Drawings of Scandinavian Plants 5–6

Rosa L.

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Rosa rubiginosa L.

(*R. eglanteria* L.)

Shrub, 1—3 m tall, with usually *erect stems and straight branches. Prickles stout* (up to 14 mm long), *curved or falcate,* often gradually tapering from the broad base, yellow or red, usually below the leaf bases but sometimes also on the internodes, *often interspersed with small ± straight prickles or acicles and glandular setae,* particularly towards the base of the sterile stems but also more occasionally on flowering branches; large prickles sometimes absent on young stems, small prickles and acicles occasionally missing. *Leaflets* 5—7, *usually 7,* suborbicular, *broadly ovate* or obovate (10—28×8—20 mm), the terminal one the largest, obtuse, rounded or almost acuminate at the top, usually *rounded at base*; *yellowish green* or somewhat reddish on young stems; glabrous or shortly pubescent above; usually pubescent and *with ± densely spaced, sessile,* yellowish or reddish *glands below* (and rarely above); *doubly glandular-serrate,* teeth varying much in size and shape, usually straight and acuminate, often 12—18 on each side; glands shortly stipitate, teeth usually absent on the basal fifth; *stipules rather broad,* straight or diverging, glandular; *leaves with a strong scent of apples.* Bracts rather broad, usually longer than the pedicels. *Pedicels* rather short, 1—1.5 cm, of about the same length as the hips, *densely stipitate- or setose-glandular. Flowers* solitary or usually a few together (3—5), *deep pink. Sepals* of about the same length as the petals, 3 pinnatifid, usually *somewhat dilated apically, pubescent and glandular on the back, ± erect or ascending after flowering, falling somewhat before the fruit ripens. Styles short, villous or lanate; stigmas in a rather dense flattened or slightly convex head covering most of the disc; disc* ca. 4.5 mm wide, usually *flat or somewhat concave*; orifice 1.0—1.2 mm.

Hips 1.0—1.8 cm long, subglobose, ovoid, or ellipsoid, *glabrous or* usually *with small acicles or glandular-hispid* at least near the base, bright red. June—July. 2n=35.

Probably native, but frequently planted and introduced in several localities. Since long it has been discussed whether *R. rubiginosa* is native or not in Scandinavia. Probably it is native in the SE. coastal districts. It has a Mediterranean and C. European distribution with a subatlantic tendency. It occurs in scrub on sunny and dry hillslopes, in hedges, on roadsides, and in grassland near the shores, mainly on calcareous soils. In Scandinavia its original distribution is difficult to establish because of its long cultivation and naturalization. In Denmark *R. rubiginosa* is rather common and evenly distributed and probably native in the E. parts. In the SW. part of Jutland it becomes rare. In S. Norway it is rare along the coast from Akershus to central Sogn; in all localities it is escaped from gardens and naturalized. In Sweden it is rather rare occurring in the southern parts northwards to S. Värmland and S. Gästrikland. In the northern and western localities it is introduced, but in the SE. coastland it may be indigenous.

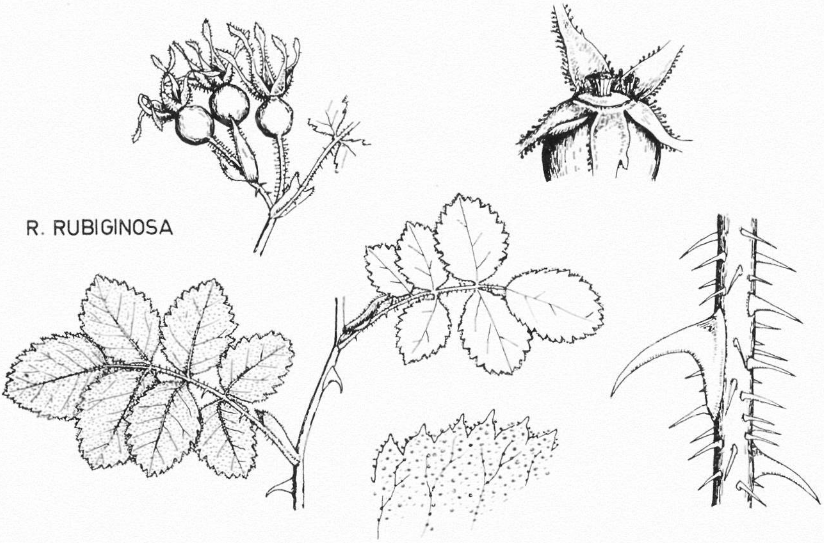
R. rubiginosa is rather variable. Var. *umbellatum* (LEERS) DUM. has prickles of different size and shape and is rather common within the Scandinavian distribution area of the species. Very rare, however, is var. *nudipes* HERR., material only seen from Denmark, with glabrous pedicels. It may easily be mistaken for *R. elliptica*.

In Scandinavia *R. rubiginosa* is known to form hybrids with *R. canina, R. dumalis,* and *R. sherardii.*

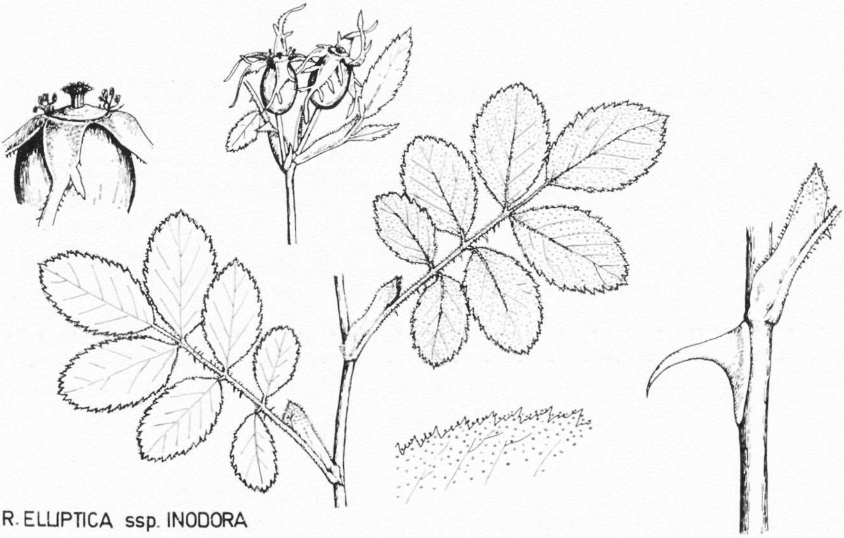
R. elliptica TAUSCH ssp. **inodora** (FR.) SCHWERTSCHL.

(*R. inodora* FR., *R. graveolens* GREN., *R. agrestis* SAVI var. *inodora* (FR.) R. KELLER)

Similar to *R. rubiginosa* but stems with *all prickles of almost equal size and shape,* usually curved or falcate, *without acicles and glandular setae*; prickles occasionally absent; *leaflets* obovate, *cuneate at base, darker green,* glabrous or often pubescent on both surfaces, *with* sessile or stipitate, yellowish, ± *densely spaced glands below, doubly serrate,* teeth subobtuse to almost acuminate; the *leaves* usually *scentless* or with a weak apple or resinate scent; *pedicels* rather long, usually somewhat longer than the hips, *glabrous*; *flowers paler pink*; *sepals eglandular on the back*; *stigmas* in a rather dense, convex head; *disc about*



R. RUBIGINOSA



R. ELLIPTICA ssp. INODORA

4 times wider than the orifice; *hips* 1.0—2.5 cm long, globose or ovoid, sometimes pyriform (usually the central in the corymb), *glabrous, red.* June—July. 2n=35, 42.

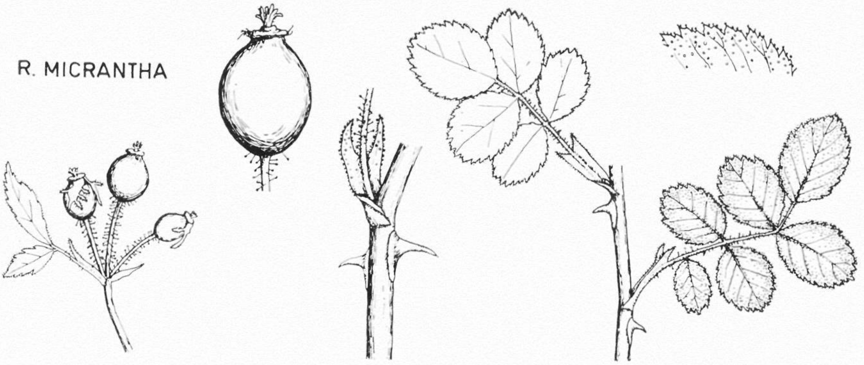
Native. In scrub and hedges, mainly in areas near the coast. *R. elliptica* ssp. *inodora* is only known from the NW. part of C. Europe and S. Scandinavia. In Denmark it is rare and local with only a few localities on Sealand (most localities), E. Fyn, Bornholm, and in E. Jutland. In Sweden it is also rare, only occurring in the northern part of the W. coast in N. Halland, W. Västergötland, and Bohuslän. In Norway it is only known from one locality, at Brevik near Skien.

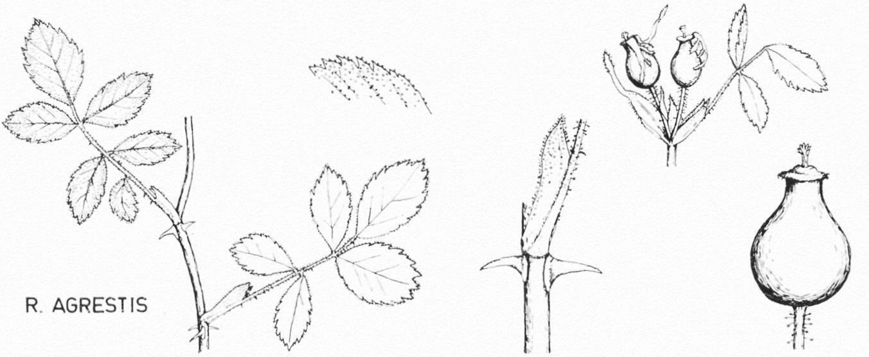
In Scandinavia *R. elliptica* ssp. *inodora* is rather uniform. Ssp. *elliptica* occurs in the montaneous areas of C. Europe. There are often very delicate problems to distinguish *R. elliptica* from some forms of *R. rubiginosa* and especially from *R. agrestis.*

R. agrestis SAVI

(*R. sepium* THUILL.)

Similar to *R. rubiginosa* but *stems* about 2 m tall, *suberect, climbing or decumbent, with arching branches,* internodes rather long; *prickles all of almost the same shape and size,* curved or sometimes straight, sometimes absent or very sparse on flowering branches, usually *without acicles or setae*; *leaflets* elliptical to *oblong-ovate, acute or acuminate, cuneate at base,* the terminal often distinctly larger than the lateral ones, *dull green,* glabrous or pubescent on both surfaces, glands of variable colours, brown, red, or black, ± densely spaced below, sometimes also on the upper side, *doubly* (or sometimes simply) *glandular-serrate,* teeth usually absent on the basal fourth, acute or acuminate, straight or curved forwards; *the leaves with a* (sometimes very weak) *scent of apples or resine*; stipules rather narrow, widening towards the base, straight or diverging, auricles rather long, straight; *pedicels* of about the same length as the hips or somewhat longer, *glabrous* or sometimes sparsely stipitate-glandular; *flowers usually white*; *sepals deflexed and falling soon after flowering,* constricted at base, usually *not terminally dilated, eglandular on the back* but often glandular-ciliated; *styles* long, *glabrous, often forming a short column after flowering* (about 2 mm long), stigmas in a small conoidal or ovoid head, *disc rather broad, 3—4.5 mm, usually conoidal, orifice very narrow,* about 0.5 mm; *hips* 1—1.5 cm long, globose, ovoid, or fusiform, ± *glabrous, scarlet or bright red.* July. 2n=35.





Native. Scrub on dry hill slopes. *R. agrestis* seems to have a submediterranean, but irregular, distribution in Europe, reaching northwards up to C. Germany, Holland and Denmark. It is a very rare and probably extinct plant in Scandinavia, found only once on a single locality in E. Jutland in Denmark. It was collected as *R. inodora* 1904 at Tjele Langsö by C. H. Ostenfeld. Later it has been looked for in vain.

The Danish specimen belongs to ssp. *agrestis*.

R. micrantha Sm.

Similar to *R. rubiginosa* (and particularly to *R. agrestis*) but *stems* often *decumbent or climbing* (occasionally erect) *with arching branches*; *prickles all of about the same size and shape,* curved or falcate, sometimes absent on flowering branches, occasionally interspersed with smaller prickles or acicles and glandular setae; *leaflets usually 5,* ovate or elliptical, acute or acuminate, occasionally obtuse, *rounded at base,* the terminal distinctly larger than the lateral ones, *dull green,* usually glabrous on the superior side, pubescent and glandular beneath, *doubly glandular-serrate,* teeth absent on the basal third, straight, acute or acuminate; *the leaves with a strong scent of apples*; stipules rather narrow, widening towards the base, straight or diverging; *pedicels usually somewhat shorter than the hips, stipitate- or setose-glandular* (occasionally glabrous); *flowers pale pink,* petals white near the base, usually somewhat longer than the sepals; *sepals deflexed and falling soon after flowering,* constricted at base and usually somewhat dilated in the terminal part, *glandular on the back*; *styles glabrous or subglabrous, forming a short column after flowering,* stigmas in a conoidal or somewhat flattened head, *disc* rather broad, *4—4.5 mm, flat or somewhat conoidal, orifice very narrow, ca. 0.7 mm; hips* 1.2—1.7 cm long, ovoid, globose, pyriform, or fusiform, *glabrous or often glandular-hispid,* occasionally very hispid, red or dark red. July.

This species has previously not been reported from Scandinavia. It grows in scrub and hedges usually on dry and sunny localities, mainly on calcareous soil. It is widespread in W., S., and C. Europe, reaching northwards to England, Holland, N. Germany and Poland. In the Botanical Museum of Lund there is one collection from Hörte in S. Scania, Sweden (collected by HERIBERT NILSSON in 1901) which probably belongs to this species. Investigations will be performed this summer in this locality in order to refind this rose and to deny or confirm this determination.

Chemotaxonomic Analysis of some Cytotypes in the Mentha ×verticillata Complex (Labiatae)

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ABSTRACT

A polyploid series of spontaneous plant material of *Mentha arvensis* L. and *M. aquatica* L. and their presumed hybrid products has been the subject of a thin-layer chromatographic investigation. The predictable genetic relationships have been studied through qualitative and quantitative analysis of the biochemical data.

INTRODUCTION

On account of their rich content of essential oils some plants of the *Mentha* species are of considerable economic importance. Most of the aromatic compounds have been isolated and chemically analysed. Being end-products of plant-cell metabolism they can be used as good characters in chemotaxonomic investigations. On the basis of biochemical studies and biogenetic considerations, Reitsema (1958), Handa et al. (1964) and Baquar & Reese (1965) have treated the taxonomic problems in the genus *Mentha*.

Reitsema presented a scheme for the possible synthesis of cyclic and acyclic constituents in mint oils. Actually, there are differences in enzyme reactions between *Mentha* species in connection with mint-oil synthesis. A single gene may change a cyclic precursor to either a peppermint (*M. piperita*) or a spearmint (*M. spicata*) type oil. Reitsema made no comparison between the chromosome numbers and the ability of the plants to synthesize mint oil. Table 5 shows how species with a higher degree of polyploidy produce more advanced intermediates in the peppermint synthesis chain.

The present investigation will also try to analyse biochemical relationships between polyploid *Mentha* cytotypes but within another group of compounds viz. phenolic substances.

Several papers on leaf phenolics as taxonomic criteria have been published. Some show a positive correlation between genetic relationships and the distribution of phenolic derivatives among the taxa examined, e.g. TURNER & ALSTON (1959), STEBBINS et al. (1963). Certain other papers show a more negative attitude towards the use of phenolics as a taxonomic aid.

MATERIAL AND METHODS

In order to examine the variation within sympatric populations of *Mentha arvensis* L. and *M. aquatica* L., material of these species and their putative hybrid progeny has been collected from some localities in southern Sweden.

Plant material	Coll. no.	Locality	Chromosome no.
M. arvensis L.	M 109	Helgeå, Denningarum, Skåne	2n=72
M.×verticillata L. . .	M 166	Ljungbyholmsån, Ljungbyholm, Småland	2n=78
M.×verticillata L. . .	10V11	Gladsax hallar, Skåne	2n=84
M.×verticillata L. . .	AKO6	Kävlingeån, NW Gårdstånga, Skåne	2n=90
M. aquatica L.	14A7	Vombsjön, NW Övedskloster, Skåne	2n=96
M.×verticillata L. . .	7V2	Krankesjön, N Silvåkra, Skåne . . .	2n=120
M.×verticillata L. . .	M 207	Kvie, NE Ire, Gotland	2n=132

The plants are kept in cultivation at the Botanical Garden of the University of Lund. Dried specimens from the original habitats and ramets of the same strains cultivated in the greenhouse and gathered in 1966 are preserved at our institute.

Chromosome counts are made through examination of mitosis in root-tip meristems. The cytological investigations have confirmed earlier determinations of the somatic numbers of *M. arvensis* L. (2n=72), *M. aquatica* L. (2n=96) and their primary hybrid *M.×verticillata* L. (2n=84) and *M.×verticillata* L. (2n=120, 132); (MORTON 1956: 2n=72, 84, 96, 120, 132; BAQUAR & REESE 1965: 2n=72, 84, 96, 120; SUOMINEN 1966: 2n=72). Plants with the chromosome numbers 2n=78, 90, 120 and 132 investigated by me also are presumably the result of introgressive hybridization between the primary hybrid and the parent species (Fig. 4). The low chromosome numbers indicate backcrosses with normal gametes. In the case of unreduced gametes of *M.×verticillata* the cytotypes 2n=120 and 2n=132 would be formed. This hypothetical assumption concerning the spontaneous material is supported by the fact that the *M.×verticillata* (2n=84) samples have a pollen fertility of on an average 15 per cent. Moreover, morphological characters indicate the intermediate position of the 84 chromosome strains and displaced position towards *M. aquatica* or *M. arvensis* of the introgressive cytotypes (unpublished results).

Of the approx. 200 populations of *Mentha* examined, most consist of 2n=72, 84 and 96-chromosomic plants. Also some aneuploid numbers have been found, as well as a few specimens of introgressive types of euploid origin. Theoretically, there are other ways of explaining the origin than that shown in Fig. 4. However the high frequency of 84-chromosomic individuals in natural populations increases the probability that the introgressive plants have originated according to that diagram.

