Fig. E, F. Young and mature fruits. — Fig. G—I. Outline diagrams of young and old ovaries cut longitudinally. — Fig. J—L. Magnified portions of pericarp marked j, k and l in Fig. G, H and I respectively to show enlargement of the cells of the pericarp. — Fig. M. Portion of mature pericarp in longisection; note layer of elongated cells above the inner epidermis. — Fig. N. Ethereal oil cell in pericarp. — Fig. O. Same, in surface view. Fig. A—C $\times 1/2$, D $\times 1/5$, E, F $\times 2$, G, H $\times 18$, I $\times 57$, J—L $\times 186$, M $\times 104$, N $\times 156$, O $\times 277$.

The pollen grains are shed at the 2-celled stage. This is in conformity with Hayashi's (1960) observations on *Schisandra nigra*. Erdtman (1960) has shown an interesting coincidence of cytological and morphological features in the Labiatae. This family is characterized, as a rule, by tri- or hexacolpate pollen grains. The former are usually shed at the 2-nucleate stage and the latter at the 3-nucleate. Two-celled, tricolpate pollen grains are also found in the Rubiaceae (Erdtman, 1952), Rhamnaceae (Arora, 1953), Verbenaceae (Padmanabhan, 1960 b), Illiciaceae (Hayashi, 1960) and Ranunculaceae (Kapil & Jalan, 1962). While Erdtman's correlation appears to hold good with regard to the tricolpate pollen grains, there seems to be no constant agreement between the 3-nucleate and hexacolpate pollen grains. Our observations on *Schisandra* indicate that although the pollen grains are hexacolpate, they are shed at the 2-celled stage and not the 3-celled stage.

Female gametophyte: Both in *Schisandra grandiflora* (Present work) and *S. chinensis* (Yoshida, 1962) the embryo sac is of the Polygonum type, a feature also described for the Cercidiphyllaceae (Swamy & Bailey, 1949), Degeneriaceae (Swamy, 1949), Menispermaceae (Sastri, 1954), Magnoliaceae (Padmanabhan, 1960 a), Anonaceae (Periasamy & Swamy, 1961), and Lauraceae (Sastri, 1962) of the order Ranales. However, in *Schisandra* the antipodal nuclei degenerate immediately after their inception and the two polar nuclei fuse very early giving the false impression of a 4-nucleate gametophyte characteristic of the Onagraceae (Maheshwari, 1950). Many instances were observed where two embryo sacs developed in the same ovule. Such supernumerary gametophytes are rare in the ranalian families except in the Lauraceae where Sastri (1962) reports the development of as many as 10 embryo sacs.

An interesting feature during megasporogenesis in *Schisandra grandiflora* is the presence of a special cytoplasmic body in the chalazal portion of the megaspore mother cell, lower dyad cell and the functioning megaspore. Earlier Karsten (1891), Mauritzon (1939), and Venkateswarlu (1939) described a similar body in different species of *Sonneratia*, and Corti (1950) in *Cytisus canariensis*. Much speculation, however, exists regarding its nature and origin. Corti (1950) is of the opinion that it is made up of some substance which enables the cell to undergo meiosis. Its specific position and staining reaction, however, indicate that it could perhaps represent some synthesis of proteins and nucleic acids (Bryan, 1955).

Endosperm and embryo: The endosperm is Cellular and in this respect the genus *Schisandra* resembles several members of the Magnoliaceae. The interval between fertilization and the first division of the zygote varies from 4—5 weeks. Such a postponement of the development of embryo is also known for other ranalian families. In *Magnolia grandiflora* (Earle, 1938) the zygote divides nearly six weeks after fertilization and in the Anonaceae the seed is already mature at the time of first division of the zygote (Corner, 1949).

The earlier divisions in the development of the proembryo are often irregular but the embryogeny conforms essentially to the Onagrad type. Swamy (1949) described many irregularities in the development of the embryo in *Degeneria,* and earlier such a pattern of development was also noted by Earle (1938) in *Magnolia grandiflora* and *Cimicifuga racemosa.* However, the embryogeny of all these plants is now interpreted as conforming to the Onagrad type (Johansen, 1950; Sastri, 1954).

Systematic position

Bentham & Hooker (1862), Hayashi (1960), Engler & Prantl (1889—1897), and Rendle (1952) placed *Schisandra* and its allies in a tribe (Schisandreae) or a subfamily (Schisandroideae) of the Magnoliaceae. Smith (1947), and Bailey & Nast (1948) created a separate family Schisandraceae comprising the genera *Schisandra* and *Kadsura.* This view is also held by Ozenda (1946), Lemesle (1955) and Jalan (1962). A comparison of morphological and embryological features is given in table 2 (for detailed literature citation see Jalan, 1962).

Although some features like (a) the phyllotaxy of the vegetative and floral appendages, (b) structure of the ovule, (c) Polygonum type of embryo sac, (d) Cellular endosperm, and (e) Onagrad type of embryogeny are common to *Schisandra* and the Magnoliaceae, there are significant differences in the structure of flower, stamen, carpel, anther, pollen, seed, and fruit; the number of chromosomes (Whitaker, 1933); and the anatomy of wood (McLaughlin, 1933). It is evident, therefore, that the genus *Schisandra* should be removed from the Magnoliaceae and assigned to a separate family Schisandraceae(see also Jalan, 1962; Kapil, 1962).

On the basis of some resemblances in the structure of the epidermis, phloem, vascular rays, and the number of chromosomes some authors (Whitaker, 1933; Smith, 1947; Baily & Nast, 1948) suggest a close

Tab. 2. Morphological characters of Schisandra and Magnoliaceae.

	Schisandra	Magnoliaceae (*sensu stricto*)
Habit	Woody climber	Trees
Leaf	Alternate, exstipulate, dentate, cuticle striated	Alternate, stipulate, entire, cuticle smooth
Flower	Unisexual, floral parts spirally arranged	Bisexual (rarely unisexual), floral parts spirally arranged
Stamens	Monadelphous	Free
Anthers	Protuberant, sclerenchymatous sheath absent	Imbedded (rarely protuberant), sclerenchymatous sheath present
Tapetum	Secretory, cells multinucleate	Secretory, cells binucleate
Microspore tetrads	Tetrahedral, decussate	Isobilateral, tetrahedral
Pollen	Hexacolpate, exine reticulate	Monocolpate, exine smooth
Carpel	Ovary bilocular with one ovule in each locule, stigma lateral	Ovary unilocular, bi- or multiovulate, stigma terminal
Ovule	Anatropous, bitegminal, crassinucellar, integumentary bundles present	Anatropous, bitegminal, crassinucellar, integumentary bundles present
Embryo sac	Polygonum type	Polygonum type
Endosperm	Cellular	Cellular
Embryo	Onagrad type	Onagrad type
Seed	Albuminous, testa undifferentiated and sclerotic	Albuminous, testa differentiated into fleshy and sclerotic layers
Fruit	Berry with a succulent pericarp	Follicle or capsule with a sclerotic pericarp

Tab. 3. Morphological characters of the Schisandraceae and Illiciaceae.