When judging the chemotaxonomic results it ought to be borne in mind that the origin of the different euploid steps is not clearly known, and the plant material analyzed consists only of a limited number of plant collections. The present paper should be regarded as only a preliminary report of principally methodological interest.

METHODS OF BIOCHEMICAL ANALYSIS

The cytologically and morphologically verified specimens have been analysed by thin-layer chromatography of their content of fluorescing leaf phenolics. The Balsgård TLC system (Nybom 1964) was used in the introductory experiments (pp. 259—260) to get average values of chromatographic data for one taxon.

In addition to this the analysis of seven selected cytotypes will be presented.

Fifty mg leaves from flowering shoots of each specimen were abstracted in 1 ml methanol (with addition of one drop of hydrochloric acid). Five μl of this abstract were applied at the starting point of the cellulose-coated plate.

The phenolic constituents were separated by the two-dimensional technique according to the Camag "sandwich" system with 2 per cent formic acid in the first (1) direction (Fig. 1) and in the second (2) direction 10 parts of amyl alcohol, 6 parts of conc. acetic acid and 5 parts of water. After spraying with approx. 1 per cent methanolic sodium hydroxide the chromatograms were inspected under "long-wave" (360 mμ) ultraviolet light.

The spots on the chromatograms have not been identified chemically.

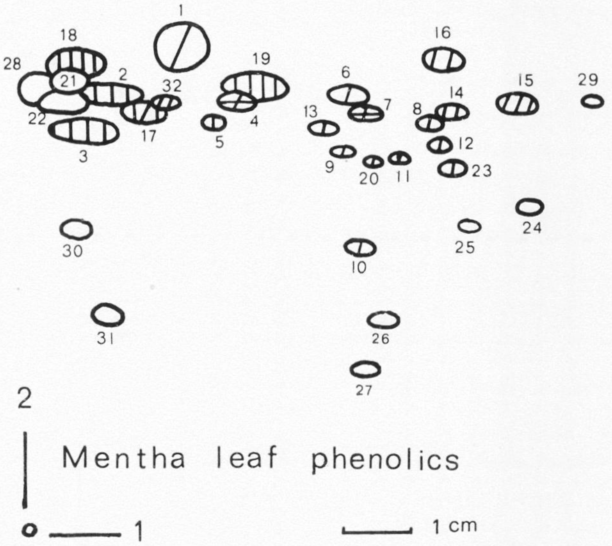

Fig. 1 "Master key" of phenolic spots of *Mentha* developed with NaOH.

For taxonomic purposes many authors have successfully used leaf phenolics as good criteria even though the description only refers to position and colour.

The hatching on the spots of the "master key" (Fig. 1) according to the system of NYBOM (1967 a) indicates the various colours of the fluorescent spots. The size and position (R_f) of the spots in this chromatogram are represented by relative values. Table 1 shows the size of corresponding spots in the different cytotypes. The numbering of corresponding spots in the individual chromatograms is based on careful measurements of R_f values with a transparent R_f-stencil in UV-light and recalculation to a test spot with known R_f-value.

Definitions of formulas used for the statistical treatment of the chromatographic data:

$$\text{The paired affinity index (Coefficient of similarity)} = \frac{m}{m+d}$$

$$\text{The matching coefficient} = \frac{m+n}{m+n+d}, \text{ where}$$

m = number of compounds occurring in both of the taxonomic units compared.
n = number of compounds missing in both of the taxa.
d = number of "differences", i.e. substances occurring in only one of the taxa.

In the last case negative matches are regarded as true similarities.

Table 1. Surfaces (mm^2) of phenolic spots of *Mentha* cytotypes

Spot	Polyploid levels (2n)						
no.	72	78	84	90	96	120	132
1	60	50	50	40	75	25	20
2	—	40	25	20	25	40	12
3	—	40	40	40	50	50	40
4	—	20	16	16	25	—	—
5	—	8	5	—	—	16	—
6	—	20	12	8	25	—	8
7	8	20	8	16	25	25	—
8	—	—	8	—	—	—	—
9	8	—	8	—	16	—	16
10	—	12	12	—	—	—	—
11	5	—	5	—	—	—	—
12	5	8	5	—	12	—	—
13	8	—	8	—	—	16	—
14	16	16	12	12	16	12	—
15	16	—	20	—	25	16	12
16	—	—	40	—	20	16	—
17	—	12	12	—	16	—	—
18	40	—	—	—	—	—	—
19	50	—	—	—	—	—	—
20	5	—	—	—	—	—	—
21	—	—	—	—	30	16	16
22	—	—	—	—	20	—	—
23	—	8	—	—	12	12	—
24	—	—	—	—	8	—	—
25	—	—	—	—	5	—	—
26	—	—	—	—	8	—	—
27	—	—	—	—	8	—	—
28	—	12	—	30	—	—	—
29	—	—	—	—	—	8	5
30	—	—	—	—	—	25	12
31	—	20	—	—	—	16	—
32	—	8	—	—	—	—	—
	72	78	84	90	96	120	132

Biochemical distance $= \frac{1}{100} \sum_{i=1}^{n} (A_{ij} - A_{ik})^2$, where

n = total number of spots in the material examined.

A_j, A_k = surfaces in mm^2 of corresponding spots of the taxonomical units j and k.

(After DASS & NYBOM 1967; further explanations in the text.)

CHROMATOGRAPHIC ANALYSIS OF MENTHA ARVENSIS (2n=72) AND M. AQUATICA (2n=96)

In order to test the reliability of phenolic patterns as specific characteristics, four specimens of *M. arvensis* (2n=72) and four specimens of *M. aquatica* (2n=96) chosen at random were chromatographed at the same time by means of the Balsgård method.

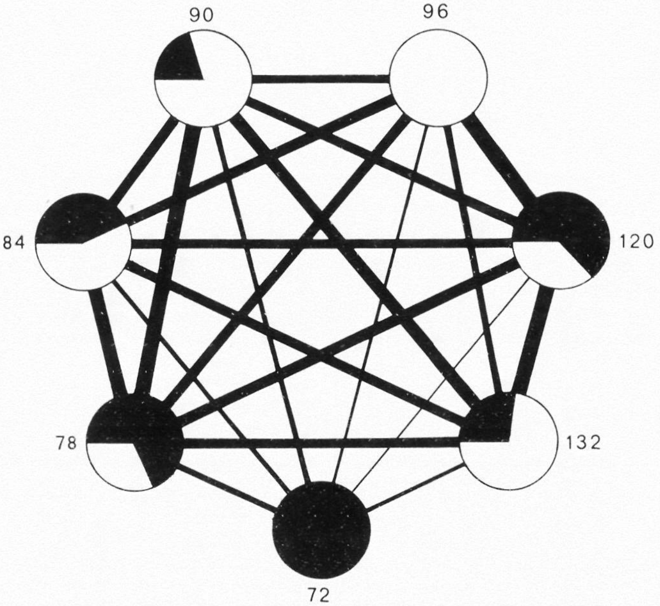

Fig. 2. Biochemical distances of paired comparisons of different cytotypes. The black segment shows the share of *arvensis* genomes according to Fig. 4. The thickness of the connecting lines is proportional to the degree of biochemical affinity.

There is both qualitative and quantitative variation of the phenolic substances. The spot-size is considered to be proportional to the quantity of the substance (Gänshirt in Stahl 1965 pp. 47—48, Nybom 1967 b). Dass and Nybom (1967) have shown in a chromatographical investigation of *Brassica* species with known genetical relationships that the concept of biochemical distance among the characters examined will best reflect the affinity of the plant group.

Represented by the values of biochemical distances between the four chromatograms of *M. arvensis* with six possible combinations the intra-

Table 2. Arranged similarity matrix of biochemical distances

2n	72	78	84	90	96	120	132
72	0	—	—	—	—	—	—
78	98	0	—	—	—	—	—
84	89	34	0	—	—	—	—
90	83	20	37	0	—	—	—
96	116	47	37	61	0	—	—
120	118	37	42	44	20	0	—
132	85	47	42	28	72	34	0

specific biochemical variation as regards phenolics ranges from 14 to 29 (14, 14, 17, 17, 18, 29), indicating a quite close chemical relationship. The corresponding values for *M. aquatica* range from 10 to 39 (10, 14, 21, 27, 33, 39). (Compare the biochemical distances between different cytotypes and species in Table 2 and in Fig. 2.)

BIOCHEMICAL COMPARISON BETWEEN DIFFERENT CYTOTYPES

As has already been mentioned in the introduction, seven cytotypes of the "*Mentha*×*verticillata* complex" with the chromosome numbers forming a polyploid series have been found in mint populations within the natural range of *M. arvensis* and *M. aquatica* in southern Sweden. One specimen of each cytotype has been chosen for the present chromatographical investigation.

The primary values forming the basis for the following discussion are found in Table 1. Colour shades and the relative positions of the 32 spots found are given in Fig. 1.

QUALITATIVE ANALYSIS

Some spots are specific for *M. arvensis* (2n=72). They are designated 18, 19 and 20; of these 18 and 19 are yellow, intensely fluorescent spots dominating the chromatographic pattern (presumably flavonol glycosides). *M. aquatica* produces five substances apparently specific but they have a lower intensity.

On the other hand, the hybrid cytotypes are almost entirely without specific constituents, except for the F_1-plant (2n=84) and its backcross product (2n=78), each with one spot of low concentration. Observe in Table 1 the exceptional position of *M. arvensis* (2n=72), which lacks many of the spots (2—6, 21—32) present in most of the other cytotypes.

One method for the statistical treatment of the qualitative (presence or absence) variation analysis is the polygonal representation of the paired affinity indices (Ellison et al. 1962). The number of spots common to two chromatograms of cytotypes divided by the total number of the spots on the plates will be the affinity index or coefficient of similarity (here interchangeably used terms).

In case of negative similarities, i.e. where the absence of a certain spot in two chromatograms is used as a true character, one gets another index called the matching coefficient (see definitions and for-

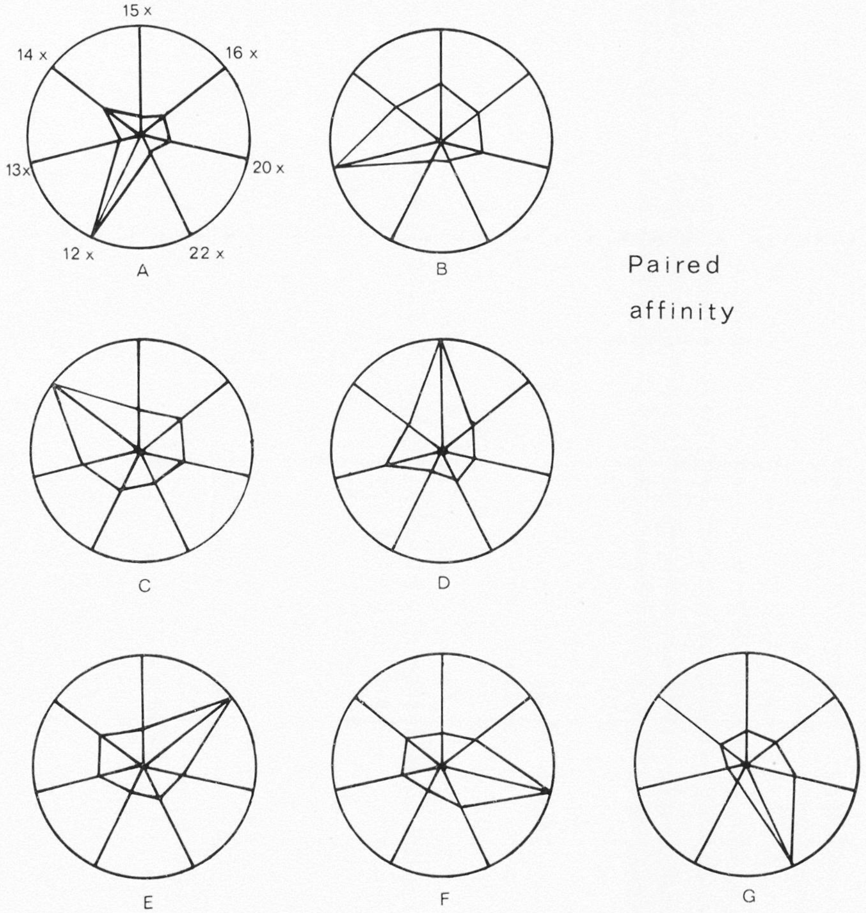

Fig. 3. Paired affinity between seven cytotypes. The radii in B—G represent the same polyploid levels as in A.

mulae above, p. 258). Such differences (neg. matches) may be able to support or refute the indication of affinity. In a small material there is an unknown number of possible negative matches. Another objection to emphasizing the negative matches may be the occurrence of unknown factors (perhaps experimental conditions) which outside of genetic control may disturb or change the phenol metabolites causing the absence of one or more phenolic compounds in some of the chromatograms. However, the introductory investigation of *M. arvensis* and *aquatica* discussed above indicates that such phenotypical manifestations do not exist to any great extent.

Table 3. Arranged similarity matrix of paired affinity (in per cent)

2n	72	78	84	90	96	120	132
72	100	—	—	—	—	—	—
78	19	100	—	—	—	—	—
84	40	52	100	—	—	—	—
90	19	53	39	100	—	—	—
96	25	42	50	35	100	—	—
120	25	38	41	29	37	100	—
132	18	20	30	31	33	44	100

As they are of methodological interest, both types of coefficient have been tabulated. The coefficients of similarity or the affinity indices expressed as a percentage are graphically represented in the polygons mentioned above (Fig. 3). In this figure the indices are expressed along the radii with 0 per cent at the centre.

The polygonal graph of G (Fig. 3) indicates a gradual increase of affinity between *M.×verticillata* (2n=132) and the other cytotypes from a lower to a higher level of polyploidy. Compare the values of indices in Table 3 with the corresponding coefficients in Table 4. It is evident that the matching coefficients in this case will not clearly manifest a gradual increase of affinity. If, however, one compares the extreme values for the two kinds of coefficients one may find some agreement. For example, the highest value for both matrices, 53 and 78 per cent respectively, correspond to the biochemical affinity of the cytotypes of 2n=78 and 2n=90.

There is a pronounced distance between *M. arvensis* (2n=72) and the other taxonomic units according to the values of paired affinity. This tendency is not so marked in the matrices of matching coefficients.

Will the qualitative analysis (Fig. 4) give any support for the putative hypothetic origin of the cytotypes? The intermediate position of the 84-chromosome plant between the parent species (2n=72 and 96) is seen in the matrices of paired affinity. There is a greater biochemical resemblance between the cross-product and either of the parents

Table 4. Arranged similarity matrix of matching coefficients (in per cent)

2n	72	78	84	90	96	120	132
72	100	—	—	—	—	—	—
78	38	100	—	—	—	—	—
84	59	67	100	—	—	—	—
90	59	78	66	100	—	—	—
96	44	50	63	59	100	—	—
120	53	59	59	63	50	100	—
132	56	50	56	72	53	72	100

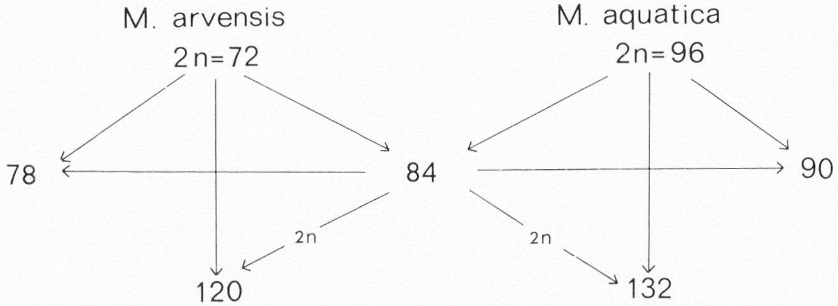

Fig. 4. Hypothetical crossing scheme of the origin of the cytotypes examined. 2n indicates unreduced gametes.

than between the parents. None of the introgressively formed cytotypes, however, shows such a relation to its parents. Each pair of parental cytotypes has greater reciprocal similarity than similarity to the putative hybrid progeny.

Furthermore, one expects that of the two "sister-cytotypes" (2n=120 and 132) that formed with one unreduced gamete should show greater resemblance to its 84-chromosomic parent (supplying that gamete). Neither the similarity nor the matching coefficients are in agreement with the last-mentioned relation between the 90 and 132, and the 78 and 120 chromosome cytotypes respectively and their putative common parent (2n=84).

A QUANTITATIVE EVALUATION OF THE CHROMATOGRAMS

The method used is according to the ideas of Nybom (Dass and Nybom 1967, under publication), taking the formulae of taxonomic distance (Sokal & Sneath 1963) and calling it biochemical distance (see under definition p. 259).

The values for biochemical distance are arranged in a matrix (Table 2). A low number indicates a close biochemical affinity. Fig. 2 shows the quantitative biochemical affinity of all possible combinations between the cytotypes arranged in order of rising degree of polyploidy. Each cytotype is symbolized by a circle with a black segment showing the share of *arvensis* genomes. The thickness of the connecting lines is proportional to the degree of biochemical affinity.

According to Table 1 there is marked quantitative variation between the amounts of different substances. The spot-sizes range from 5 to

Table 5. A comparison of the degree of polyploidy and biochemico-phylogenetic sequence of *Mentha* species with the ability to synthesize more and more reduced compounds of peppermint-oil type. Biochemico-phylogenetic sequence after REITSEMA 1958.

Biochemico-phylogenetic sequence ↓	Degree of polyploidy (after MORTON 1956)														
	2x	3x	4x	5x	6x	7x	8x	9x	10x	11x	12x	13x	14x	15x	16x
M. rotundifolia	—	—	24	—	—	—	—	—	—	—	—	—	—	—	—
— *longifolia*	—	—	—	—	36	—	48	—	—	—	—	—	—	—	—
— *pulegium*	10	—	20	—	30	—	40	—	—	—	—	—	—	—	—
— *aquatica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	96
— *piperita*	—	—	—	—	—	—	—	—	—	66	72	—	—	—	—
— *arvensis* var. *piperascens* .	—	—	—	—	—	—	—	—	—	—	—	—	(84)	—	—

Note: *M. pulegium* x=5.
Other mints x=6.

75 mm². The quantitative variation of one compound in the polyploid series is not so remarkable. This is presumably due to the fact that a multiplication of the genomes, i.e. the enzymatic gene-material, does not effect a larger production of a phenol derivative. Actually, however, there is a quantitative difference between two compared cytotypes. Perhaps an analysis of the biochemical distance values might illustrate genetic relationships within the plant group?

Apparently the amphidiploid hybrid of 2n=84 in this quantitative analysis also has a biochemical contribution due to its parentage. There is a larger biochemical distance between the parents than between the hybrid (2n=84) and either of the parents. One may also note that the values indicate a greater affinity between plants with 2n=84 and those with 2n=96 than between plants with 2n=84 and those with 2n=72, according to the supposed proportions of the *arvensis* and *aquatica* genomes in the hybrid. The same will be valid for the origin of the 2n=78 cytotype. A similar discussion concerning the cytotypes with a higher degree of polyploidy will not, however, confirm the hypothetical idea of introgressively formed units.

CONCLUSIONS

Among the different chemotaxonomic methods used, the quantitative one seems better to indicate some of the supposed biogenetic relationships. The alternative or qualitative methods only elucidate the parentage of one of the hybrid products, the amphidiploid *M.×verticillata* (2n=84). Cytotypes with fifteen genomes and more appear to show rather small biochemical differences with respect to their phenolics. In this case the methods used cannot account for the origin of these polyploid plants.

Perhaps a closer chemical analysis of the compounds to ascertain the genetic background of the phenol synthesis chains, might better reflect the cytologically confirmed relations. It is also obvious that further information on the biochemical variability within the various cytotypes must be obtained.

ACKNOWLEDGEMENTS

The present investigation has been carried out at the Agardhianum Department of Experimental Plant Taxonomy of the Institute of Systematic Botany (Director: Prof. H. WEIMARCK) of the University of Lund. I am very grateful to my colleagues and teachers who have given me valuable advice and I am especially indebted to Prof. N. NYBOM (Balsgård Fruit Breeding Institute) who has critically discussed the results. The investigation has been supported by grants from the University of Lund, for which I am sincerely grateful.

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A New Species of Lebeckia (Leguminosae) from the Cape Province

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ABSTRACT

Lebeckia melilotoides R. DAHLGR. is described. It is characterized mainly by the small and very numerous flowers in long spikes, the glabrous petals, and the large trifoliolate leaves with obovate leaflets. It occurs on the desert border in the Ceres Division of the Cape Province, South Africa.

Lebeckia melilotoides R. DAHLGR. sp. nov.

Original collection. H. HALL no. 177 (NBG, holotypus).

Fruticulus decumbens vel ascendens; rami dense villoso-velutini. — *Folia* petiolata, normaliter trifoliolata; petiolus 12—22 mm longus lignosus villoso-velutinus; foliola plerumque 14—28×10—17 mm, obovata, basi cuneata, apice obtusa vel retusa, omnino sericea vel velutina, costa distincta. — *Inflorescentia:* spica longa linearis densissima plerumque 50—100-flora. — *Bracteae* lineares—filiformes, plerumque 3—5.5 mm longae, flexiles, dense albo-lanatae. — *Pedicelli* ca. 1.0—1.4 mm longi, dense lanati. — *Bracteolae* subulatae minutae lanatae plerumque 1.0—2.0 mm longae. — *Calyx:* tubus campanulatus ca. 3 mm longus dense lanato-villosus; lobi superni late triangulares, ad ca. 1 mm longi; lobus infimus anguste triangularis ca. 1.5 mm longus. — *Petala* glabra pallide flava exilia flexilia. Lamina vexilli 6.8—7.5×5.0—5.5 mm, ovata, apice ± incurva, ungue 2.2—2.7 mm longo. Laminae alarum anguste oblongo-ovatae, 6.1—6.5×2.4—2.9 mm, unguibus 3.2—3.6 mm longis. Laminae carinae lunatae obtusae 6.7—7.6×3.5—4.2 mm, marginibus superis leviter convexis, unguibus 2.8—3.1 mm longis. — *Pistillum:* stipes ca. 1 mm longus glaber; ovarium lineare 4—5-ovulatum, in dimidio superiore villosum; stylus glaber; stigma minutum capitatum.

Decumbent or ascending shrublet with woody branches, up to 8 mm thick or more, covered by dense, villous-velutinous, white pubescence almost from base.

Leaves alternate, petiolate, normally trifoliolate (sometimes with one

Fig. 1. *Lebeckia melilotoides;* from STORY no. 3606. — A: Branch. — B: Calyx, the lowest lobe=the narrow one. — C: Bract of flower from the basal part of the spike. — D: Bracteole. — E: Vexillum, side view. — F: Ala petal. — G: Carina petal. — H: Long basifixed anther. — I: Short dorsifixed anther. — J: Pistil. (A ×0.42; B—J ×4.)

or two leaflets). Petiole woody, 12—22 mm long, pubescent as branches, persistent for some time after leaflets have been dropped. Leaflets sessile, obovate, usually 14—28×10—17 mm large, with cuneate base and obtuse or retuse apex with or without short apical tip; entirely densely silky-sericeous or velutinous; midvein distinct, other veins faint.

Inflorescence a long, linear, very dense spike usually with from ca. 50 to much more than a hundred rel. small flowers. Lateral branches ending as inflorescences and repeating the appearance of the main

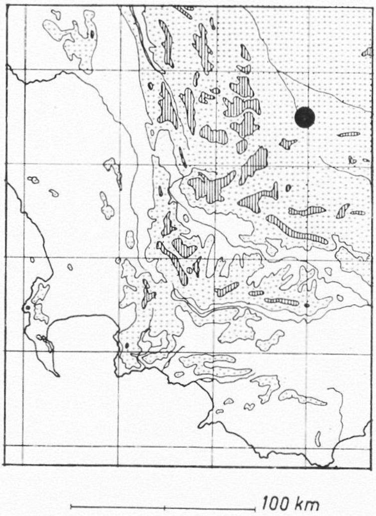

Fig. 2. The approximate area of *Lebeckia melilotoides.*

branch (="Bereicherungstriebe" sensu TROLL) sometimes emerging below main spike.

Bracts linear-filiform, usually 3—5.5 mm long (successively shorter from base to apex of inflorescence), weak and flexible, closely white-lanate. — Pedicel stout, ca. 1.0—1.4 mm long, closely lanate. — Bracteoles subulate, small, usually 1.0—2.0 mm long, closely lanate.

Calyx campanulate, dark at base, otherwise pale; tube ca. 3 mm long, closely lanate-villous on distal parts, more sparsely lanate on basal half. Upper lobes very broadly triangular, ca. 1 mm long or less, lowest lobe narrowly triangular, ca. 1.5 mm long; all closely lanate.

Petals glabrous, pale yellow, thin and fragile. — Vexillum blade ovate, 6.8—7.5×5.0—5.5 mm large, at anthesis standing at right angles to claw and with apical parts ± incurved; back side slightly striated at base. Claw 2.2—2.7 mm long. — Ala blades narrowly oblong-ovate, 6.1—6.5× 2.4—2.9 mm large, rounded at apex, with 3—4 distinct rows of numerous close minute folds on most of upper half. Claws 3.2—3.6 mm long. — Carina blades lunate, 6.7—7.6×3.5—4.2 mm large; with prominent basal longitudinal bulge, very slightly concave upper margin, and triangular subacute upper basal lobe. Claws 2.8—3.1 mm long.

Staminal sheath split on either side of upper stamen; 5 anthers basifixed and ca. 1.8 mm long and 5 dorsifixed and ca. 1.1 mm long.

Pistil: stipe ca. 1 mm long, glabrous; ovary linear, villous on upper parts, within 4—5 ovules; style upcurved, glabrous; stigma small, capitate. (Pods not seen).

DISTRIBUTION. The species is recorded from Platfontein situated NE of the Bonteberg in the S end (probably border) of the so-called Tanqua Karroo (see ACOCKS 1953 p. 104) at an altitude of ca. 700 m, where it grows in sand. According to the label of STORY no. 3606 it is "avoided by stock".

COLLECTIONS

Ceres Div.: Bare sandy patch, S end of Tanqua Karroo; ca. 700 m. 1948, STORY no. 3606 (K. PRE). — Platfontein, E of Hottentots Kloof. 1950, H. HALL no. 177 (NBG).

Sine loco: Sheet no. 897 · 17 in LINN (without remarks whatsoever).

MORPHOLOGICAL AFFINITY. *Lebeckia melilotoides* belongs to those species referred by BENTHAM (1844 p. 358) and HARVEY (1862 p. 86) to the section *Calobota.*

In this group there are species with pubescent as well as glabrous petals (especially the carina is usually ± pubescent). In petal shape *L. melilotoides* resembles *L. sericea* THUNB., but this is slightly sericeous on the apical parts of the carina (the leaflet shape, indumentum, etc., are also different). The large, broad leaflets are slightly similar to those of *L. obovata* SCHINZ, which is mainly unifoliolate, however, and has much longer and fewer flowers with sericeous petals (see DAHLGREN 1963 pp. 256—257). In the closely pubescent branches and relatively small flowers *L. melilotoides* also resembles slightly *L. cinerea* E. MEY., which has few-flowered inflorescences, ± pubescent vexillum and carina, and much smaller leaves.

The present species is accordingly very distinct. Some other species in the same group (*Calobota*), in the Cape Province and South West Africa, show great variation and deserve revision combined with further field work.

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Studies on Mire Vegetation in the Torneträsk Area, Northern Sweden

I. Regional Aspects

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ABSTRACT

The regional variation of the poor mire vegetation in the investigation area is described. Two regional vegetational gradients are recognized, viz. the gradient low—high altitude and the gradient west—east, along which some limits in the mire vegetation are distinguished. The main limits found run parallel to but do not coincide with the biogeographical limits set by the tree layer of the forests.

INTRODUCTION

In the poor mire vegetation (def., see below) of the Torneträsk area two principal types of variation are apparent. There is a local variation found in most of the separate mire complexes, provided these are not too small. It is chiefly the variation along the gradients poor—rich, hummock—mud-bottom and mire expanse—mire margin vegetation (Sjörs 1948, 1950, Persson 1961, Malmer 1962). There is also a regional variation which appears when comparing ". . equivalent communities within different complexes . ." (Sjörs 1950 p. 178). These locally and regionally recognized types of variation are generally well separated, but in some respects they seem to be intergradient too. In this paper I shall discuss the regional variation. In a following paper (Sonesson in prep.) some local vegetational gradients will be presented when describing the chief plant communities of the mires investigated.

The concept 'vegetational gradients' is proposed by Sjörs (1963 b in Swedish, i.a. 1965 b in English) to replace the concept 'directions of variation in vegetation' (Tuomikoski 1942, Sjörs 1948, 1950).

The terminology of mires and mire vegetation mainly follows that of Du

RIETZ 1949, 1954, SJÖRS 1948, 1950, 1952, 1965 b, PERSSON 1961, 1965, MALMER 1962, 1965. The concept poor mire vegetation includes both bog vegetation and poor fen vegetation, sensu DU RIETZ 1949 and 1954 (cf. MALMER 1962 pp. 46—47, 1964 p. 1, "Die Variation von der sphagnumdominierten 'armen' . . zu der braunmoosdominierten 'reichen' . ." and 1965 p. 150; cf. also SONESSON 1966 p. 397).

The terminology of the biogeography of Scandinavia is that used by SJÖRS (1963 a, 1965 a). The Subalpine belt thus means the Birch woodland belt of the Boreal zone of Fennoscandia, situated between the Alpine zone and the Prealpine subzone without spruce (equiv. to the Prealpine pine forest subregion without spruce, as used by DU RIETZ 1950). There are three regions in the Alpine zone, i.e. the Low Alpine belt, the Middle Alpine belt and the High Alpine belt (cf. DU RIETZ op. cit., 1964). The upper limit of the Subalpine belt, the timberline, runs at the uppermost birches (ENQUIST 1933, DU RIETZ 1964).

The nomenclature of the vascular plants follows that of HYLANDER (1955), *Sphagnum* that of ISOVIITA (1966), other bryophytes that of NYHOLM (1954—1965) for the groups dealt with by her so far and the rest that of MÅRTENSSON (1955, 1956 a). Lichens are named according to MAGNUSSON (1952).

For detailed maps of the investigated area, see the topographic maps issued by Generalstabens Litografiska Anstalt (1 : 100 000, 1 : 200 000, Sweden) and by Norges Geografiske Oppmåling (1 : 100 000, Norway).

The maps, Figs. 2 A and B, 3 A and C, 4 A—D are founded on herbarium material (no material from Finland). This also applies to the complementaries of the maps, Figs. 2 C and D and 3 B. Likewise many localities derive from my own material and from private herbaria and/or from diary data provided by several persons (see pp. 291—292). All the *Sphagnum* material has been seen by me.

The exactness in position of the given localities varies, but the fault is generally less than the diameter of the dot (corresp. sign). The maps are, however, drawn with the main aim of showing the general picture of distribution of the species in question, not the situation of separate localities.

Sphagnum fuscum has been mapped to illustrate the distribution of some species in relation to a typical mire plant. Thus species found intermingled with *S. fuscum* in the samples have been recorded (indicated by filled circles on the maps). Obvious duplicates are referred to the same collection. By random selection the lumping of dots on a small area has been avoided. The 94 collections mapped on the Swedish side derive from 30 collectors, the 60 from the Norwegian side from 12 collectors. Material of *S. fuscum* collected by me has not been used in this connection.

Terrestrial species means those growing mainly on mineral soils contrary to those on organic soils, e.g. peat.

The present account is based on plant sociological analyses, on species-lists of the diary books and on other observations made during my investigations in the area (1960—1967).

THE INVESTIGATION AREA

The main investigation area is situated near Lake Torneträsk (342 m s.m.) Torne Lappmark, Northern Sweden (Fig. 1). It belongs to the mountain area, the Scandes (LJUNGNER 1948), that occupies Western Scandinavia. The areas between Riksgränsen in the west (ca. 25 km from the Atlantic Ocean) and Torneträsk railway-station in the east about 5—10 km south and north of the railway have been investigated most intensely. Other parts are more briefly studied. Still others have not been visited by the present author (i.a. the parts furthest to the southwest and to the northeast of the lake). On the Norwegian side, close to the Atlantic, I have made a few comparative studies below the timberline at Holmvann and Gratangen (ca. 30—35 km WNW—NW of Riksgränsen at ca. 150—250 m above sea-level) and above the timberline east of Narvik (ca. 25—30 km W of Riksgränsen at ca. 800 m above sea-level). The northern side of Lake Torneträsk has recently been investigated by PERSSON mainly on rich mire vegetation (PERSSON 1961, 1962, 1965). I have also spent a few days on that side performing comparative studies especially on hummock vegetation (cf. PERSSON 1961 p. 91).

Most of the mires investigated below the timberline are situated at ca. 350—500 m above sea-level. This corresponds approximately to the altitudes of the mires on the plains or plateaux of Northern and Northeastern Lappland east of the Scandes (see J. LUNDQVIST 1965, SJÖRS 1965 b pp. 182—183).

From macro-climatic data a decisive oceanic—continental gradient (or rather oceanic—less oceanic, according to ÅNGSTRÖM 1958 p. 34) is evident from west to east (see Fig. 1). On the Norwegian side at Narvik (at sea-level) the difference between the mean temperatures in February and July is 16.9°C and the mean annual precipitation is more than 600 mm (HANSEN 1960). With increasing altitude the climate also adopts a more oceanic character (cf. GAMS 1931/32 in WALTER 1954 p. 149, BÖCHER 1954 p. 27, ÅNGSTRÖM 1958 p. 33). The humidity is greatest in the western parts and at high altitudes. Owing to the scarcity of meteorological stations, however, it is impossible to give any detailed information concerning the humidity of the topographically rough area investigated. A great difference in duration of

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Fig. 1. A adapted from MÅRTENSSON 1956 b ('forest limit' appr. equivalent to 'timberline'), B, D—E after Atlas över Sverige, C adapted from ÅNGSTRÖM 1958.

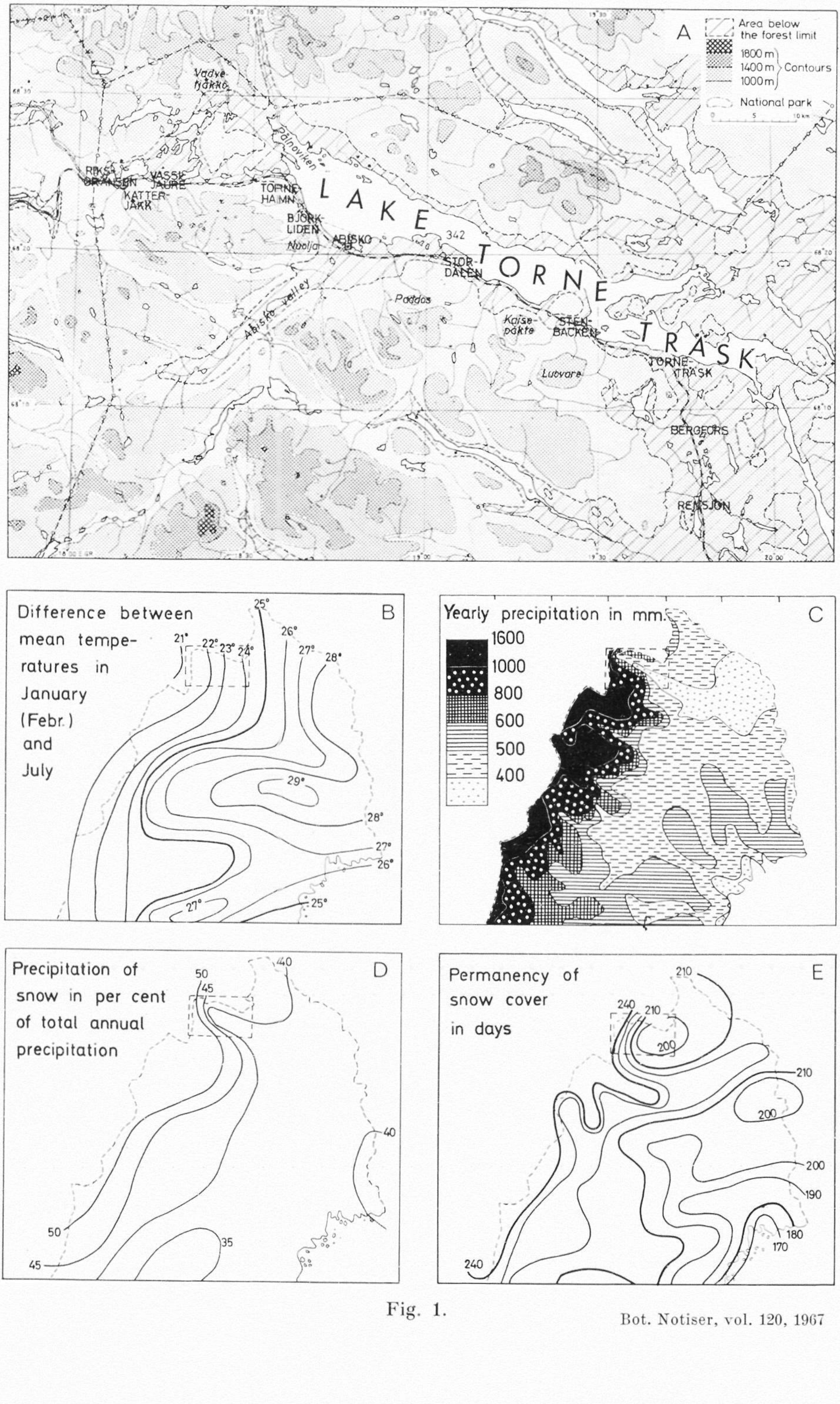
A
Area below the forest limit
1800 m
1400 m
1000 m
Contours
National park
0 5 10 km
LAKE TORNETRÄSK
RIKSGRÄNSEN
VASSIJAURE
KATTERJÅKK
Vadvetjåkko
Pålnoviken
TORNEHAMN
BJÖRKLIDEN
ABISKO
Nuolja
342
STORDALEN
Abisko valley
Paddos
Kaisepakte
STENBACKEN
Luovare
TORNETRÄSK
BERGFORS
RENSJÖN
68°30
68°20
68°10
18°00
18°30
19°00
19°30
20°00
B
Difference between mean temperatures in January (Febr.) and July
21° 22° 23° 24° 25° 26° 27° 28° 29° 28° 27° 26° 27° 25°
C
Yearly precipitation in mm.
1600
1000
800
600
500
400
D
Precipitation of snow in per cent of total annual precipitation
50 45 40 40 50 45 35
E
Permanency of snow cover in days
210 240 210 200 210 200 200 190 180 170 240

Fig. 1.

snow cover and snow depth between the western and the eastern parts is evident too. Details of the climate of the Torneträsk area (especially concerning permafrost) are given in EKMAN 1957.