	Schisandraceae (*sensu stricto*)	Illiciaceae (*sensu stricto*)
Habit	Climbers	Shrubs or small trees
Stem	Eustelic, pericycle well developed, a vesselless zone present in the xylem	Pseudosiphonostelic, pericycle poorly developed, vesselless zone absent
Node	Three-traced, unilacunar	Single-traced, unilacunar
Leaf	Alternate, thin	Pseudoverticillate, leathery
Stomata	Haplocheilic	Syndetocheilic
Sclereids	Non-pitted, crystals present	Pitted, crystals absent
Flowers	Unisexual, torus short	Bisexual, torus protruded
Carpels	Spirally disposed, styleless, ovary bilocular	Whorled, with a style, ovary unilocular
Stamens	Monadelphous	Free
Pollen	Heteropolar, hexacolpate	Isopolar, tricolpate
Embryo sac	Polygonum type	Polygonum type
Endosperm	Cellular	Cellular
Embryogeny	Onagrad type	Asterad type
Seeds	Reniform with a lateral hilum	Ellipsoid, hilum sub-basal
Fruit	Berry with a succulent pericarp	Follicle with a sclerotic pericarp

alliance of the Schisandraceae with the Illiciaceae. However, the totality of characters does not support this view as shown in table 3 (for literature see Earle, 1941; Jalan, 1962).

Thus, in several characters pertaining to the vegetative and floral morphology; anatomy of stem, node, leaf; structure of carpels, stamens, pollen grains; development of the embryo; and the morphology of the seeds and fruits, the Schisandraceae and Illiciaceae deviate considerably and there seems to be no near relationship between them.

Summary

The flowers of *Schisandra* are solitary and are borne in the axils of leaves. They are actinomorphic, bracteate, and unisexual containing three series of 9—12 tepals. The floral appendages are spirally arranged on the elongated receptacle. The male flowers contain 30—35 stamens having protuberant anther lobes. The carpels vary from 25—30 in each flower, and are characterized by papillose stigmatic crests along the ventral side.

The anther is bilobed. Its wall consists of the epidermis, 1- or 2-layered fibrous endothecium, two ephemeral middle layers, and a multinucleate secretory tapetum. The microspore tetrads are tetrahedral or decussate. The pollen grains are hexacolpate with a reticulate exine. They are shed at the 2-celled stage.

The ovules are anatropous, bitegminal and crassinucellar. Both the integuments take part in the formation of the micropyle. The primary parietal cell and the nucellar epidermis divide to form a thick parietal tissue. The archesporium is 1- or 2-celled. The megaspore triads are linear. A cytoplasmic body is seen during megasporogenesis in the chalazal portion of the megaspore mother cell, lower dyad cell and the functioning megaspore. The development of the embryo sac is of the Polygonum type. Supernumerary embryo sacs may also develop.

The endosperm is *ab initio* Cellular. The first division of the primary endosperm nucleus is transverse. At maturity the endosperm forms a compact mass of cells which are rich in food materials like starch and oil globules.

The zygote divides by a transverse wall and the apical cell takes a major part in the formation of the embryo. The mature embryo is dicotyledonous.

The seeds are reddish-brown and kidney-shaped with a crustaceous testa. The cells of the outer epidermis and the two subepidermal layers become sclerenchymatous to form the stony part of the seed coat. The inner integument is completely crushed and destroyed.

The fruit consists of numerous berries, each of which is dark purple, globose and contains two seeds. The ovary wall is pulpy and consists of 10—12 layers of enlarged and elongated cells.

On the basis of embryology it is confirmed that the genus *Schisandra* should be excluded from the Magnoliaceae and assigned to a separate family, the Schisandraceae. Moreover, the Schisandraceae do not seem to be closely related to the Illiciaceae.

Acknowledgements

We are grateful to Professor P. Maheshwari for guidance and encouragement, to Drs M. R. Vijayaraghavan and N. N. Bhandari for helpful suggestions, and to Dr M. A. Rau for sending some material used in this investigation. Thanks are also due to the National Institute of Sciences of India, and the Council of Scientific and Industrial Research, New Delhi, for awarding Senior Post-doctoral Research Fellowships to the authors.

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Botaniska Notiser 1964 · Vol. 117 · Fasc. 3 · Lund

Einige Bemerkungen über das Vorkommen von Brennhaaren im Pflanzenreich

Von H. Hjelmqvist

(Meddelande från Lunds Botaniska Museum, Nr 189)

Während in älterer Zeit der Bau und die Funktion der pflanzlichen Brennhaare von mehreren Forschern eingehend untersucht wurden, hat in den letzten Jahrzehnten die Forschung sich mehr für die physiologischen Wirkungen der Brennhaare interessiert, insbesondere für ihre Bedeutung als Hautkrankheitserreger. Dabei sind zu den Fällen, die seit alters her als Beispiele von Brennhaaren bekannt sind, einige weitere Familien und Gattungen gelegt worden, wo Brennhaare auch vorkommen sollen. Ausser den vier Familien, die seit langem für das Vorkommen von Brennhaaren bekannt sind — Urticaceae, Euphorbiaceae, Loasaceae und Hydrophyllaceae —, werden also solche auch für die Familie Leguminosae (die Gattung *Mucuna*), Lythraceae (*Cuphea*), Malpighiaceae (*Malpighia*) und Malvaceae (*Malachra*) angegeben oder vermutet. Diese Fälle werden hier etwas besprochen werden.

Gattungen wo das Vorkommen von Brennhaaren fraglich ist

1. *Cuphea* (Lythraceae)

Von der Art *Cuphea urens* Koehne wird angegeben (Pardo-Castello 1923), dass sie Dermatitis verursacht. In der Beschreibung der Art schreibt Koehne (1903, S. 117), dass nach Angabe des Einsammlers die Stämme und Zweige mit Brennborsten („setulis urentibus") versehen sind, eine Angabe, die auch von anderen Verfassern wiederholt wird.

Eine Untersuchung einer Kollekte der Art von Haiti (Massif de la Selle, coll. E. L. Ekman 1924, det. O. C. Schmidt, Herb. Stockh.) zeigt, dass an Stämmen und Blättern drei verschiedene Typen von

Haarbildungen vorhanden sind, teils grosse vielzellige Drüsenhaare, teils ganz kleine Haare, aus einer einfachen Zellenreihe von wenigen Zellen bestehend, teils endlich kräftig gebaute Haare, in der Grösse intermediär zwischen den beiden anderen Typen. Die letzteren (Fig. 1 *a*) sind scharf zugespitzt, gerade oder etwas gebogen, und haben stark verdickte Wände. Die Oberfläche ist uneben von zahlreichen Höckern, ausser an der Haarspitze, die ganz glatt ist. Diejenigen Haare von diesem Typus, die am Blattrande sitzen, sind dem Rande schief angewachsen und vorwärts gerichtet. Ohne Zweifel sind diese Haare die bei Berührung irritierenden, wegen ihrer scharfen Spitze und rauhen Oberfläche. Ihre Wirkung ist indessen rein mechanisch; sie öffnen sich nicht und können keine chemische Einwirkung durch ihren Inhalt haben, was für ein eigentliches Brennhaar kennzeichnend ist. Sie können also nicht zu den Brennhaaren gezählt werden.

2. *Mucuna* (Leguminosae)

Einige Arten der Leguminosen-Gattung *Mucuna* haben an der Hülse ein dichtes Haarkleid von langen stechenden und irritierenden Haaren. Zu diesen gehört die Schlingpflanze *M. pruriens* aus tropischem Amerika, Afrika und Asien (in Afrika Hell Fire Bean genannt), ferner z.B. *M. stans* aus Afrika und *M. gigantea* aus Indien, Australien und Polynesien. Nach Pardo-Castello (1923) wird von *Mucuna pruriens* eine Dermatitis verursacht, die angeblich ohne Berührung entstehen kann, nur wenn man in der Nähe der Pflanze sich befindet, dadurch dass Haare von den Früchten herabwehen. Besonders schwer werden nach demselben Verfasser die Arbeiter angegriffen, die in den Zuckerrohrplantagen arbeiten und dabei in die Dickichte von *Mucuna*-Pflanzen eindringen müssen. Von verschiedenen Verfassern, auch solchen aus späterer Zeit, wie Rao und Sundararaj (1951), wird die Wirkung der Haare als nur rein mechanisch angesehen; dagegen spricht doch die lange Dauer der Wirkung, die zuweilen mehrere Stunden beträgt (Pardo-Castello, a.a.O.), wie auch, dass zuweilen krampfartige Zustände entstehen können (v. d. Pijl 1928). Mit Rücksicht auf die Wirkungen und darauf, dass der Inhalt der Haare ölartig, ähnlich dem Inhalt anderer Brennhaare ist, ist Pardo-Castello der Meinung, dass die Haare hauptsächlich chemisch reizend sind und also wirkliche Brennhaare vorstellen. Eine genaue Untersuchung wurde von v. d. Pijl (1928) gemacht, die jedoch wegen der Publizierung (in holländisch in einer auf Java herausgegebenen Zeitschrift) wenig beachtet zu sein scheint. Nach

v. d. Pijl hatten Haare, die altem Herbarmaterial entstammten, ihre irritierende Wirkung verloren, sie wirkten nur stechend, obwohl sie ganz intakt waren. Dasselbe galt von frischen Haaren, die auf za. 100° erwärmt wurden. Ein intaktes Haar, in die Haut gesteckt, wirkte nur mechanisch wie ein Stich, aber wenn durch kräftige Bewegung oder Zurückziehen des Haares die Spitze abgebrochen wurde, war ein juckendes Gefühl bemerkbar. Offenbar handelt es sich also nicht um eine rein mechanische Wirkung, sondern der Haarinhalt ist auch chemisch wirksam, es ist also ein wahres Brennhaar. Nach der Ansicht von v. d. Pijl sind im anatomischen Bau des Haares keine Eigenschaften vorhanden, welche die Natur eines Brennhaares andeuten; nur für das Loslassen des Haares ist an der Basis eine Verdünnung der Zellwand bemerkbar. Dies ist natürlich wahr, insofern dass keine so vollendeten Anordnungen wie bei den Nesselhaaren vorhanden sind, aber es ist doch hervorzuheben, dass die Wand des Haares im oberen Teil verhältnismässig dünn ist (s. besonders Fig. 1 *c*), während darunter eine starke Wandverdickung bemerkbar ist. Dies ist ja das Gegenteil von dem, was man von einer mechanisch wirksamen Haarspitze zu erwarten hat, und bildet gewissermassen eine Parallele zu den Verhältnissen bei den Haaren vom *Urtica*-Typus, wo unter dem „Köpfchen" eine dünne Wandpartie an der einen oder an beiden Seiten vorhanden ist, wo das Haar abbricht, während weiter unten die Wand verdickt ist. Der Unterschied ist der, dass bei *Mucuna* das Haar mehr unregelmässig abbricht und dass dies offenbar oft erst dann geschieht, wenn das Haar zurückgezogen wird und die Spitze durch die oft widerhakenähnlichen Höcker an der Oberfläche festgehalten wird. Ohne Zweifel sind die Haare an der *Mucuna*-Frucht indessen als wahre Brennhaare zu bezeichnen.

3. *Malpighia* (Malpighiaceae)

Bei mehreren Arten der Gattung *Malpighia* kommen Haare vor, die in der englischen Literatur als „stinging hairs" bezeichnet werden. Dies ist die gewöhnliche Benennung für Brennhaare, aber der Begriff „stinging hairs" ist offenbar etwas weiter und dürfte auch mechanisch stechende Haare umfassen können. Eine der Arten wird indessen „*urens*", brennend, genannt, und sie soll nach Pardo-Castello Dermatitis verursachen können. Es liegt also ein Grund vor, zu untersuchen, ob wir hier wirkliche Brennhaare haben.