Also geologically the area investigated is very heterogeneous. Broadly speaking, there are soils derived from hard silicious rocks in the western and the eastern parts but soils from softer rocks containing more calcium in the central part of the area (Abisko valley and the mountains bordering on it to the west) and on the northern side of Lake Torneträsk. The lower, eastern part of the Torneträsk area (appr. east of Stordalen) is situated east of the Caledonian overthrust nappes and might therefore be considered as outside the mountains in a restricted, geological sense (see KULLING 1965, cf. J. LUNDQVIST 1965 p. 215, O. RUNE 1965 p. 66).

Biogeographically the area investigated is situated both in the Boreal and the Alpine zones of Fennoscandia. The western limit of pine forests constituting the limit of the Prealpine subzone without spruce thus runs to Stenbacken on the southern side of Lake Torneträsk. Within and close to the Abisko valley there are small extrazonal stands of pine forests isolated from the Prealpine subzone (cf. DU RIETZ 1950 p. 9).

In the Torneträsk area the Subalpine belt extends up to ca. 700—800 m in the eastern part and up to ca. 550—650 m in the western part. In the Narvik-Holmvann-Gratangen area the timberline is situated at about 400—500 m (cf. the topographic maps of the areas). On the Norwegian side there also occur pine forests below the timberline.

Trees are lacking in the mires of the area investigated (except in the mire margins). According to SJÖRS (1950 p. 192) it may be regarded as an oceanic feature of the area.

The frequency of mires rapidly decreases with increasing altitude.

THE REGIONAL VARIATION OF THE VEGETATION

The regional variation in the mire vegetation depending on ". . unequal geographical distribution of species." (SJÖRS 1950 p. 185) appears mainly between mires situated at different altitudes and between mires situated at different distances from each others in west—east direction.

The strongest regional vegetational gradient in the mires of the area is the gradient low altitude—high altitude. With increasing altitude the frequency of alpine (chiefly terrestrial) and/or terrestrial species occurring both in the Alpine and the Boreal zones rapidly increases in the communities. In mire vegetation i.a. the following species occur mainly in the Alpine zone:

a. Species characteristic of chionophilous vegetation (Dahl 1956 p. 252):

Cassiope hypnoides
Salix herbacea
Carex lachenalii
Conostomum tetragonum
Anthelia spp.

b. Species characteristic of chionophobous vegetation (Dahl l.c.):

Diapensia lapponica
Thamnolia vermicularis

c. Species occurring in vegetation of both types, *a* and *b*:

Loiseleuria procumbens
Lycopodium selago
Carex bigelowii

d. Other species:

Cassiope tetragona
Pedicularis lapponica
Polygonum viviparum
Solidago virgaurea
Calamagrostis lapponica
Deschampsia alpina
Festuca ovina
Festuca vivipara
Luzula arcuata coll.
Phleum commutatum
Vahlodea atropurpurea
Aulacomnium turgidum
Rhacomitrium lanuginosum

(Cf. Nordhagen 1927—1928, 1943, Kalliola 1939, Du Rietz 1942, 1950, 1964, Gjaerevoll 1949, 1950, 1965, Dahl 1956, Persson 1961, Bringer 1961, 1965, Wistrand 1965).

Most of these species are also found in the Boreal zone at least in the Subalpine belt, but in this case they never or very seldom occur in poor mires. *Calamagrostis lapponica* and to some extent also *Pedicularis lapponica*, however, are not unusual below the timberline in the communities of the mire margin and in the mire vegetation that occurs as small patches in wet parts of the heaths on a thin peat layer (cf. Sjörs 1950 p. 182). In mire vegetation I have recorded *Rhacomitrium lanuginosum* only in the Alpine zone in the Torneträsk area. Further to the west it also occurs below the timberline, though infrequently.

The plant communities below the timberline, i.e. the Subalpine and Prealpine communities, are characterized by the absence or the very low quantity of species of the mentioned groups and by the presence of several species which are never or rarely found in alpine mires:

e. Species characteristic of mire vegetation below the timberline:

Salix myrtilloides
Ledum palustre
Drosera anglica
Drosera rotundifolia
Menyanthes trifoliata
Utricularia minor
Utricularia vulgaris
Carex chordorrhiza
Carex lasiocarpa
Carex livida
Carex pauciflora
Eriophorum medium
Eriophorum russeolum
Molinia coerulea
Sphagnum aongstroemii
Sphagnum magellanicum
Sphagnum papillosum
Sphagnum tenellum

However, some of these species are quantitatively insignificant in the mires. Some are mentioned by Persson (1961 pp. 120—121) as Subalpine on the northern side of Lake Torneträsk too. *Sphagnum balticum* and *S. riparium* which are Subalpine on that side (Persson l.c.) also occur in the Low Alpine belt on the southern side.

The gradient west—east in the vegetation is also apparent though weaker. Especially the following species characterize mire communities in the western and eastern parts respectively of the area investigated:

Western distribution types

1.	*Molinia coreulea*		l		
2.	*Calluna vulgaris*	h			A
	Potentilla erecta	h	l		
	Deschampsia flexuosa	h	l		
	Sphagnum tenellum		l		
3.	*Phyllodoce coerulea**	h			A
	*Vaccinium myrtillus**	h			A
	Cornus suecica	h			A
	Carex rariflora		l	c	A
	Nardus stricta	h	l		A
	Trichophorum caespitosum ssp. *austriacum**		l		A
	*Dicranum fuscescens**	h			A
	Drepanocladus badius		l	c	A
	*Pleurozium schreberi**	h			A
	*Sphagnum compactum**		l		A
	*Sphagnum teres**		l	c	A

Eastern distribution types

1.	*Carex laxa*			c	m	
	Carex tenuiflora		l			
2.	*Ledum palustre**	h				
	Salix myrtilloides	h				
	Carex livida				m	
	Eriophorum medium			c	m	
	Eriophorum russeolum			c	m	
3.	*Pinguicula villosa*	h				A
	*Dicranum elongatum**	h				A
	*Sphagnum balticum**		l			A
	Cetraria cucullata	h				A
	*Cetraria delisei**		l			A
	*Cetraria nivalis**	h				A
	Ochrolechia frigida	h	l			A

Species of the types designated by *1* have the most restricted area of distribution, *2* a less restricted area of distribution, *3* the least restricted area of distribution. The consecutive order within the groups is uncertain. For a few species there is also some uncertainty in the delimitation of the distribution types. Species followed by * are often dominants in the area investigated. Symbols: h, l, c, m = chiefly in hummock, lawn, carpet and mud-bottom communities respectively (valid primarily for the Boreal zone but also to some extent for the Low Alpine belt). A = also in the Alpine zone.

In mire vegetation I have recorded *Calluna, Potentilla erecta* and *Molinia* only from the Norwegian side. There is only one known locality of *Calluna* occurring in mire vegetation in the Torneträsk area (at Pålnoviken, K. LINDBERG and B. RING pers. comm.).

ASPLUND (1950) reports *Carex rariflora* also at the railway stations Bergfors and Rensjön in the eastern part of the investigation area.

I have found *Sphagnum tenellum* (new to Torne Lappmark) only at Vassijaure and Katterjåkk near the Norwegian border (Fig. 4 D).

Potentilla erecta is most frequent on the climatically and edaphically deviating northern side of Lake Torneträsk (cf. Fig. 2 B).

With the exception of *Calluna, Molinia* and *Sphagnum tenellum* all mentioned species of the western distribution types occur in mire or spring vegetation on the northern side of Lake Torneträsk according to PERSSON (1961). *Potentilla erecta* and *Nardus stricta* are mentioned as western species too.

Ledum, Salix myrtilloides, Eriophorum medium and *E. russeolum* occur sparingly at Stordalen (see Fig. 2 A—B) but become more common towards the east. *Ledum* seems to grow only in terrestrial vegetation in the localities west of Torneträsk.

Pinguicula villosa occurs as a whole in small quantities, but the variability in frequency in the mires is puzzling. In some apparently suitable mires it is missing or very rare, in others rather frequent as in the westernmost locality indicated on the map (Fig. 2 A).[1] *Pinguicula villosa* occurs in several places in the Alpine zone too.

Dicranum elongatum in the mires has a clearly easterly distribution in the investigation area. This applies at least to the type growing as firm, dense cushions on the hummocks. The same is probably also the case with *Sphagnum balticum*. This species, however, is morphologically heterogeneous in the Torneträsk area, with types approaching *S. angustifolium* (cf. ISOVIITA 1966 p. 205).

Apart from *Pinguicula villosa, Carex livida* and *Sphagnum balticum* PERSSON mentions none of the other easterly species in question from the northern side of Lake Torneträsk. Neither does FRIES (1925) nor does SANDBERG (1963 b) from Vadvetjåkko, nor has the present author been able to find them there or in the vicinity of Vadvetjåkko.

Carex pauciflora occurs over the whole area but is very infrequent between Tornehamn and Stordalen. According to HULTÉN (1950) it has a disjunctive area of distribution in Northern Scandinavia, being missing or infrequent in a part comprising almost the whole of the Torneträsk area.

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[1] In 1967 also found about 6 km further to the west, at Katterjåkk.

In the Torneträsk area *Sphagnum magellanicum* has its westernmost known locality at Stordalen. It becomes more frequent towards the east. It is also common on the Norwegian side (cf. Fig. 4 B).

Sphagnum papillosum is found sparingly at Vassijaure and at Torneträsk. It is common on the Norwegian side (cf. Fig. 4 C) and seems also to increase towards the southeast.

Carex pauciflora is reported from the northern side of Lake Torneträsk by PERSSON (1961) but not either *Sphagnum magellanicum* or *S. papillosum.*

The variation in mire vegetation due to the differences in the distribution areas of the species of the types *1*—*2* is obvious when studying the variation of the whole area investigated in the west—east direction. In the Torneträsk area at the limits of their distribution in the mires, however, the quantities are generally low. Here the species of the type *3* are more important (cf. Table 1). Thus they show higher frequencies and are often prominent as dominants too.

Many of the mentioned species are only facultative mire plants and have their main distribution in terrestrial vegetation. They may have another type of distribution outside the mires, in many cases a much more even distribution.

ZONES OF TRANSITION IN THE VEGETATION

Along the vegetational gradients recognized it is possible to distinguish some regional limits in the mire vegetation of the investigation area. The limits are to be considered as more or less broad areas or zones of transition instead of border lines in a restricted sense.

Concerning the vegetation in the direction low—high altitude there is a zone of transition in the Low Alpine belt. It generally runs at a higher altitude than does the timberline. The level is, however, locally more or less influenced by exposure, edaphic conditions, etc. I cannot distinguish any limit along this gradient between Subalpine and Prealpine mires (cf. SJÖRS 1950 p. 187). However, after a closer investigation some subordinate zone might be established in the Alpine zone.

Concerning the vegetation in the direction west—east in the Torneträsk area a broad zone of transition runs through the Tornehamn region. At Tornehamn both the qualitative and the quantitative changes in the mire vegetation are greatest (cf. Fig. 2 A—B and Table 1). The zone does not run in a straight south to north direction but deviates to the east further to the north and south. At least below the timberline

Table 1. Survey of the west—east variation in a hummock community dominated by *Sphagnum fuscum*. Several indifferent species excluded. The frequencies (in per cent or as the quotients localities: occurrences) and the characteristic degrees of cover according to PERSSON 1961. A = the Alpine zone. *Empetrum hermaphroditum* incl. possible *E. nigrum*.

	Norway		Riksgränsen — — Björkliden		Björkliden — — Stenbacken		Torneträsk
Appr. altitude, m s.m.	850	150	600—1100	380—500	880—1000	340—600	350—380
	A		A		A		
Number of localities: squares (0.25 m^2)	1:1	1:4	4:8	8:27	4:11	6:24	2:5
Calluna vulgaris	$1/1^1$	$3/4^3$	.	.	.	.	.
Molinia coerulea	.	$1/4^1$	.	.	.	.	.
Potentilla erecta	.	$1/4^1$	.	.	.	.	.
Phyllodoce coerulea	$1/1^3$	.	38^2	33^1	.	.	.
Vaccinium myrtillus	.	$2/4^2$	50^2	93^2	9^3	.	40^1
Cornus suecica	.	$1/4^1$	13^1	22^2	.	.	.
Nardus stricta	.	.	.	7^1	.	.	.
Carex pauciflora	.	$1/4^1$	.	11^1	.	.	.
Trichoph. caesp. ssp. *austr.*	.	$1/4^1$	.	11^3	.	.	.
Carex rariflora	.	.	.	7^1	.	.	.
Pleurozium schreberi	.	$4/4^2$	38^1	59^3	9^1	4^1	20^1
Sphagnum fuscum	$1/1^5$	$4/4^5$	100^5	100^5	100^5	100^5	100^5
Betula nana	.	$3/4^2$	88^3	82^3	100^2	62^3	60^1
Empetrum hermaphroditum	$1/1^3$	$4/4^2$	75^3	93^3	100^3	100^2	80^3
Orthocaulis binsteadii	.	$2/4^1$	88^1	15^1	55^1	58^2	60^1
Pinguicula villosa	.	.	.	4^1	18^1	25^1	60^1
Ochrolechia frigida	.	.	.	4^1	.	21^1	.
Cetraria nivalis	.	.	38^1	7^1	36^1	45^1	.
Dicranum elongatum	.	.	.	.	36^2	71^3	40^1
Ledum palustre	.	.	.	.	.	.	80^4

it passes much more to the east on the climatically and edaphically deviating northern side than on the southern side of Lake Torneträsk.

To the east a subordinate zone of transition may be drawn where the eastern species of the types *1*—*2* (p. 278) become conspicuous. It seems to coincide approximately with the western limit of the Prealpine subzone as defined by DU RIETZ (1950).

Further to the west, on the Norwegian side, another zone of transition may be drawn delimiting the parts where the western species of the types *1*—*2* are prominent in the mires. However, since my investigations on that side are rather fragmentary I have no definite view concerning the importance and course of that zone. No doubt the mire vegetation of the whole of this westernmost part is more complex than that which appears from my analyses (SONESSON in prep., cf. also OSVALD 1925).

The differences in mire vegetation along the gradients low—high altitude and west—east also have parallels in the mire complexes themselves when considering them as topographic-geographic phenomena. With increasing altitude there is a rapid disintegration and disappearance of the structures that constitute mire complexes at lower levels. This is allied to a decreasing depth of peat. Where mires with a deep peat layer occur in the Alpine zone (only in the Low Alpine belt) the differences in topography in relation to corresponding mires at lower altitudes are slight.

The differences in the direction west—east are seen roughly in at least two respects. West of the Tornehamn area the frequency of sloping mires with relatively smooth surfaces (SJÖRS 1946 p. 90) is increasing. To the east the mires are more horizontal. The hummocks are also higher and more extended, forming broad island-like features or strings in the mires. This tendency culminates to the east and northeast (cf. FRIES 1913, G. LUNDQVIST 1951) in the high palses seen at e.g. Torneträsk. South of Lake Torneträsk the hummock vegetation east of the Tornehamn area rests to a large extent on frozen peat, even in late autumn frozen below a level of about 30—50 cm under the surface of the mire. This permafrost probably reaches deep into the mineral bottom strata (at least more than 20 cm in average). Also in the Alpine zone in the eastern parts such permafrost is proved in the mires investigated, provided the peat layer is not too shallow (further in SONESSON, in prep.).

Table 2. Occurrence of some species characterizing mire vegetation along the gradient low—high altitude in a hummock community dominated by *Sphagnum fuscum*. The number of occurrences refers to the squares analyzed, size 0.25 m². From the same primary material as in Table 1.

	Boreal zone						*Alpine zone*					
Appr. range of altitude, m s.m.	130—600						600—1100					
Depth of peat	frozen peat	>100 cm	>50—100 ,,	>20—50 ,,	>10—20 ,,	0—10 ,,	frozen peat	>100 cm	>50—100 ,,	>20—50 ,,	>10—20 ,,	0—10 ,,
Diapensia lapponica	.	.	.	.	.	.	.	.	.	.	.	1
Luzula arcuata coll.	.	.	.	.	.	.	.	.	.	.	1	.
Festuca spp.	.	.	.	.	.	.	.	.	.	.	2	.
Thamnolia vermicularis	.	.	.	.	.	.	.	.	.	2	1	.
Carex bigelowii	.	.	.	.	.	.	.	.	.	3	4	2
Calamagrostis lapp.	.	.	.	.	.	.	.	.	.	2	2	.
Salix herbacea	.	.	.	.	.	.	.	.	.	1	1	.
Pedicularis lapponica	.	1	1	2	.	.	.	.	.	2	.	1
Sphagnum fuscum	19	17	13	3	.	.	6	.	2	7	7	6

DISCUSSION

The Vegetational Gradient Low—High Altitude

Many species characteristic of Alpine mire vegetation are mountain or Scandian plants, i.e. species most frequently occurring in the Alpine zone and in the Subalpine belt but also found further down in the upper part of the Boreal zone though more or less sparingly (PERSSON 1961 p. 122).

But many species are evenly distributed or northern in Fennoscandia (see HULTÉN 1950). To this category of distribution belong some of the species referred to the type *d* (p. 277). *Lycopodium selago* (type *c*) may be placed in this category too.