Die Haare kommen ausser bei *Malpighia urens* bei einer Reihe ande-

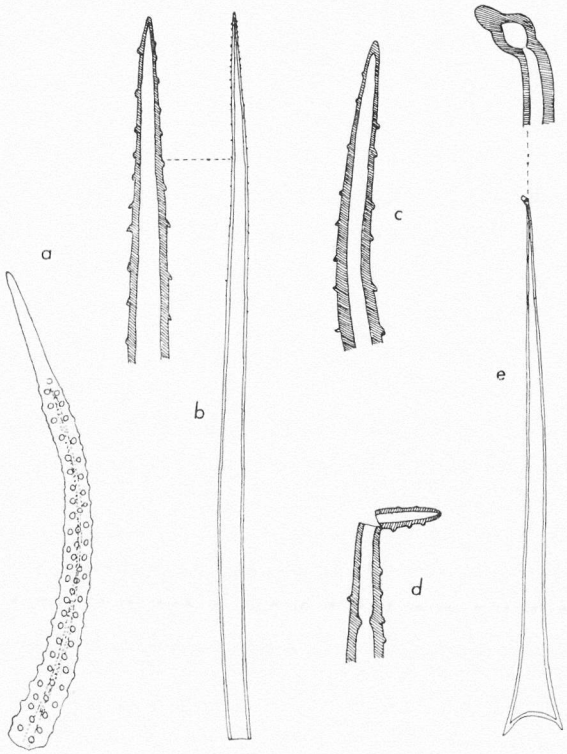

Fig. 1. *a* Haar von *Cuphea urens*. *b* Brennhaar einer Hülse von *Mucuna pruriens* mit der Spitze in stärkerer Vergrösserung. *c*—*d* Zwei Brennhaarspitzen von *Mucuna pruriens* in starker Vergrösserung, die eine abgebrochen. *e* Brennhaar eines Blattes von *Fleurya aestuans*, oben die Spitze bei stärkerer Vergrösserung. — *a* ×220, *b* und *e* (die Hauptfiguren) ×58.

rer Arten vor: unter den auf Jamaica vorkommenden Arten sind also nach Fawcett und Rendle (1920) *Malpighia fucata, incana, biflora* und *urens* mit „stinging hairs" versehen, dasselbe gilt nach Britton und Millspaugh (1920) für die Art *M. polytricha* auf den Bahama-Inseln. Die fraglichen Haare sind zweischenkelig mit kurzem Stiel („Malpighische Haare", Netolitzky 1932), und die Schenkel sind in der Längsrichtung des Blattes orientiert. Sie sind teils am Blattrand, teils an der unteren Oberfläche befestigt. Bei Berührung dringt eine der scharfen Spitzen, die verkieselt sind (Keller 1890) in die Haut ein, und der Stiel bricht ab. Im Mikroskop zeigt sich, dass die Haare ganz glatte Oberflächen haben und dass die Wand gleichmässig verdickt ist, ohne jede Öffnungsanordnung. Ohne Zweifel wirken diese Haare nur rein mechanisch; sie sind folglich keine eigentlichen Brennhaare.

4. *Malachra* (Malvaceae)

Ungefähr dasselbe wie von *Malpighia* gilt von *Malachra urens*. Für diese in Mittelamerika heimische Art wird auch angegeben, dass sie

„stinging hairs" hat und eine Ursache von Dermatitis sein kann, und der Artname deutet auch auf die Auffassung, dass sie brennende Haare hat. Die Haare sind aber auch hier ohne Zweifel nur mechanisch wirksam. Sie sind hier sehr lang, gerade, scharf gespitzt, mit einer Wandverdickung, die besonders gegen die Spitze sehr stark ist, so dass das Lumen beinahe schwindet. Keine präformierte Öffnungsstelle ist vorhanden. Der Bau ist also derjenige der für Stechhaare, nicht für Brennhaare charakteristisch ist.

Übersicht über die bekannten Fälle von Brennhaaren

Nach der vorstehenden Erörterung dürfte es geeignet sein, eine kleine Übersicht über die Familien und Gattungen zu geben, wo Brennhaare bekannt sind, was vielleicht für die Forscher nützlich sein kann, die sich mit ihren physiologischen Wirkungen beschäftigen wollen.

Urticaceae. Seit alters her ist es bekannt, dass Brennhaare in den Gattungen *Urtica* (hauptsächlich gemässigte Zonen der ganzen Erde) und *Laportea* (Tropen der alten Welt, N. Am.) vorkommen, sowie in *Girardinia* (Trop. Afr. u. As.) und *Urera* (Trop. Am. u. Afr., Pazif. Inselwelt). Die beiden ersten Gattungen sind in Bezug auf die Brennhaare u.a. von Haberlandt (1886) untersucht worden, während *Girardinia* von Rouppert (1915) und *Urera* von Besecke (1909) speziell studiert wurden. Andere Gattungen, wo Brennhaare nach verschiedenen Autoren auftreten, sind *Fleurya* (Tropen, S. Afr.), *Hesperocnide* (N. Am., Sandwich-Inseln), *Nanocnide* (O. As.), *Obetia* (Madagascar, Réunion), *Sceptrocnide* (Japan), und *Gyrotaenia* (Mittelamerika). Eine gewisse Variation kommt jedoch innerhalb dieser Gattungen vor: während einige Arten Brennhaare haben, können sie bei anderen fehlen, und auch innerhalb derselben Art können Formen mit und ohne Brennhaare auftreten, so bekanntlich z.B. bei *Urtica dioica*.

In allen Gattungen, die untersucht worden sind, sind die Brennhaare von dem für *Urtica* typischen Bau mit oben verkieselter Wand und an der Spitze mit einem rundlichen Köpfchen, das leicht abbricht, so dass eine Öffnung zum Kanal des Haares hergestellt wird. Für die Gattung *Fleurya* ist angegeben worden, dass die Brennhaare von anderem Bau sind, gerade und konisch zugespitzt. Dies ist jedoch wahrscheinlich darauf zurückzuführen, dass man Haare mit abgebrochener Spitze oder die kürzeren Haare, die neben den Brennhaaren vorhanden sind, untersucht hat. Wie von Fig. 1 *e* gezeigt wird, ist der Bau der

eigentlichen Brennhaare, wenn sie intakt sind, von typischem Aussehen, mit einem kleinen, schiefen Köpfchen an der Spitze; dieses wird bei Berührung leicht abgebrochen.