The species of the types *a*—*d* are mainly distributed over terrestrial habitats, but most species of the type *e* (p. 278) are mire plants.

With regard to the restricted Torneträsk area *Rhacomitrium lanuginosum* seems to be Alpine, but concerning a more extended area of North Scandinavia it is better characterized as primarily western in mires (Fig. 3 C). *Rhacomitrium* as a prominent component of mire vegetation in oceanic areas is often referred to in literature (see JALAS 1955 and TALLIS 1958 and the literature quoted there). Beside the oceanic character of the mountains (cf. p. 274) the Alpine occurrence of *Rhacomitrium lanuginosum* is also connected with shallow peat layers (see below).

In terrestrial vegetation, especially on boulders, *Rhacomitrium* is common also below the timberline (cf. MÅRTENSSON 1956 a p. 128).

The ecologic conditions underlying the gradient low—high altitude are no doubt complex. Differences in temperature, length of the vegetation period, humidity, snow-cover may be mentioned in this connection together with the vegetational gradient west—east (see further below). Differences in exposure and stability of soil have probably a great significance also (cf. SJÖRS 1956 p. 180, PERSSON 1961 pp. 126—127). The occurrence in mires of many species almost entirely in the Alpine zone might depend on a thin peat layer. With the decreasing depth of peat with increasing altitude the habitat becomes more and more terrestrial (cf. Table 2). That condition must favour at least such species which also occur mainly below the timberline in terrestrial vegetation (e.g. *Rhacomitrium lanuginosum, Calamagrostis lapponica,* cf. SJÖRS 1950 p. 182).

In those cases where there are mires with a deep peat layer or — concerning hummock vegetation — where at least the lower strata of peat are permanently frozen, the differences in vegetation between Pre- and Subalpine and Alpine mires are slight and concerning the bottom-layer practically none (cf. SJÖRS op. cit. p. 187, PERSSON op. cit. p. 126).

The recognized zone of transition in the alpine mire vegetation may have a parallel in terrestrial vegetation too. When comparing e.g. the poor heath vegetation occurring in more or less close vicinity to the timberline, the differences between the vegetation above and below seem to be practically nil, apart from tree growth (cf. NORDHAGEN 1928 pp. 588, 594, 1943 p. 57, DU RIETZ 1942 p. 178, KILANDER 1965 pp. 78, 80, O. RUNE 1965 p. 73).

The Vegetational Gradient West—East

Most of the species when occurring in mires are hummock and/or lawn species.

Most of the species of the eastern distribution types have a more or less northeast distribution when considering the whole of North Scandinavia (HUL-

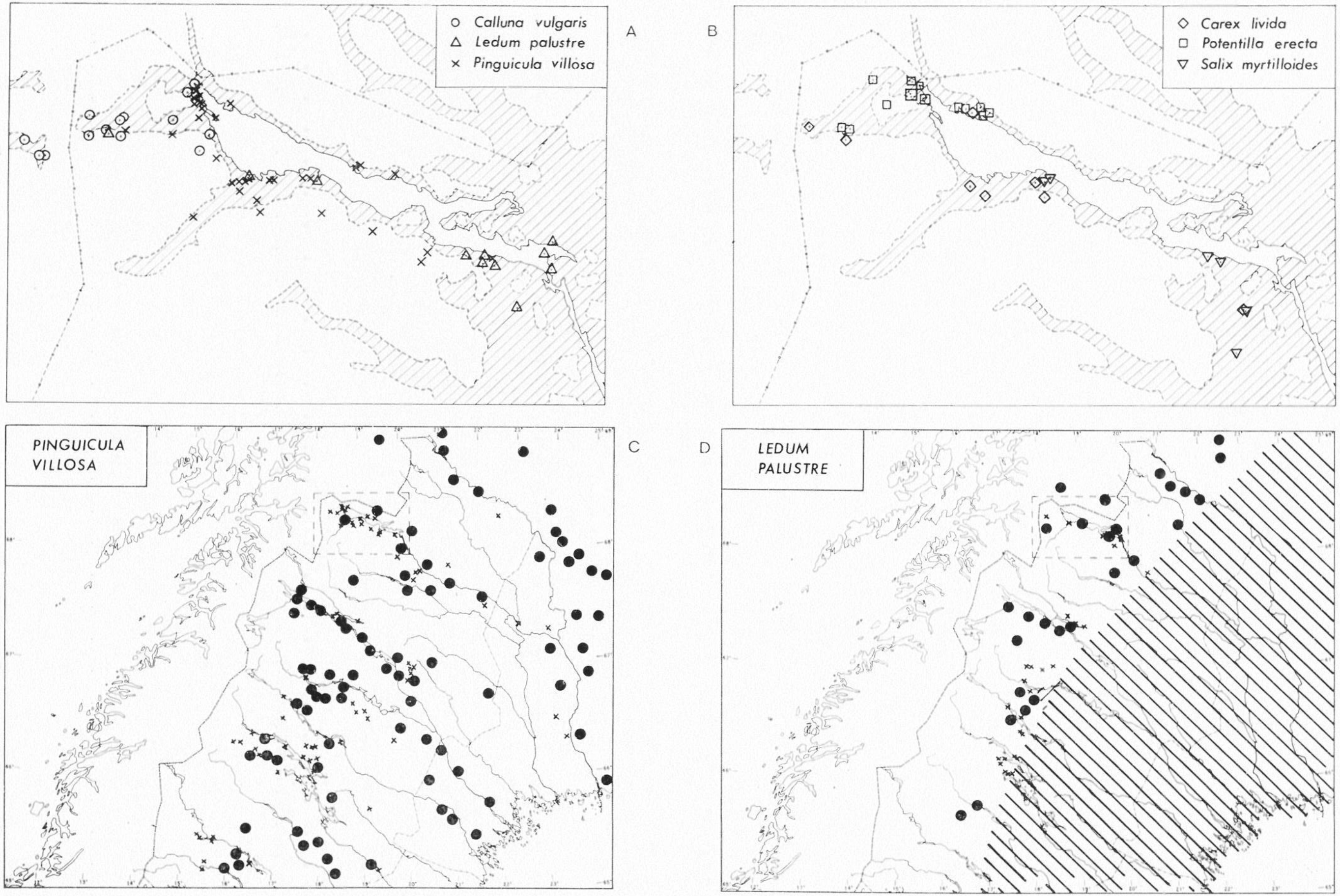

Fig. 2. A—B base-map after Fig. 1 A, area below timberline lined, C—D after HULTÉN 1950, with complementaries (×).

TÉN 1950) and according to SJÖRS (1956) many belong to the northeastern floristic element of Fennoscandia. Many are also characteristic of mire vegetation (cf. DU RIETZ 1956 pp. 70 et seq., S. RUNE 1965 b pp. 223—224, SJÖRS 1965 b pp. 187—188). *Pinguicula villosa, Cetraria delisei, Carex livida, Ledum palustre* and *Sphagnum balticum* are also prominent in mires further to the south and southeast (MELIN 1917, MALMSTRÖM 1923, SJÖRS 1948, 1950, HASSELROT 1953, DU RIETZ op. cit.).

Cetraria nivalis, C. cucullata and *Ochrolechia frigida* are northern species in Scandinavia characteristic of chionophobous vegetation in the mountains (NORDHAGEN 1927—1928, 1943, SJÖRS 1950, DU RIETZ 1952, HASSELROT op. cit., DAHL 1956, BRINGER 1961). *Cetraria delisei* has about the same distribution but has a wider amplitude so far as snow-cover, moisture and freezing in ice are concerned (DAHL op. cit.). Below the mountains it is restricted to poor mires (cf. DU RIETZ 1952, 1959, HASSELROT 1953). It is together with i.a. *Ochrolechia* prominent in the investigation area in depressions which drain late in spring and which have highly variable water conditions. *Cetraria delisei* is also encountered in snow-bed vegetation together with *Ochrolechia frigida.*

Dicranum elongatum according to MÅRTENSSON (1956 a p. 83) is "absent or very rare in S. and low-lying areas of Sweden but is present in Norwegian coastal areas down to sea level". "The distribution . . is concentrated in the Scandes and N. Fennoscandia . .". KALLIOLA (1939 p. 244) considers it ". . zu den Hauptarten der Tundra der Eismeergestade . .". *Dicranum elongatum* is a chionophobous species (at least with regard to the type described on p. 279) and is a characteristic follower to i.a. *Cetraria nivalis* in the mires. *Dicranum elongatum* and *Cetraria nivalis* seem to be especially common in mires in the upper and northern parts of the Subarctic and Boreomontane subzone which approximately corresponds to the Continental Subalpine subzone according to HÄMET-AHTI (1963), cf. FRIES (1913), DU RIETZ (1921) and RUUHIJÄRVI (1960). These species are also frequent in the Alpine and the Arctic zones.

Many species of the western distribution types have a southwest distribution when considering the whole of North Scandinavia. Some of them are referred by SJÖRS (1956) to the western Suboceanic element of Fennoscandia too. In this element mire plants and plants of wet heaths growing on mor soils are especially common. In typical cases their areas of distribution extend further to the north in Western Norway than in the interior of Scandinavia (see SJÖRS op. cit.). A few species, however, have a northwest distribution from a Scandinavian point of view.

Sphagnum tenellum, S. papillosum and *S. magellanicum* extend far to the north on the Norwegian side (cf. LID 1925, RØNNING 1965) but seem to be more or less southerly in Sweden and Finland (cf. Fig. 4 B—D, MÅRTENSSON 1956 a, b and literature quoted there and RUUHIJÄRVI op. cit.), thus indicating a Suboceanic distribution in Fennoscandia in SJÖRS' estimation.

Calluna vulgaris is evenly distributed over the whole of Scandinavia (HULTÉN 1950) but is less common in the Scandes. In the northern part of the Scandes and further to the northeast it is missing or very infrequent (Fig. 3 B). This is also the area where permafrost occurs in the mires (G. LUNDQVIST 1951).

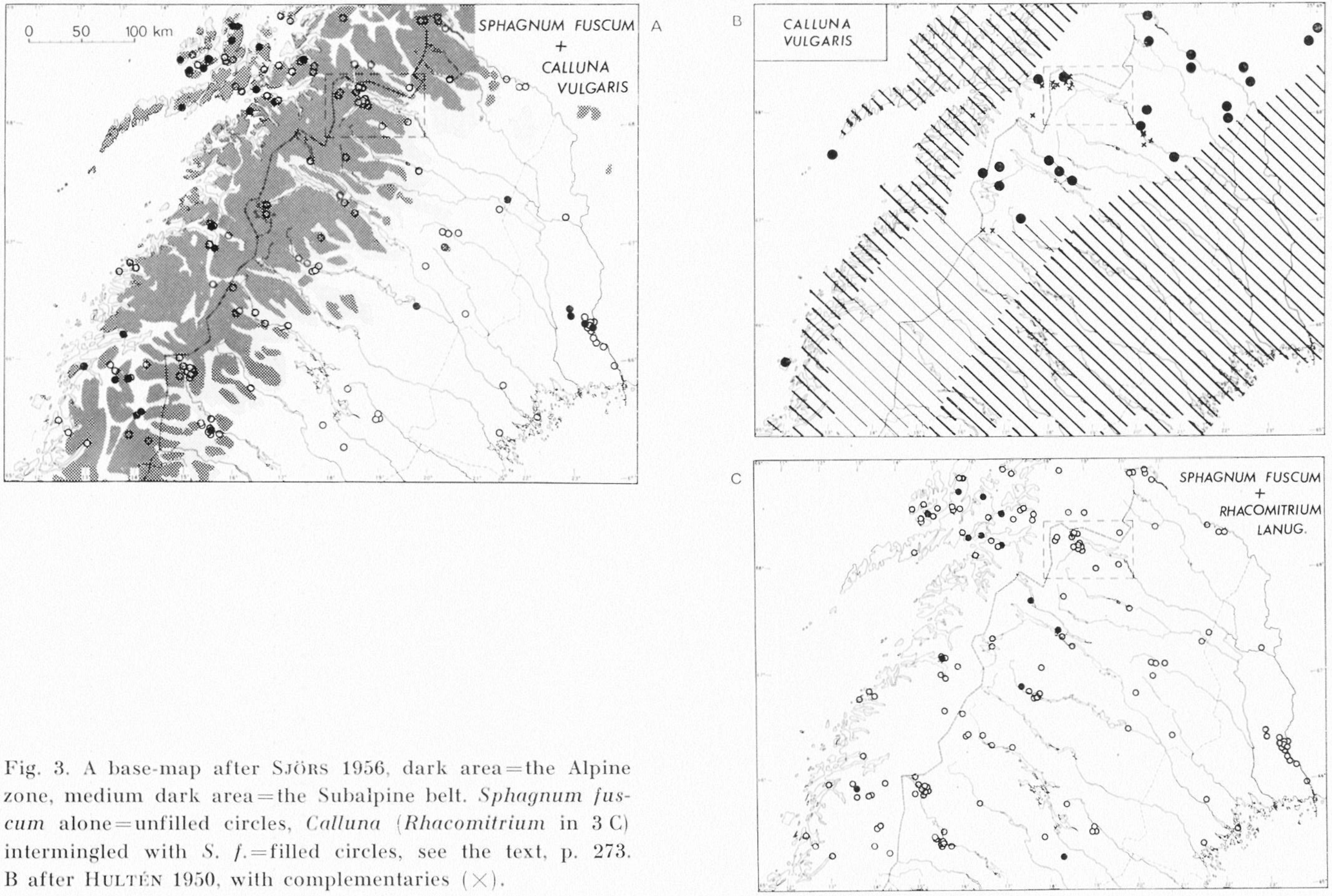

Fig. 3. A base-map after SJÖRS 1956, dark area = the Alpine zone, medium dark area = the Subalpine belt. *Sphagnum fuscum* alone = unfilled circles, *Calluna* (*Rhacomitrium* in 3 C) intermingled with *S. f.* = filled circles, see the text, p. 273. B after HULTÉN 1950, with complementaries (×).

Ruuhijärvi (op. cit. p. 148) considers frozen peat to be one principal reason why *Calluna* is absent in mire vegetation in North Finland (cf. Fries 1913 p. 341). In the area south of the Torneträsk area as in other parts of the interior of Swedish Lappland *Calluna* is, however, common on the shores of many lakes and rivers, where it forms a distinct "*Calluna*-belt" (Du Rietz 1925 p. 67, Björkman 1939 p. 28, J. Lundqvist & Wistrand 1964, S. Rune 1965 a, Wassén 1966, pers. comm. by Du Rietz, L. Granmark and S. Rune). In mires *Calluna* has a westerly type of distribution in North Scandinavia (Fig. 3 A). This is still more evident when also regarding the combination *Calluna-Sphagnum magellanicum* and *S. papillosum* (see p. 273). Though slighter, it seems, however, to have a likeness for the northeast parts near the Baltic Sea too. In Finland an affinity for *Calluna* to habitats even outside the mires in oceanic-maritime areas is described (Ruuhijärvi 1960 p. 147, Kalela 1961 p. 77, Hämet-Ahti 1963 p. 35).

Dahl (1956 p. 246) mentions from mountain areas *Calluna* and *Betula nana* as vicarious species in hummock communities: "*Calluna vulgaris* is a species which is dominant in oceanic areas, while *Betula nana* is a species with marked continental tendencies . .".

For racial differences within *Calluna vulgaris,* different migrant types etc., see e.g. Fries (l.c.), Arwidsson (1926 pp. 211—215) and Björkman (1939 pp. 216—217).

Drepanocladus badius and *Sphagnum teres* increase in frequency towards the north of Fennoscandia according to Mårtensson (1956 a).

Vaccinium myrtillus, Deschampsia flexuosa, Dicranum fuscescens and *Pleurozium schreberi* are evenly distributed in Scandinavia (Hultén 1950, Jensen 1939, Mårtensson op. cit.). They are characteristic of heath communities on well drained, moderately wet soils with a mor humus layer. They are more or less chionophilous in the mountains which might be the main reason why they display westerly types of distribution in the mires of the investigation area (cf. i.a. Nordhagen 1927—1928, 1943, Du Rietz 1942, 1950, 1964, Sjörs 1950, 1965 a, Dahl 1956, Kalela 1961, Havas 1965).

Though mainly chionophilous, *Deschampsia flexuosa* is also recorded from chionophobous vegetation (Dahl op. cit. p. 117). It is, however, a taxonomic heterogeneous species (Hylander 1955). *Deschampsia flexuosa* growing in oceanic mires in Scandinavia is described by e.g. Osvald (1925) and Sjörs (1956). In the area investigated it has been observed, though sparingly, on peat of more than 100 cm-deep at Vassijaure and at Katterjåkk.

Phyllodoce coerulea and *Carex rariflora* are considered to be primarily mountain plants or western (oceanic) mountain (arctic) plants by several authors (see e.g. Du Rietz 1956 p. 75, Persson 1961 p. 122, Wistrand 1962 pp. 164, 173, S. Rune 1965 b p. 225).

Calamagrostis lapponica, Deschampsia flexuosa and *Festuca ovina* may increase locally in quantity owing to biotic influence (Sandberg 1958 pp. 59—60, 1963 a p. 896, Hämet-Ahti 1963 p. 35, Steen 1965).

Many of the western species in the mires are mainly distributed over terrestrial habitats, especially on the heaths. The occurrence in mires of

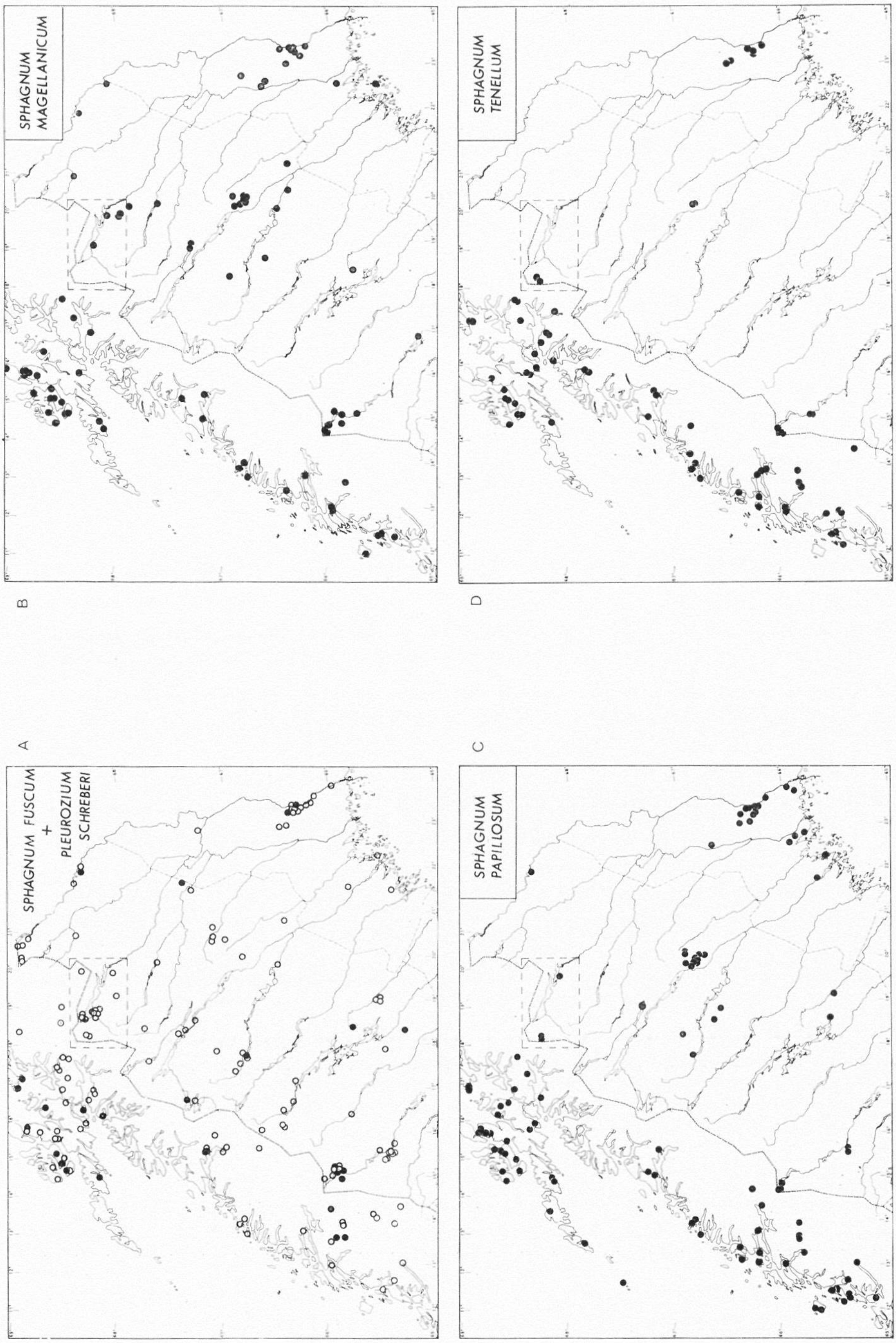

Fig. 4. A *Sphagnum fuscum* alone=unfilled circles, *Pleurozium* intermingled with *S. f.*=filled circles, see the text, p. 273.

these species may to some extent depend on the thin peat layers often occurring in the western, Subalpine parts of the investigation area as in the Alpine zone. Corresponding patches, however, also occur in the eastern mires, but these species are never or only rarely found there (usually restricted to the mire margins in those cases).

The gradient west—east in the vegetation has a prominent parallel in the gradient oceanic—continental climate (Fig. 1). Locally the climate may deviate through, e.g., the high mountains that guard against precipitation (especially prominent in the Abisko valley) or through large stretches of water that influence the temperature. Thus the large lake, Lake Torneträsk, affects the climate especially by lowering the summer temperatures and affording the surroundings a more oceanic character of temperature (cf. SANDBERG 1963 a). However, not until Tornehamn on the western shore of Lake Torneträsk and further to the west (concerning the northern side, see pp. 280—282) there is seen a prominent oceanic influence on the poor mire vegetation (especially on the hummock and lawn communities). The winter climate is perhaps more important than the summer one at least to the mire vegetation in the vicinity of Tornehamn and further to the east. Because of the slight snow cover in the eastern part (Abisko: mean annual precipitation less than 300 mm) the mires are more affected by frost than the mires further to the west and on corresponding parts on the northern side of Lake Torneträsk (mean annual precipitation equivalent to or exceeding that of Tornehamn, cf. Fig. 1).

The recognized main zone of transition through the Tornehamn area roughly coincides with that of the limit between the Oceanic Subalpine and the Continental Subalpine subzones of the Fennoscandian mountain birch forests according to HÄMET-AHTI (1963 Fig. 19). The westernmost exclaves of pine forests of the Torneträsk area (p. 276) coincide approximately with that zone too. The part in the Subalpine belt between this transitional zone and the western limit of the Prealpine subzone at Stenbacken seems to be horizontally analogous to the vertically extended part between the timberline and the main transitional zone of the Alpine zone. Thus the limits in the mire vegetation run parallel to but do not coincide with the biogeographical limits set by the trees (cf. RUUHIJÄRVI 1960 p. 245). This discrepancy may have some connection with an oceanic, although slight, tendency of climate even in the eastern parts of the investigation area (O. RUNE 1965 p. 70, cf. p. 274).

Concerning poor mire vegetation the importance of the limit between the Subalpine belt on the one side and the rest of the Boreal zone on the other is controversial (see DU RIETZ 1949 pp. 287, 301, SJÖRS 1950 pp. 186—187, cf. also MÅRTENSSON 1956 b p. 20).

The described discrepancy in vertical direction does not seem to be valid for rich mire vegetation, because the main vegetational zone of transition in the rich mire vegetation along the gradient low—high altitude coincides closely with the timberline according to PERSSON (1961 pp. 120, 124 and pers. comm.).

The regional vegetational gradients discussed are to some extent difficult to distinguish from each other and also from the local gradients. Since many Subalpine mires in the western part of the Torneträsk area are close to or touching the Alpine zone the recognized vegetational differences in west—east direction might depend partly on altitude too (cf. the distribution of *Rhacomitrium lanuginosum, Phyllodoce coerulea* and *Carex rariflora* pp. 283, 288). Concerning the regional gradients intergrading with the local ones may be mentioned the gradients west—east and mire margin—mire expanse (cf. *Deschampsia flexuosa* pp. 288, 290), west—east and poor—rich (cf. *Potentilla erecta* p. 279), low—high altitude and mire margin—mire expanse (cf. *Calamagrostis lapponica, Pedicularis lapponica* p. 277). Further in SONESSON, in prep.

Since the lower, eastern part of the Torneträsk area is situated on the Precambrian peneplane (cf. p. 276) the vegetational differences in west—east direction might be further emphasized for that reason as it is in Central and Southern Lappland (J. LUNDQVIST 1965, O. RUNE 1963, 1965, S. RUNE 1965 b). However, though details in the regional distribution of species are determined by edaphic, biotic and local-climatic factors, it is possible to refer the main regional patterns of distribution in the area to the influence of macroclimatic (and historic) factors.

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Chromosome Numbers in Othonna (Compositae)

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ABSTRACT

Somatic chromosome numbers of 34 species of *Othonna* (*Compositae-Senecioneae*) are listed. 58 collections were investigated. The basic number is invariably x=10, and most species are diploid (2n=20). Polyploidy occurs esp. among the tuberous-rooted species. Six tetraploids, three hexaploids, and one octoploid were found. Accessory chromosomes occur in two collections.

INTRODUCTION

The genus *Othonna* (*Compositae-Senecioneae*) comprises more than 100 species, all confined to Southern Africa. All species are perennial, but there is a considerable variation in their gross morphology. Many species are geophytes either with tuberous roots or rootstocks. Others are shrubs or half-shrubs, many of them with fleshy leaves or succulent stems. The taxonomy of the genus is very intricate. I have studied many species in nature and in cultivation with the aim of producing a revision of the whole genus in due time. Some data concerning chromosome numbers are presented in this paper.

PREVIOUSLY PUBLISHED CHROMOSOME NUMBERS IN OTHONNA

In earlier literature only six diploids have been reported, which are listed below.

O. brandbergensis B. Nord.	2n=20	(Nordenstam 1966)
O. carnosa Less.	n=10	(Afzelius 1924)
O. coronopifolia L.	n=10	(Afzelius 1949)
O. crassifolia Harv. (=*O. capensis* L. H. Bailey)	n=10	(Afzelius 1967)
O. protecta Dtr	n=10	(Afzelius 1967)
O. sedifolia DC.	n=10	(Ornduff et al. 1967)

MATERIAL AND METHODS

My material was collected in South Africa in 1962—64 and later cultivated in greenhouses in the Botanical Garden, Lund, either grown from seeds or brought to Sweden as living plants. Root tips were fixed in the Svalöf modification of the Navashin-Karpechenko fixative, embedded in paraffin, microtome-cut (usually 10 μ), and stained in crystal violet, sometimes with an addition of aniline. In some cases the plants were treated in a refrigerator (+2—4 °C) overnight before fixation.

The drawings of metaphase plates were made with the aid of a camera lucida.

Voucher specimens of the plant material are preserved in the Botanical Museum, Lund (LD).

RESULTS

The chromosome numbers determined in this investigation are presented in the table below.

Chromosome Numbers in Othonna

Species	Collection and voucher (N.=leg. B. NORDENSTAM)	Somatic chromosome number (2n)
alba COMPTON	S. Africa, Ceres: Karoo Poort, 1963, N. 3222	20
amplexicaulis THUNB. [Syn. *O. rigens* (L.) LEVYNS ex ADAMSON & SALTER]	S. Africa, Stellenbosch: Jonkershoek, The Twins, 1963, N. 3319	20
amplexicaulis THUNB.	S. Africa, Ladismith: Seven Weeks Poort, 1962, N. 1902	20
amplexifolia DC.	S. Africa, Paarl: Dutoitskloof Pass, 1962, N. 146	c. 80
auriculifolia LICHT. ex LESS.	S. Africa, Calvinia: Klip Koppies, 1963, N. 3005	20
auriculifolia LICHT. ex LESS.	S. Africa, Calvinia: Below Klip Koppies, 1963, N. 3014	20
bulbosa L.	S. Africa, Peninsula: Rooihoogte, 1962, N. 443	20
bulbosa L.	S. Africa, Somerset West: Steenbras River Mouth, 1962, N. 456	20
bulbosa L.	S. Africa, Cape Flats: Isoëtes Vlei, 1962, N. 984	40
bulbosa L.	S. Africa, Ceres: Kuinjes River, 1963, N. 3083	40
capensis L. H. BAILEY (Syn. *O. crassifolia* HARV.)	Cult. in Hort. Bot. Lund., 1964, N. 3933	20
carnosa LESS.	Cult. in Hort. Bot. Lund., 1964, N. 3932	20
ciliata L. f.	S. Africa, Malmesbury: Darling, 1963, leg. T. NORLINDH	20
clavifolia MARL.	S. Africa, L. Namaqualand: Arrisdrift, 1962, N. 1684	20
coronopifolia L.	S. Africa, Hopefield: Hopefield, 1963, N. 3287	20
coronopifolia L.	S. Africa, Peninsula: Between Retreat and Muizenberg, 1963, N. 3312	20
coronopifolia L.	S. Africa, Peninsula: South of Little Lions Head, 1966, DAHLGREN & STRID 4705	20

Species	Collection and voucher (N.=leg. B. NORDENSTAM)	Somatic chromosome number (2n)
cuneata DC.	S. Africa, Vanrhynsdorp: Nuwerus, 1962, N. 1365	20
cylindrica (LAM.) DC.	S. Africa, Vanrhynsdorp: Between Ebenezer and Strandfontein, 1963, N. 2969	20
dentata L.	S. Africa, Peninsula: Chapmans Peak, 1963, N. 3934	20
digitata L.	S. Africa, Peninsula: Cape Point, 1962, N. 438	20
digitata L.	S. Africa: Vanrhynsdorp: Giftberg, 1962, N. 688	40
digitata L.	S. Africa, Vanrhynsdorp: Giftberg, 1962, N. 1386	40
filicaulis JACQ.	S. Africa, Ceres: Karoo Poort, 1962, N. 501	20
filicaulis JACQ.	S. Africa, Calvinia: Willemsriver, 1963, N. 3020	20
filicaulis JACQ.	S. Africa, Calvinia: Botterkloof Pass, 1963, N. 3037	20
filicaulis JACQ.	S. Africa, Malmesbury: Mamre, 1962, N. 473	60
floribunda SCHLTR	S. Africa, L. Namaqualand: 25 m. N. of Port Nolloth, 1962, N. 1276	20
frutescens L.	S. Africa, Malmesbury: Saldanha Bay, 1963, N. 3294	20
herrei PILLANS	S. Africa, L. Namaqualand: Richtersveld, Stinkfontein, 1962, N. 1246	20
herrei PILLANS	S. Africa, L. Namaqualand: Richtersveld, Stinkfonteinberg, 1962, N. 1850	20
lasiocarpa (DC.) SCH. BIP.	S. Africa, L. Namaqualand: Richtersveld, Hellskloof, 1962, N. 1757	20
lasiocarpa (DC.) SCH. BIP.	S. Africa, L. Namaqualand: Richtersveld, Annisfontein, 1962, N. 1704	20 + 4 B
lasiocarpa (DC.) SCH. BIP.	S. Africa, L. Namaqualand: Anenous Pass, 1962, N. 3935	40
lasiocarpa (DC.) SCH. BIP. (ecotype "*litoralis*")	S. Africa, L. Namaqualand: 25 m. N. of Port Nolloth, 1962, N. 1273	20
lepidocaulis SCHLTR	S. Africa, Vanrhynsdorp: Komkans, 1962, N. 968	20
leptodactyla HARV.	S. Africa, Clanwilliam: Between Het Kruis and Leipoldtville, 1963, N. 3401	20
leptodactyla HARV.	S. Africa, Clanwilliam: Between Graaffwater and Clanwilliam, 1963, N. 3427	20
lobata SCHLTR	S. Africa, Calvinia: Klip Koppies, 1963, N. 3018	60 + 4 B
opima MERXM.	S. Africa, L. Namaqualand: Richtersveld, 8 m. N. of Annisfontein, 1962, N. 1722	20
osteospermoides DC. (Syn. *O. barkerae* COMPTON)	S. Africa, Ladismith: Seven Weeks Poort, 1963, N. 3118	20
petiolaris DC.	S. Africa, Vanrhynsdorp: Klawer, 1963, N. 3111	20
pinnata L. f.	S. Africa, Worcester: Hot Springs, 1962, N. 530	40
protecta DTR	S. Africa, Clanwilliam: Bulshoek, 1962, N. 572	20
protecta DTR	S.W. Africa, Swakopmund: 66 m. W. of Kuiseb Canyon, 1963, N. 2421	20
protecta DTR	S. Africa, Vanrhynsdorp: Holriver, 1963, N. 2933	20

Species	Collection and voucher (N.=leg. B. NORDENSTAM)	Somatic chromosome number (2n)
protecta DTR	S. Africa, Richmond: Between Schietkuyl and Richmond, 1963, N. 3212	20
quinquedentata THUNB. (Syn. *O. parviflora* L.)	S. Africa, Humansdorp: Karredouw Pass, 1963, N. 3125	20
quinquedentata THUNB.	S. Africa, Stellenbosch: Jonkershoek, The Twins, 1963, N. 3326	20
ramulosa DC.	S. Africa, Ceres: Karoo Poort, 1963, N. 3215	40
ramulosa DC.	S. Africa, Ceres: Verkeerde Vlei, 1963, N. 3232	60
sedifolia DC.	S. Africa, L. Namaqualand: 14 m. S. of Oranjemund, 1962, N. 1662	20
sedifolia DC.	S. Africa, L. Namaqualand: Richtersveld, Granite Boss, 1962, N. 1790	20
semicalva (DC.) SCH. BIP.	S. Africa, L. Namaqualand: Groot Vlei, 1963, N. 3936	20
sparsiflora (S. MOORE) B. NORD.	S. Africa, L. Namaqualand: Richtersveld, Arrisdrift, 1962, N. 1683	20
sparsiflora (S. MOORE) B. NORD.	S.W. Africa, Lüderitz-Süd, leg. H. MERXMÜLLER	20
stenophylla LEVYNS	S. Africa, Cape Flats: Isoëtes Vlei, 1962, N. 985	40
taraxacoides (DC.) SCH. BIP.	S. Africa, L. Namaqualand: Steinkopf, 1962, N. 638	20

DISCUSSION

The basic number in *Othonna* is x=10, which is also by many workers believed to be the original basic number of tribe *Senecioneae* (cf. ORNDUFF et al. 1963, 1967). Most species are diploid, but several cases of polyploidy occur. Tetraploids (2n=40) were found in four species with tuberous roots (sect. *Caulescentes* HARV.), viz. *O. bulbosa, digitata, pinnata,* and *stenophylla,* but also in the shrubby *O. ramulosa* (sect. *Fruticosae* HARV.) and in *O. lasiocarpa,* which fits into sect. *Carnosae* HARV. Hexaploids were found in three species, representing three different sections, viz. *O. ramulosa* (sect. *Fruticosae*), *lobata* (sect. *Carnosae*), and *filicaulis* (sect. *Caulescentes*). An obvious octoploid (2n=c. 80) is a collection of *O. amplexifolia* (sect. *Caulescentes*).