Der wirksame Bestandteil im Gift der Nesseln ist nach Untersuchungen von Emmelin u. Feldberg (1947, 1949) von *Urtica dioica* und *U. urens* ein Histamin und ein Azetylcholin, während ein dritter, nicht näher spezifizierter Stoff möglicherweise verstärkend wirken kann. Dieser dritte Stoff ist später als 5-Hydroxytryptamin identifiziert worden (Collier u. Chesher 1956). Eine Untersuchung von Pilgrim (1959) von der neu-zeeländischen *Urtica ferox* gab ein etwas abweichendes Ergebnis: ausser Azetylcholin wird ein komplexer Stoff von der Guanidin-Gruppe als wahrscheinlich wirksam angesehen. Ob die kräftige Wirkung, die für einige *Laportea*-Arten charakteristisch ist — nach Gagnepain (1928, 1929) ist es für Kinder mit Lebensgefahr verbunden, mit der hinterindischen *L. urentissima* in Berührung zu kommen —, auf eine andere Zusammensetzung des Giftes oder nur auf stärkere Konzentration desselben zurückzuführen ist, scheint nicht untersucht worden zu sein.

Loasaceae. Innerhalb der Familie Loasaceae kommen Brennhaare bei Arten der Gattungen *Loasa* (S. Am.—Mex.), *Blumenbachia* (S. Am.), *Cajophora* (S. Am.), *Eucnide* (N. Am.), *Gronovia* (N. Am. u. nördl. S. Am.), *Cevallia* (N. Am.) und *Fuertesia* (Mittelam.) vor. In seiner Monographie über Loasaceae gibt ferner Urban an (1900), dass die Gattung *Sympetaleia* (Kaliforn., Sonora) Brennhaare besitzt. Dies ist jedoch nach späteren Angaben nicht zutreffend; Shreve und Wiggins (1964) sagen von der Gattung: „Stinging hairs absent".

Der Bau der Brennhaare ist nach den Untersuchungen von Haberlandt (1886), Greinert (1886), Winkelmann-Küster (1914) u.a. von demselben Typ wie die Urticaceen-Haare, doch mit etwas grösserer Variation, zwischen schiefen und symmetrischen Haaren, solchen mit und ohne Köpfchen usw. Nach den Angaben von Urban (1911) zu urteilen, hat *Fuertesia* verzweigte Brennhaare. Die Wirkungen des Giftes sind in einigen Fällen ungefähr mit denen der europäischen Nesseln vergleichbar, bei manchen Arten sind sie aber grösser und auch lange andauernd (Greinert, a.a.O., Flury 1927, Touton 1932); nach Flury (1927) gehört die wirksame Substanz wahrscheinlich zu derselben chemischen und pharmakologischen Gruppe wie bei den Nesseln.

Euphorbiaceae. Bei mehreren Gattungen von Euphorbiaceae sind Brennhaare bekannt; in einigen Fällen finden sie sich besonders zahlreich

an der Frucht oder überhaupt in der Blütenregion. Die Gattungen sind: *Jatropha* (Trop. Am., Afr., As.), *Tragia* (Am., Afr., As., Austr.), *Dalechampia* (Trop. Am., Afr., As.), *Platygyne* und *Acidoton* (beide Mittelamerika), *Cnesmone* und *Cenesmon* (beide O. As.), *Pachystylidium* (Java, Philipp.), *Tragiella* (O. u. S. Afr.) und *Sphaerostylis* (Madag., Malaya).

Die Brennhaare der Euphorbiaceen sind von zwei verschiedenen Typen. Der eine, der bei *Jatropha* vorkommt und schon von Haberlandt (1886) nachgewiesen wurde, stimmt mit dem allgemeinen Bau der Urticaceen-Brennhaare überein. Der zweite Typus wurde von Rittershausen (1892) und Knoll (1905) für die Gattungen *Tragia, Dalechampia* und *Cnesmone* beschrieben; Rao und Sundararaj (1951) haben auch die Verhältnisse bei *Tragia* studiert. Das Haar hat bei diesen Gattungen kein „Köpfchen", sondern ist zugespitzt und gerade, und die zentrale Zelle (nach Knoll ist es nur eine), die das Gift enthält, hat im oberen Teil einen spitzen Kristall von Kalziumoxalat, der bei Berührung durch die dünne Zellwand des Haares in die Haut des berührenden Menschen oder Tieres eindringt, wobei sich das Gift in die Wunde entleert. Die Wirkungen sind zuweilen schwach: Bei einigen *Dalechampia*-Arten sind sie überhaupt nicht für die menschliche Haut wahrnehmbar, während andere Arten der Gattung auch im getrockneten Zustand irritierend wirken (Pax u. Hoffmann 1919).

Hydrophyllaceae. In der Familie Hydrophyllaceae kommen Brennhaare nur bei einer Gattung, *Wigandia,* vor, und zwar bei der Art *Wigandia urens* aus Südamerika. Sie wurden schon von Haberlandt studiert (1886), der feststellen konnte, dass alle Übergänge vorhanden waren zwischen Haaren, die fein zugespitzt sind, zu solchen, die ein dem Urticaceen-Typus ähnliches Köpfchen besitzen, das jedoch dem Haar gerade aufsitzt; die Konstruktion ist also dem Urticaceen-Typus am nächsten aber nicht so vollkommen ausgebildet wie in dieser Familie.

Zu diesen Familien soll also auch die Familie Leguminosae mit der Gattung *Mucuna* gelegt werden.

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Botaniska Notiser 1964 · Vol. 117 · Fasc. 3 · Lund

Acanthophyllum xanthoporphyranthum sp. nov. from W. Afghanistan

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Abstract

The new species *A. xanthoporphyranthum* is described from W. Afghanistan. It is placed in the section *Macrodonta* Boiss. together with the previously described *A. pulcherrimum* Hedge et Wendelbo.

In a recent paper (Hedge and Wendelbo 1964, 23) we described *Acanthophyllum pulcherrimum* from Afghanistan. It was considered to be a very distinct and rather isolated species because of its one-flowered inflorescence and the brownish-orange and purple colours of its corolla. We refrained from placing the new species in any section. The new species described here is closely related to *A. pulcherrimum*. It came to light when the botanical collections made by the late Dr. Lindberg of Lund in Afghanistan in 1962 were being worked over by Dr. K. H. Rechinger at the Naturhistorisches Museum in Vienna. We are indebted to Dr. Rechinger for pointing out the novelty to us.

Acanthophyllum xanthoporphyranthum Hedge et Wendelbo, sp. nov.

Sect. *Macrodonta* Boiss.

Fruticulum ubique breviter puberulum pulvinos densos c. 30 cm altos efficiens. *Rami* erecti compressi internodiis c. 0.5—1.2 mm longis. *Folia* patentia vel adscendentia, ad 12 mm longa, prope basin c. 0.7 mm lata, linearia-subulata nervo medio crasso, rigidula, spinula pallida glabra terminata. *Flores* terminales solitarii, subsessiles, basi squamis 6—8 imbricatis bracteatis. *Bracteae* ellipticae, concavae, virides, late hyalino-marginatae in spinulam terminatae, ad calcycem adpressae; infimae c. 4.5 mm longae, superiores c. 6.5 mm longae. *Calyx* c. 15 mm longus, tubulosus, nervis in sicco 5 conspicuis, in dentes anguste ovatos inaequilongos 5—6 mm longos, hyalino-marginatos, spinulosos,

Fig. 1. *Acanthophyllum xanthoporphyranthum* sp. nov. (Lindberg 52/1962). Branch (nat. size), flower with calyx and bracts (×3), petal (×3). Miranda Bødtker del.

fissus. *Petala* c. 27 mm longa; lamina c. 7×3.3 mm, elliptica, obtusa, aurea (in sicco); unguis c. 0.75 mm latus, anguste bilamellatus, aureus purpureo suffusus. *Stamina* 10 filamentis filiformibus, c. 23 mm longis, purpureis; antherae c. 1.2 mm longae, late oblongae, albae. *Ovarium* obovoideum, membranaceum, 4-ovulatum, breviter pedicellatum. *Styli* duo, filiformes, parce inaequales, c. 25 mm longi, purpurei. *Capsula* ignota. Floret Junio.

Afghanistan. Herat: Obeh, 12. June 1962 (Lindberg 52/1962 holotype W, isotypes BG and E).

The new species is undoubtedly closely related to *A. pulcherrimum*, but differs from it in several important features.

	A. xanthoporphyranthum	*A. pulcherrimum*
Leaves	8—12 mm	4—5 mm
Bracts	elliptic, acute, apex adpressed	narrowly ovate, acuminate, apex somewhat recurved
Lower bracts	4.5 mm	6.5 mm
Uppermost bracts	6.5 mm	9 mm
Calyx	15 mm	17—18 mm
Calyx lobes	5—6 mm, narrowly ovate, green	9—10 mm, narrowly triangular, suffused with purple
Petals	27 mm	32 mm

As regards the taxonomic position of the two species we have decided to place them in sect. *Macrodonta* Boiss. which originally only included *A. grandiflorum* Stocks — another Afghanistan species. Other than the differences in flower colour — orange in contrast to rosy-pink — and the shorter broader claws in the petals of *A. grandiflorum,* there are no important differences between them. *A. pulcherrimum* also has 6 bracts below the flower (not 4 as stated in the original description). They share the features of single-flowered and very brittle inflorescences. Usually, in all 3 species the inflorescence breaks off below the upper pairs of the bracts — i.e. leaving 4 bracts on the pedicel (all 3 species have 6(—8) bracts).

Acanthophyllum sect. ***Macrodonta*** Boiss.

Three (or four) species in Afghanistan and Baluchistan.

Corolla purple or rose ..... 1. *A. grandiflorum* Stocks (syn.: *A. fissicalyx* Rech. f.)

Corolla ± orange, suffused purplish on the claws

Calyx lobes 5—6 mm long, narrowly ovate; leaves 8—12 mm long
2. *A. xanthoporphyranthum* Hedge et Wendelbo

Calyx lobes 9—10 mm long, narrowly triangular; leaves 4—5 mm long
3. *A. pulcherrimum* Hedge et Wendelbo

Gilli (1956, 166) redescribed *A. grandiflorum* Stocks and stated that it was a very variable species. He included in it *A. macrodon* Edgew. (1874, 216). Using the emended description we are not able to find any distinctive character that separates *A. fissicalyx* Rech. fil. (1957, 174), although this plant was collected at about 1000 m whereas all the collections of *A. grandiflorum* mentioned by Gilli are from above 2300 m.

We also described *A. longicalyx* as one-flowered but added in a note that it might be 2-flowered (Hedge et Wendelbo 1964, 29). As may be seen from fig. 20 D and I the ovary of this species differs from that of the species of sect. *Macrodonta.* We have therefore still hesitated to place *A. longicalyx* in section *Macrodonta.*

Literature

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Rechinger, K. H.: Caryophyllaceae novae afghanicae. — Öster. Bot. Zeitschr. 104: 173—174; 1957.

Litteratur

H. G. Burström och Camilla Odhnoff: *Vegetative Anatomy of Plants.* — Svenska Bokförlaget/Bonniers. Stockholm 1964. 8+149 sid., bil. 9 sid.

Boken omfattar ungefär vad som genomgås på 2-betygskurserna i växtanatomi vid Lunds Universitet. Inledningsvis ges en kort översikt över växtanatomins historia, och begreppen onto- resp. fylogenetisk definieras. Förff. fastslår sin avsikt att koncentrera sig på den ontogenetiska linjen.

I bokens huvuddel behandlas helt naturligt först växtcellens allmänna byggnad, den moderna uppfattningen om plasmastrukturen och om cellväggens byggnad. Kanske onödigt utförligt uppräknas även sällsynta kemiska beståndsdelar och arter där dessa förekommer.

Spermatofyternas allmänna byggnad ägnas ett kapitel, vari behandlas de olika cellformerna och deras förekomst i epidermis, grundvävnad och stele. Trots att den ontogenetiska utvecklingen av rot, stam och blad hos mono- och dikotyledoner har erhållit det mesta utrymmet, har dock även de fylogenetiska linjerna något berörts. Olika växtgrupper fr.o.m. svampar och alger jämföres i fr. om vävnadsdifferentiering, meristemtyper m.m.

Det sista, och relativt stora, kapitlet behandlar den ekologiska anatomin. Huvudsakligen beskrives anatomiska effekter av ståndorternas vatten- och ljusförhållanden, men exempel på anatomiska egenheter hos lagringsorgan, parasiter och symbionter avslutar framställningen. Förff. betonar att ekologiska specialiseringar många gånger uppstår genom kraftig utveckling av någon ärftlig karaktär, som är typisk för en hel taxonomisk grupp. De påpekar också, att den fysiologiska funktionen av anatomiska särdrag ofta är okänd.

Texten är lättläst och belyses av talrika illustrationer, som mestadels består av goda fotografier av preparat och planscher som användes i kursundervisningen. Möjligen skulle den som på egen hand vill lära sig växtanatomi önska fler schematiska bilder. Ett värdefullt supplement utgör den lista över anatomiska termer, som anger var i texten termernas definitioner kan slås upp.