From the data available it seems that polyploidy is a common phe-

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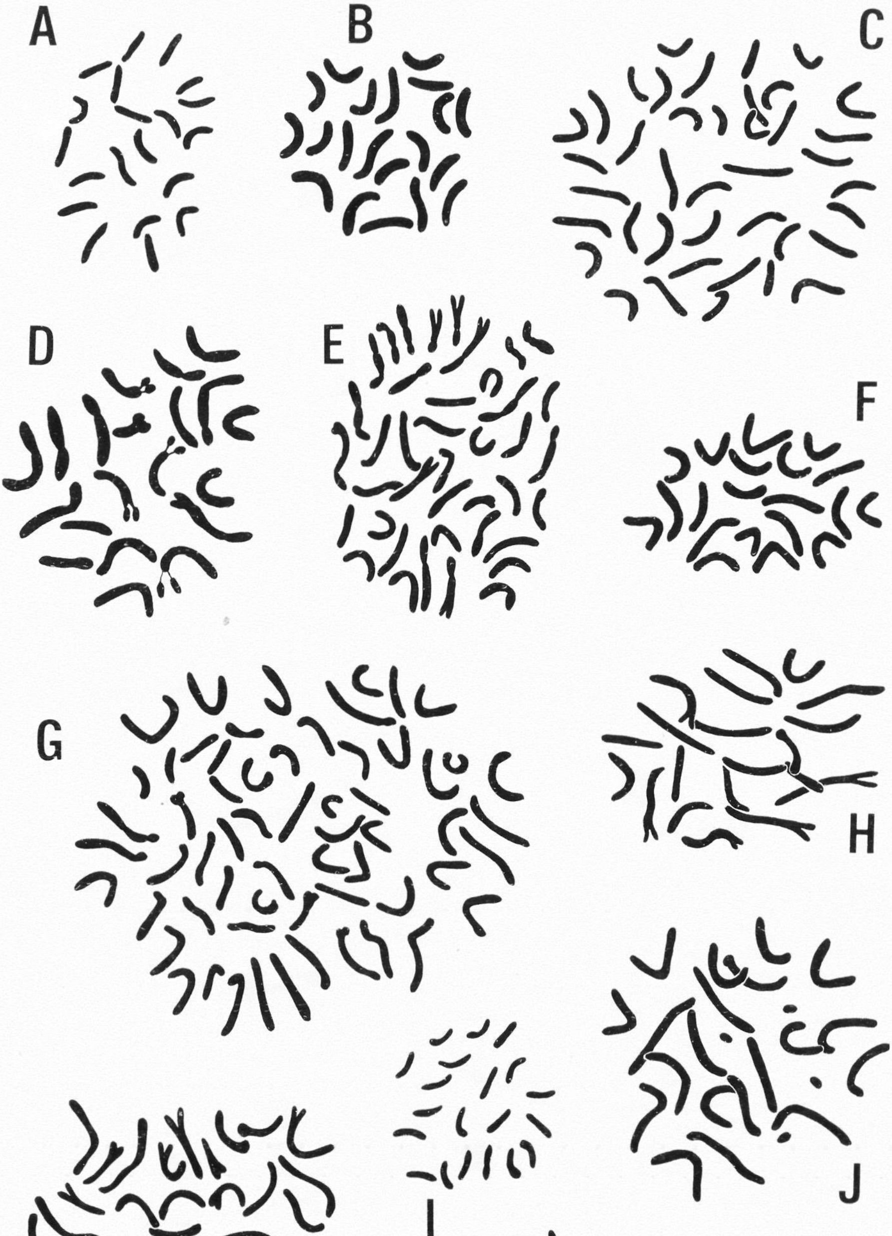
Fig. 1. Somatic metaphase plates in some *Othonna* species. A: *O. alba,* 2n=20, N. 3222. — B: *O. bulbosa,* 2n=20, N. 443. — C: *O. bulbosa,* 2n=40, N. 3083. — D: *O. digitata,* 2n=20, N. 438. — E: *O. digitata,* 2n=40, N. 688. — F: *O. filicaulis,* 2n=20, N. 3037. — G: *O. filicaulis,* 2n=60, N. 473. — H: *O. lasiocarpa,* 2n=20, N. 1757. — I: *O. opima,* 2n=20, N. 1722. — J: *O. lasiocarpa,* 2n=20+4 B, N. 1704. — K: *O. lasiocarpa,* 2n=40, N. 3935. — L: *O. lobata,* 2n=60+4 B, N. 3018.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nomenon in sect. *Caulescentes,* occasional in sect. *Fruticosae* and sect. *Carnosae,* and not known in the sections *Suffruticosae* HARV., *Paniculatae* HARV., and *Scapigerae* HARV.

Some taxa investigated are briefly discussed below.

O. amplexicaulis THUNB.

This is a fairly variable species, and the two collections investigated differ from each other in several details. My no. 1902 has rather small capitula and distinctly denticulate leaves [=var. *denticulata* (AIT.) HARV.], whereas no. 3319 has larger flowerheads with more conspicuous rays and smooth leaf-margins. These differences are maintained in cultivation, but I regard them as having little taxonomic value.

The name *O. rigens* (L.) LEVYNS ex ADAMSON & SALTER (1950) is illegitimate, as pointed out earlier (NORDENSTAM 1961).

O. amplexifolia DC.

The single collection studied is apparently an octoploid (2n=c. 80). The species has a wide distribution range and exhibits a variation similar to that of the related species *O. filicaulis.* Further cytological investigations will very likely prove rewarding.

O. bulbosa L.

Of the four collections studied, two turned out to be diploids (2n=20) and two tetraploids (2n=40). The tetraploid from Ceres Division (N. 3083) is morphologically distinguishable from the others by its smaller leaves and capitula, fewer involucral bracts (normally only 8), etc. The tetraploid from Cape Flats, however, is remarkably similar to the diploids. In nature both tetraploids were growing in moister habitats than the diploids. It has often been observed, that polyploids prefer wetter habitats than the corresponding diploids. This phenomenon is explained by the change in osmotic pressure caused by polyploidization.

O. digitata L.

The two cytotypes found are morphologically very much alike. The diploid is southern, collected at Cape Point, and the tetraploid comes from the northern part of the distribution range, viz. the Giftberg in Vanrhynsdorp Division.

O. filicaulis JACQ.

In this case the two cytotypes found are morphologically quite distinct. The diploids (Ceres and Calvinia Divisions) are rather tall-growing with wiry weak stems, getting support from other vegetation. The leaves are lanceolate or even linear from a broader, cordate and clasping base, and the leaf tips are more or less acuminate. The flowerheads are borne usually two or more together on the same branch. The hexaploid, on the other hand, is free-growing in sand (Malmesbury Division). It has short erect branches from an often creeping main stem. The leaves are broad, more or less elliptic or ovate to obovate, and shortly mucronate. The capitula are always single with rather short pedicels.

This species complex needs further study, and an attempt at a taxonomic treatment of the two cytotypes would be premature at present.

O. lasiocarpa (DC.) SCH. BIP.

The diploids and the tetraploid were all collected in the same geographical area. There are no obvious morphological differences between the two cytotypes. The most deviating collection is no. 1273, which belongs to the form series described as *O. litoralis* DTR. MERXMÜLLER regards it as a coastal ecotype of *O. lasiocarpa* (MERXMÜLLER 1965).

In no. 1704 four accessory chromosomes were found in addition to the normal set of 20 (Fig. 1 J).

O. lobata SCHLTR

The collection studied is a hexaploid with 2n=60 and four accessory chromosomes. These are small and rounded (Fig. 1 L), similar to those found in *O. lasiocarpa.*

O. ramulosa DC.

The tetraploid and the hexaploid are morphologically very similar. The most closely related species is probably *O. coronopifolia,* which is diploid. Probably *O. ramulosa* can be regarded as a polyploid complex derived from ancestors allied to *O. coronopifolia.*

ACKNOWLEDGEMENTS

For my research in South Africa I was awarded the Smuts Memorial Fellowship for 1962—63 and grants from the Swedish Natural Science Research Council, the Royal Swedish Academy of Science, and the Lennander Foundation, Uppsala. For my subsequent research in Lund financial support was received from the Royal Physiographical Society in Lund and the University of Lund. I am most grateful to Prof. H. B. RYCROFT, Kirstenbosch, who supervised my research in South Africa and provided me with all necessary facilities. My special thanks are due to Mr. HARRY HALL, Senior Horticulturist at Kirstenbosch, for his invaluable assistance and friendly companionship on botanical tours hunting rare *Othonna* species.

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Aizoaceae – A Study of its Embryology and Systematics[1]

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ABSTRACT

This study deals with the life history of *Aptenia cordifolia* and post-fertilization development in *Delosperma cooperi*. In *Aptenia cordifolia* the flowers are bisexual, regular and epigynous. The calyx consists of four sepals which are covered with bladder-like epidermal cells. There are numerous stamens of which the outer ones are petaloid and represent the staminodes.

The ovary is tetralocular with numerous ovules in each locule, borne on axile placentae.

The anther is tetrasporangiate and possesses four wall layers. The innermost constitutes the secretory tapetum comprising multinucleate and polyploid cells. Cytokinesis is simultaneous and results in tetrahedral or decussate tetrads. The pollen grains contain copious starch and are shed at the 3-celled stage.

The ovules are bitegminal and crassinucellar. They are anacampylotropous and are subtended by long funiculi. A placental obturator is present. The inner integument forms the micropyle and swells at the distal end to form a collar. Although the presence of an aril is a common feature in the family, it is absent in *Aptenia*. The cells of the nucellar epidermis divide actively and along with the highly stretched parietal cells constitute a nucellar cap. The nucellus persists in the seed as perisperm.

The ovular archesporium is usually many-celled. Although usually only one cell develops further, sometimes two others may also persist until the initiation of sporogenesis.

The development of the embryo sac corresponds to the Polygonum type. The polar nuclei are surrounded by starch grains and the antipodal cells are ephemeral.

The endosperm is Nuclear and shows a chalazal accumulation of cytoplasm and large nuclei. It is a folded (*Aptenia*) or a horse-shoe-shaped structure (*Delosperma*) at maturity. Cell formation occurs throughout the endosperm in *Delosperma* but only at the micropylar end in *Aptenia*. The ripe seeds are exalbuminous.

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[1] The article is part of a thesis approved by the University of Delhi for the award of the Ph.D. degree.

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The embryogeny corresponds to the Solanad type. The embryos have a massive suspensor made up of hypertrophied cells. The mature embryo is dicotyledonous and curved. Indications of suspensor polyembryony are shown by *Aptenia*.

Both the integuments participate in the formation of the seed coat. Initially each consists of two layers of cells. After fertilization, the outer layer of the outer integument enlarges conspicuously and the cells become thick-walled and filled with tannin. The inner epidermis of the outer and outer epidermis of the inner integument become compressed and eventually degenerate.

A comparison of the morphology and embryology of different subgroups of the family *Aizoaceae* leads to the conclusion that (*1*) the subfamily *Molluginoideae* need not be raised to the rank of a family, (*2*) the tribe *Mesembryanthemeae* should be elevated to the status of a subfamily, and (*3*) *Tetragonia* should be placed in an independent subfamily, *Tetragonioideae*.

INTRODUCTION

The status of various taxa within the *Aizoaceae* is problematic. BENTHAM & HOOKER (1862—1883) divided the family into three tribes — *Mesembryeae, Aizoideae* and *Mollugineae,* and ENGLER & PRANTL (1889) recognised two subfamilies, *Molluginoideae* and *Ficoideae*. HUTCHINSON (1926, 1959) split the *Aizoaceae* into two families designating them *Molluginaceae* and *Ficoidaceae*, an opinion which was supported by TAKHTAJAN (1959) and MELCHIOR (1964). FRIEDRICH (1955) removed *Tetragonia* and *Tribulocarpus* from the *Ficoidaceae* of HUTCHINSON and included them in the new family *Tetragoniaceae*, while SCHWANTES (1947; quoted in JACOBSEN 1960) and HERRE & VOLK (1950; quoted in JACOBSEN 1960) pleaded for the separation of the mesembryanthemums from the *Ficoidaceae* to form the family *Mesembryanthemaceae*.

As compared to the size of the family (150 genera and 2600 species) the number of embryologically investigated species are few. The present study incorporates the life history of *Aptenia cordifolia* (L.f.) SCHWANT., and post-fertilization events in *Delosperma cooperi* (HOOK. f.) L. BOL.

MATERIALS AND METHODS

Bud, flowers and fruits of *Aptenia* and fruits of *Delosperma* were collected from the plants growing in Botanical Gardens of the University of Delhi in March—April 1963, 1964. They were fixed in FAA (5 ml neutral formalin+5 ml glacial acetic acid+90 ml of 70 percent ethanol) and embedded in paraffin after dehydration. Sections were cut between 8—15 microns and stained in safranin-fast green and the details of microsporogenesis were studied from propionocarmine squashes. Acetolysed pollen grains were also examined (see ERDTMAN 1960).

OBSERVATIONS

1. Aptenia cordifolia

EXTERNAL MORPHOLOGY

The plants are trailing herbs with profuse prostrate branches. The leaves are opposite, entire, petiolate, cordate-ovate, up to 2 cm long and nearly as broad. The purple red flowers are borne terminally or laterally in the axils of leaves, and are bisexual, pedicellate, epigynous and regular. Two of the four sepals are broad and alternate with two narrow ones, but both types are covered with small saccate protuberances all over their outer surfaces. There are several whorls of stamens, the outer being petaloid and constitute the staminodes. Each stamen consists of a short filament bearing a reniform anther. The ovary is inferior, tetracarpellary and syncarpous with axile placentation. Each of the four locules contains many ovules. There are four sessile stigmas. The fruit is a capsule.

MICROSPORANGIUM

The anther is tetrasporangiate (Fig. 1 A, B) and its wall is made up of four cell layers — the epidermis, endothecium, middle layer and secretory tapetum (Fig. 1 D, E). At places the endothecium is biseriate. The tapetal cells are densely cytoplasmic and in each a large vacuole develops which displaces the nuclei to a peripheral position. The tapetal nuclei undergo divisions and fusions (Fig. 1 G—M) resulting sometimes in the polyploid condition. Rarely a tapetal cell was observed which contained up to seven small nuclei and presumably fusion of daughter nuclei was suppressed.

At the time of dehiscence the anther wall comprises two layers: (*a*) an epidermis of cells with an irregular outline and covered by cuticle and (*b*) an endothecium which had developed fibrous thickenings at the uninucleate stage of the pollen grain (Fig. 1 C, F). The partition wall between the adjacent locules breaks down and the pollen grains are discharged through a longitudinal slit on each side of the anther.

MICROSPOROGENESIS AND MALE GAMETOPHYTE

Cytokinesis in the microspore mother cells is simultaneous (Fig. 1 N—P) and results in the formation of tetrahedral or decussate tetrads (Fig. 1 Q, R) which are enclosed by a mucilagenous substance. The microspores become rounded after liberation from the tetrads and each develops a thick exine (Fig. 1 S). The nucleus of the microspore divides and cuts off the generative cell towards the periphery of the vegetative cell (Fig. 1 T). The generative cell divides to form two male cells. The pollen grain at the time of shedding is 3-celled, tricolporate and filled with starch grains (Fig. 1 U, V).

MEGASPORANGIUM, MEGASPOROGENESIS AND FEMALE GAMETOPHYTE

The ovules are anacampylotropous, bitegminal and crassinucellar, with the micropyle formed by the swollen lips of the inner integument (Fig. 4 C). The archesporium is one- to many-celled, but only one of these cuts off a primary parietal cell and undergoes further development (Fig. 2 A—C). The sporogenous cell thus formed enlarges and becomes the megaspore mother cell (Fig. 2 D). Sometimes a few archesporial cells persist below the megaspore mother cell (Fig. 2 E). A linear tetrad of megaspores is formed as a result of reduction division in the megaspore mother cell. The chalazal megaspore functions and its nucleus undergoes three successive mitoses to form an 8-nucleate embryo sac of the Polygonum type (Fig. 2 F—H). The polar nuclei fuse before fertilization and the secondary nucleus is surrounded by starch. The three antipodal cells are ephemeral.

ENDOSPERM

The division of the primary endosperm nucleus precedes that of the zygote and is not followed by wall formation. As early as the 2-nucleate stage (Fig. 3 A) the chalazal portion of the endosperm contains denser cytoplasm and subsequently forms a caecum. Repeated nuclear divisions result in a large number of nuclei, most of which are restricted to the chalazal pole. By the time a globular embryo is formed, the embryo sac has invaded the chalazal nucellus and develops a double fold (Fig. 4 D). Cell formation commences at the globular stage of the embryo and is restricted to the micropylar pole where a few cells are formed.

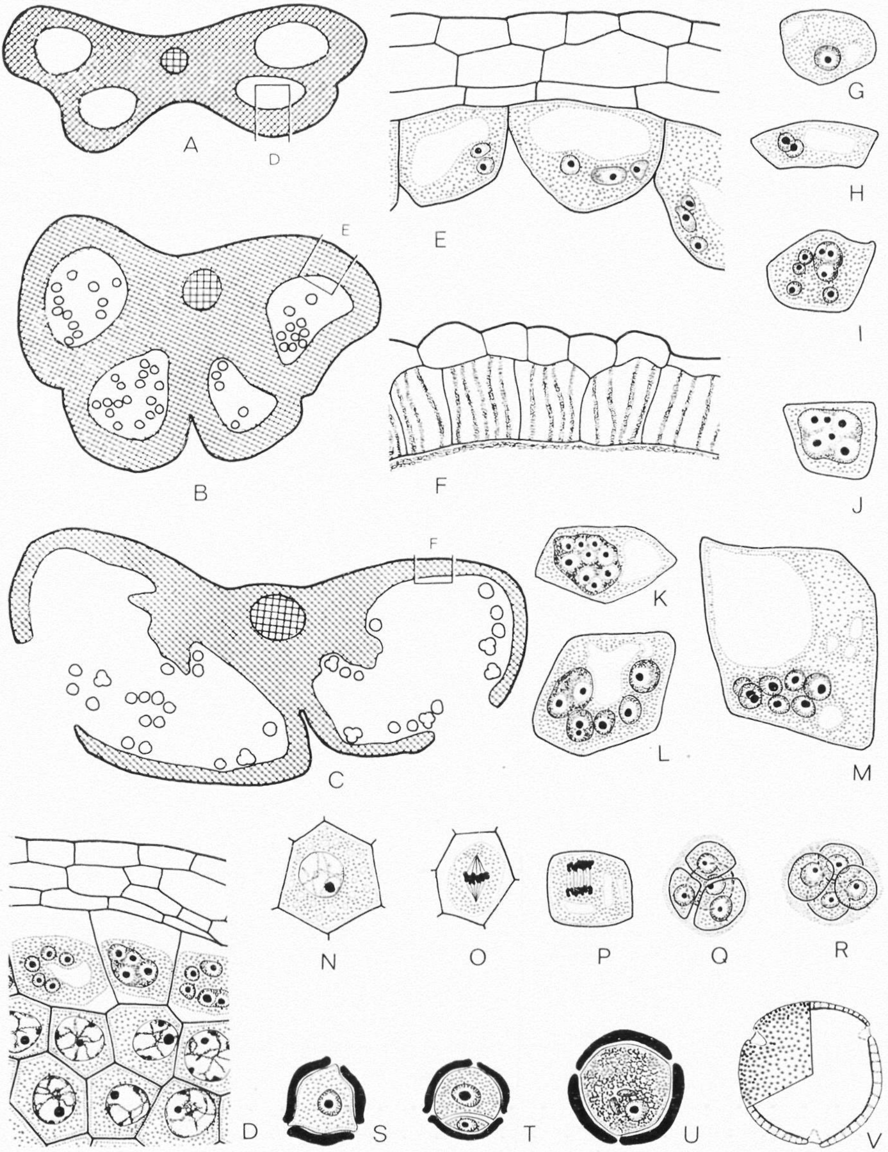

Fig. 1. *Aptenia cordifolia* A—C: Cross sections of anthers at various stages of development (diagrammatic.) — D: Enlarged view of portion marked *D* in A to show microspore mother cells and wall layers. — E: Magnified view of sector marked *E* in B to show vacuolate and multinucleate tapetal cells and other wall layers. — F: Wall layers of a dehisced anther enlarged from region *F* marked in C; endothecium shows fibrous thickenings and epidermal cells are healthy. — G—M: Tapetal cells showing nuclear divisions and fusions. — N—P: Meiosis I in microspore mother cells. — Q, R: Tetrahedral and decussate microspore tetrads. — S—U: One, 2 and 3-celled pollen grains. — V: Palynogram. — A—C ×110, D—V ×705.