K. Lexander

G. Erdtman, J. Praglowski and S. Nilsson: *An Introduction to a Scandinavian Pollen Flora. II.* Almqvist & Wiksell, Uppsala 1963. 89 s., 59 planscher. Pris inb. 46: —.

Palynologiska laboratoriet i Solna presenterar en fortsättning på »An Introduction to a Scandinavian Pollen Flora» utgiven av samma förlag 1961.

Boken består av tre kapitel. Det första behandlar pollenmorfologin hos svenska träd och buskar och är skrivet av assistenten vid Palynologiska laboratoriet J. Praglowski (tidigare publicerat i Grana Palynologica 3: 2, Uppsala 1962). Det innehåller utförliga diagnoser jämte utomordentligt detaljrika fotografier. Främst de senare är av stort värde för pollenanalytiker och kanske även för cytotaxonomer. Inför arturvalet kan man möjligen ställa sig frågande. De extraskandinaviska släktena *Casuarina* och *Ostrya* finns beskrivna, medan *Rhamnus, Rubus, Viburnum* m.fl. ej är omnämnda.

Den väsentligaste nyheten i boken är en bestämningsnyckel för pollen och sporer av arter tillhörande den skandinaviska kärlväxtfloran. Detta synnerligen mödosamma arbete har utförts av J. Praglowski och assistent S. Nilsson. Huvudnyckeln grundar sig på den s.k. NPC-klassifikationen (tidigare presenterad bl.a. i Erdtman: Introduktion till palynologin. Stockholm 1963). Den är enkel och logisk. Varje kombination av antal, läge och karaktär av aperturer hos ett pollenkorn eller en spor motsvaras av en sifferkod jämte beskrivande term. Tyvärr är termerna ofta krångliga, och det är svårt att finna större fördelar hos NPC-klassifikationen jämfört med andra system. Flera skisser belyser dock termernas innebörd. Redan i förordet omtalas, att nyckeln behandlar 1200 arter av 460 släkten. Emellertid är detta stora antal en nackdel för nyckelns användbarhet. Här förutsätts att den är avsedd främst för identifiering av fossila pollen och sporer i senkvartära lagerföljder. Man har bland annat tagit hänsyn till många arter, vilkas pollen knappast kan påträffas fossilt (ex. arter inom Orchidaceae). Vidare kunde flera stora familjer med fördel ha brutits ut och behandlats i specialnycklar, ex. Caryophyllaceae, Umbelliferae, Cruciferae. Det stora artantalet belastar nyckeln och minskar överskådligheten. Denna är ändå dålig, eftersom indragning av texten från vänsterkanten ej förekommer. Tekniskt är detta omöjligt, då någon sektionsindelning av NPC-grupperna ej förekommer. Som exempel kan nämnas gruppen tricolporata pollen, som beskrives i en oavbruten nyckel på nio sidor (med användning av hela alfabetet, både med små och stora bokstäver). Här kunde man med lätthet skilt tetrader från monader samt uppdelat de senare i sektionerna reticulata, striata, spinulata etc. Det är med andra ord mycket svårt och tidsödande att hitta rätt i denna bestämningsnyckel. Tyvärr kan denna ej bli till stor hjälp för pollenanalytiker. Vad som står i Praglowskis förord bör understrykas: »Keys can be useful, particularly in elementary studies, but they may also be confusing and cause unforeseen complications.»

I det avslutande kapitlet redogör assistenten vid Riksmuseets paleobotaniska avdelning K. E. Samuelsson för tekniken vid mikrofotografering av pollen och sporer. Detta värdefulla kapitel har tidigare publicerats på svenska i Erdtman: Introduktion till palynologin.

BJÖRN E. BERGLUND

Proceedings of the Second Flora Europaea Symposium. — Webbia, vol. 18, 1963. 562 s.

Vid det symposium, som 1961 hölls i Genua av Flora Europaea-organisationen, förelåg ett antal rapporter från olika deltagare om den taxonomiska och floristiska verksamheten i deras respektive länder efter år 1945. Dessa redo-

görelser har i något omarbetad och utvidgad form publicerats i en specialvolym av tidskriften Webbia, där de utgör huvuddelen. De olika rapporterna är i huvudsak utformade efter samma mönster och innehåller uppgifter om taxonomiska och floristiska arbeten, om nybeskrivna taxa och för området nya sådana, om cytotaxonomiska undersökningar o.s.v. En utförlig bibliografi är bifogad till varje rapport. Givetvis varierar uppläggningen något mellan de olika bidragen: somliga är mycket utförliga, andra består huvudsakligen av en bibliografi. För Sveriges del har Nils Hylander skrivit en utförlig och detaljerad redogörelse, där det floristiska och taxonomiska arbetet belyses från alla tänkbara aspekter. Storbritannien och Irland behandlas av D. H. Kent i två artiklar, vilka tydligt visar forskningens livaktighet i dessa områden. Bland nya taxa från England är bl.a. fyra *Salicornia*-arter; nyfunna arter är t.ex. *Koenigia islandica* och *Diapensia lapponica* i Storbritannien, *Hypericum canadense* och *Arenaria norvegica* på Irland. En mycket utförlig redogörelse lämnas från Ryssland av Schischkin och Fedorov; i samband med det stora floraarbetet »Flora URSS» och en rad lokalfloror har talrika nya arter upp-ställts. Från Grekland (K. H. Rechinger) och Spanien (Heywood och Ball) anges också ett avsevärt antal nybeskrivna arter, givetvis ej blott beroende på intensiv forskning utan också på att det här är relativt jungfrulig mark, i jämförelse t.ex. med Nordeuropa. I andra områden är de nya arterna till stor del microspecies av kritiska släkten, som *Taraxacum* (särskilt i Finland), *Ranunculus* (Tyskland, Finland), *Alchemilla* (Polen), *Rubus* (Rumänien) och *Sorbus* (Tyskland).

För den som vill lära känna forskningens senaste framsteg och nuvarande ställning på det aktuella området i olika europeiska länder är arbetet en värdefull uppslagsbok.

H. HJELMQVIST

Katalog över växterna i Göteborgs Botaniska Trädgård 1962. 191 s. — Göteborg 1963.

Sällskapet D.B.V:s botaniska trädgård, Visby. Av I. NORDIN. 69 sid. Visby 1964.

Under professor Bertil Lindquists ledning har under senare år utarbetats en förteckning över växtbeståndet i Göteborgs Botaniska Trädgård, vilken omfattar fleråriga växter, som varit i odling under 1962. Därtill har fogats en lista över vilda och förvildade växter i naturpark och ytterområde. Förteckningen över de odlade växterna har reviderats av C. Blom, och listan över de vilda växterna har sammanställts av O. Olsson och Å. Strid (för högre växter), Elsa Nyholm och A. Crundwell (mossor), G. Degelius (lavar), F. Karlvall, J. Erikson och A. Munk (svampar) samt T. Flensburg (alger).

Huvuddelen av katalogen utgöres naturligtvis av förteckningen över de odlade arterna. Det är ett imponerande antal som har sammanbragts; ca 10.000 arter finns i odling, vida mer än t.ex. i Lunds Botaniska Trädgård. Det grundläggande arbetet på att sammanbringa detta stora bestånd är givetvis utfört av Carl Skottsberg, trädgårdens grundare; på senare tid har genom Bertil Lindquist och hans medarbetare särskilt antalet lignoser utökats, liksom växthusens orkidésortiment. Genom det milda klimatet kan åtskilliga mycket ömtåliga arter odlas; ett märkligt exempel är att en bananväxt, *Musa basjoo,*

kan växa på friland, ett annat är att den intressanta *Franklinia alatamaha* (okänd i vilt tillstånd sedan 1790) likaså i flera år odlats under bar himmel — i Lund har rec. försökt odla arten, men plantorna frös bort den första vintern.

Hybrider är ej upptagna i förteckningen med undantag av *Salix*-bastarder. Som en följd härav har t.ex. *Crataegomespilus* uteslutits ur förteckningen, vilket kanske är att väl strikt följa principerna.

Förteckningen är ej blott ett äreminne över det nitiska arbete som ledningen för Göteborgs Botaniska Trädgård har utfört, utan också en värdefull tillgång för forskare, som vill ha exakta uppgifter om vilka arter som finns att tillgå för studier av olika slag.

Om Göteborgs Botaniska Trädgård utan tvivel är Sveriges största, både till yta och artantal, så kan man kanske säga att D.B.V:s trädgård i Visby är den minsta. Den förteckning som utgivits härifrån av I. Nordin, är också av en annan karaktär än den ovannämnda. Katalogen upptar endast träd och buskar, och varje art får en kort beskrivning, ofta kompletterad med en avbildning — boken är illustrerad av författaren med teckningar och fotografier. En likhet som D.B.V:s trädgård har med Göteborgs är att läget även här är gynnsamt, genom det insulära klimatet, och medger odling av ett antal ömtåliga arter. I trädgården finns sålunda ej blott mandel, fikon och mullbärsträd utan också t.ex. *Abies pinsapo*, *Cedrus atlantica* var. *glauca*, *Hibiscus syriacus*, *Ruscus aculeatus* och *Prunus laurocerasus*.

H. Hjelmqvist

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Notiser

Docentförordnanden. Till docenter i växtbiologi vid Uppsala universitet har förordnats fil. dr K. Thomasson och fil. dr E. A. Sjögren.

Forskningsanslag. Jordbrukets Forskningsråd har i april och maj 1964 utdelat följande anslag. Förädlingsledare G. Carlsson, Hammenhög, för studier av mutationer i tulpaner och narcisser 500: —; fil. kand. I. Ekberg, Stockholm, för undersökning över genetiskt betingade sterilitetsmekanismer i relation till kromosomaberrationer, sterilitetsgrad, pollenfertilitet och klyvningstal 15.732: —; fil. lic. S. Ellerström, Svalöv, för undersökning av möjligheterna att genom upprepad röntgenbestrålning och urval positivt påverka frösättningen hos artificiella autotetraploider 2.947: —; fil. dr O. Gelin, Landskrona, för teoretisk och tillämpad mutationsforskning med ärter rörande genetiskt betingade skillnader i känsligheten för olika mutagena agentier 7.212: —; fil. dr O. Gelin och försöksledare S. Blixt, Landskrona, för undersökningar rörande S-allel-systemet hos *Brassica* 10.000: —; professor Å. Gustafsson, Stockholm, för försök att dirigera mutationsprocessen samt induktion av produktiva mutationer och av små mutationer (»modifiers») 86.500: —; docent A. Hagberg och fil. kand. G. Persson, Svalöv, för cytogenetisk analys av inducerade mutationer hos korn 36.504: —; docent A. Hagberg och fil. mag. J. Sjödin, Svalöv, för cytogenetiska studier i translokationsmaterial av *Vicia faba* 18.730: —; Institutet för växtforskning och kyllagring, Nynäshamn, för undersökning över sambandet mellan utsädespotatisens groningstillstånd och dess produktionsförmåga 26.400: —; Institutet för växtforskning och kyllagring, Nynäshamn, för undersökning över användningen av nonanol för groningshämning av potatis 20.920: —; agr. dr G. Julén, Svalöv, för undersökning av olika mutageners effekt på apomiktisk typ av *Poa pratensis* 4.300: —; assistent A. Koch, docent N. Nybom och assistent P. Tamás, Fjälkestad, för biokemiska resistensstudier hos jordgubbar och hallon 11.391: —; Lantbrukshögskolans institution för växtodling, Uppsala, för metodforskning avseende växtodlingsstudier vid mikroklimatstationen på Ultuna 69.500: —; docent K. Lindsten, Uppsala, för undersökning över viroser på vallväxterna, särskilt vallgräsen 12.300: —; agronom P. Oxelfelt, Uppsala, för studier av virusproteinsyntesen under utbildandet av systemiska symptom vid växtviroser med hjälp av fluorescerande antikroppar och annan serologisk teknik 5.271: —; docent H. Rufelt, professor J. Mac Key och agr. lic. H. E. Nilsson, Uppsala, för rotstudier på vete ur fysiologisk, morfologisk och resistensbiologisk synpunkt 55.000: —; fil. lic. B. Walles, Stockholm, för elektronmikroskopiska undersökningar av det genetiska materialet hos växter med särskild hänsyn till biokemiska mutanter 14.000: —; professor D. von Wettstein, Köpenhamn, för undersökningar av kloroplasternas och vaxbeläggningens genetiska kontroll 23.500: —; professor B. Åberg, Uppsala, för undersökningar över herbicidernas fysiologiska verkningssätt 16.320; professor G. Östergren, Uppsala, för mutations- och kromosombrottstudier 11.725: —.