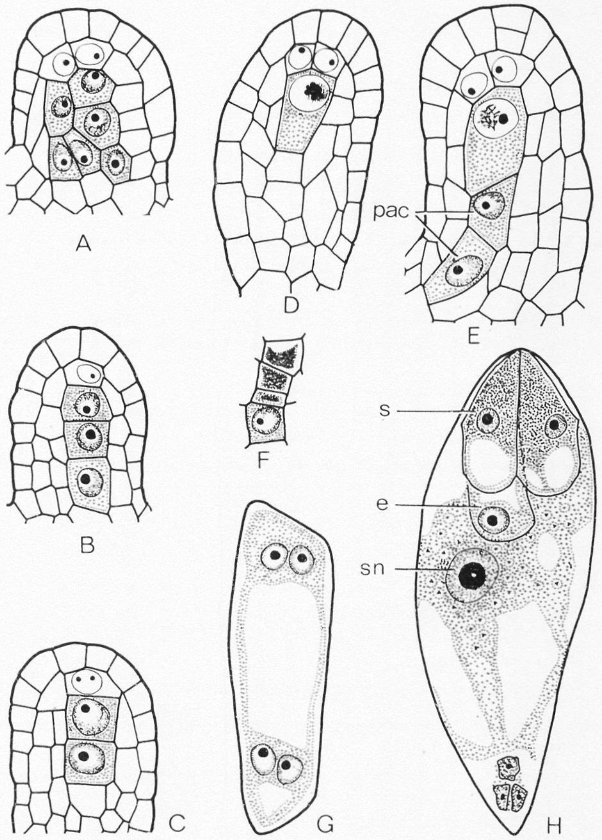

Fig. 2. *Aptenia cordifolia* (*e*, egg; *pac*, persistent archesporial cell; *s*, synergid; *sn*, secondary nucleus.) — A—C: Longisections of young nucelli showing archesporial and sporogenous cells; parietal cells are also seen. — D, E: Same, showing megaspore mother cells; two archesporial cells are persisting in E. — F: Linear megaspore tetrad; chalazal megaspore is healthy whereas others have degenerated. — G: Four-nucleate gametophyte. — H: Organized embryo sac; polar nuclei have fused and antipodal cells are degenerating. Plenty of starch accumulates around the secondary nucleus. — A—H ×696.

The remainder of the endosperm remains nuclear until broken down in older seeds.

The nucellar tissue situated in between the folds of the endosperm persists in the seed and constitutes the perisperm. Its cells accumulate starch and in the absence of an active endosperm help to nourish the embryo.

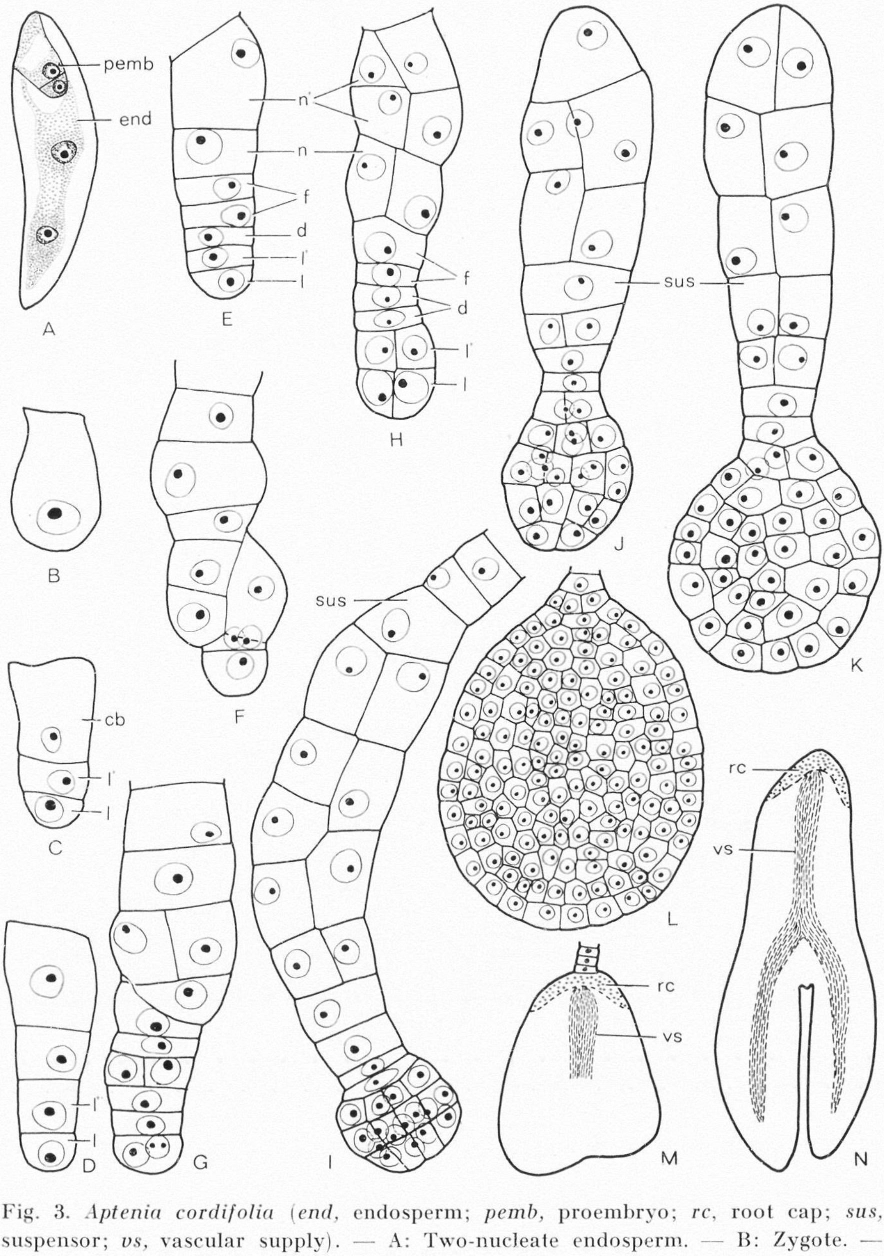

Fig. 3. *Aptenia cordifolia* (*end*, endosperm; *pemb*, proembryo; *rc*, root cap; *sus*, suspensor; *vs*, vascular supply). — A: Two-nucleate endosperm. — B: Zygote. — C—E: Linear, uniseriate proembryos. — F, G: Linear proembryos showing budding from suspensor. — H—L: Stages leading to the formation of globular embryo; note massive suspensor in I—K. — M, N: Stages in the differentiation of cotyledons. — A, M ×306, B—K ×790, L ×423, N ×195.

EMBRYO

The zygote divides transversely and forms a terminal cell *ca* and a basal cell *cb*. The cell *ca* undergoes a transverse division to form the tiers *l* and *l'* whereas *cb* gives rise to *m* and *ci*. Repeated transverse divisions in *m* and *ci* result in a uniseriate, filamentous proembryo which is often as long as seven cells (Fig. 3 B—E). The basal cells of the proembryo are hypertrophied and vacuolate whereas the terminal cells are small and contain dense cytoplasm. Subsequently however, the suspensor becomes biseriate by vertical divisions. In two ovules the linear proembryos showed lateral budding (Fig. 3 F, G) but none of the mature seeds examined contained more than one embryo. Vertical wall formation is initiated in *l* and *l'* (Fig. 3 H) and is followed by divisions in diverse planes so that a globular embryo is produced (Fig. 3 I—L). This later differentiates into a heart-shaped structure (Fig. 3 M). The mature embryo is dicotyledonous (Fig. 3 N) and curved. The suspensor is massive, biseriate along most of its length, and consists of conspicuously large uninucleate cells.

SEED COAT

In the early stages of development (Fig. 4 A, B) each of the two integuments of the ovule consists of two layers of rectangular parenchymatous cells (Fig. 4 E, F). Soon the distal end of the inner integument becomes 3—5 cells thick and constitutes a collar around the micropyle. After fertilization the cells of the outer epidermis of the outer integument and the inner epidermis of the inner integument enlarge (Fig. 4 C, G) and show deposition of tannin. When a globular embryo is formed (Fig. 4 D), two layers of the seed coat are prominent: (i) the outer layer of the outer integument whose cells become radially

Fig. 4. *Aptenia cordifolia* (*ii*, inner integument; *nu*, nucellus; *oi*, outer integument). — A, B: L.s. ovules at archesporial and megaspore mother cell stages respectively (diagrammatic). — C. D: L.s. immature and ripe seeds (diagrammatic). — E: Portion *E* marked in A magnified to show integuments at archesporial cell stage. Both consist of two cell layers along their major length. — F: Portion *F* enlarged from B. Outer integuments is 2-layered throughout but the inner becomes many-layered near its tip. — G: Portion *G* marked in C magnified to show enlargement and vacuolation of cells of the outer layer of outer integument and degeneration of the cells of the outer epidermis of the inner integument. Copious tannin is present in the cells of the outer layer of outer integument and inner layer of inner integument. — A—C ×82, D ×41, E—H ×800.

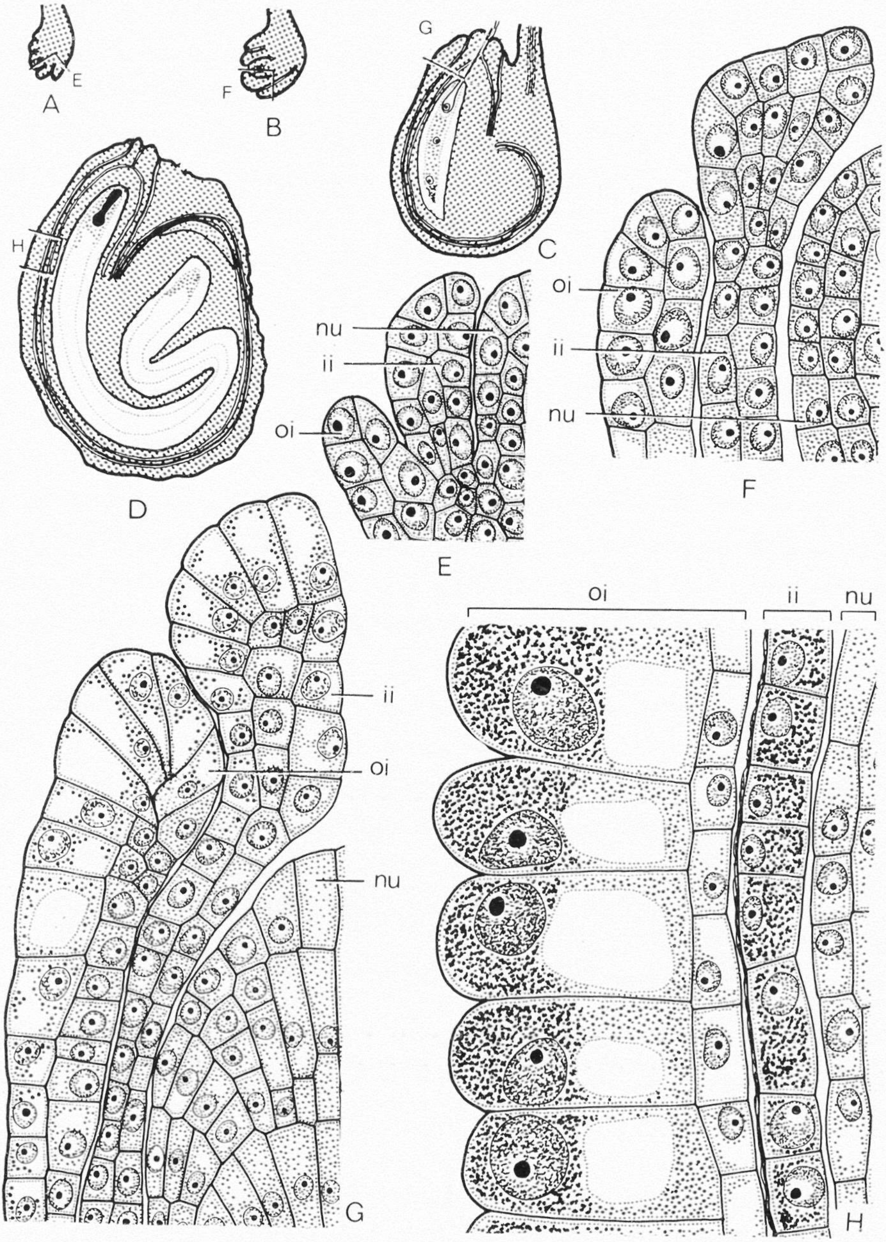

Fig. 4.

elongated and show accumulation of excessive tannin along their tips, and (ii) the inner layer of the inner integument which also contains tannin (Fig. 4 H). On the other hand, the inner epidermis of the outer integument is represented by compressed cells with scanty cytoplasm and the outer epidermis of the inner integument is completely disorganized.

2. **Delosperma cooperi**

ENDOSPERM

The endosperm is Nuclear and the division of the primary endosperm nucleus precedes that of the zygote. A large number of free nuclei are produced as a result of repeated divisions and, as in *Aptenia cordifolia,* many of these are larger and aggregate in the chalazal caecum which is densely cytoplasmic. Some nuclei are also present around the suspensor of the embryo, and others in a thin layer of cytoplasm along the periphery of the endosperm. Nucellar cells lying in the immediate vicinity of the caecum collapse suggesting a haustorcial function of the caecum. Cell formation is sparse and commences at the micropylar pole at the late globular stage of the embryo. The endosperm does not form a compact tissue but consists of loosely arranged cells. At maturity the embryo sac with the contained endosperm becomes curved (Fig. 6 D).

As the activity of the endosperm declines, the nucellar cells lying in the fold of the endosperm show deposition of reserve materials and constitute the perisperm.

EMBRYO

The division of the zygote is transverse and results in a terminal cell *ca* and a basal cell *cb*. These now divide transversely to give rise to a linear proembryo with the cells designated as *l, l', m* and *ci* (Fig. 5 A—C). The tiers *m* and *ci* divide repeatedly by transverse walls forming a long uniseriate, filamentous structure of about 11 cells (Fig. 5 D—F) whereas *l* and *l'* divide by vertical walls to give rise to the quadrant and the octant stages of embryos. By subsequent periclinal and anticlinal walls a globular embryo is produced (Fig. 5 G—O) which subsequently differentiates into a heart-shaped (Fig. 5 P) and finally a dicotyledonous embryo (Fig. 5 Q). The tier *l* gives rise to the cotyle-

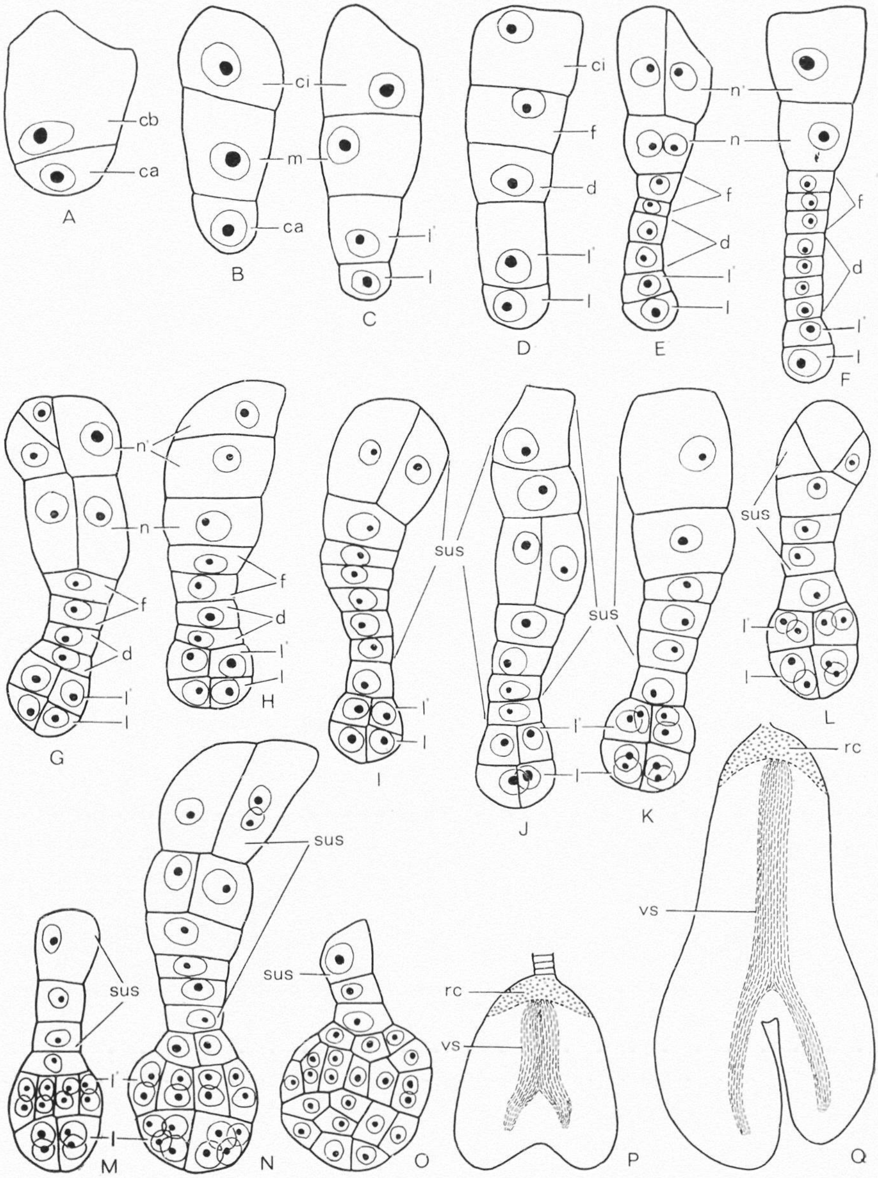

Fig. 5. *Delosperma cooperi* (*rc*, root cap; *sus*, suspensor; *vs*, vascular supply). — A—F: Stages in the formation of filamentous proembryo. — G—O: Stages leading to the differentiation of globular embryo; note large suspensor in G—J, N and comparatively short suspensor in M and O. — P, Q: Young and mature dicotyledonous embryos. — A—O ×628, P, Q ×259.

donary portion and *l'* to the hypocotyl, periblem and plerome of the root. Some derivatives of *m* lying in the immediate vicinity of the tier *l'* produce the root tip. All other descendants of *m* and *ci* constitute the suspensor. The development thus conforms to the Solanad type.

The basal cells of the suspensor become conspicuously enlarged even at an early stage, show scanty cytoplasm but hypertrophied nuclei. Often one or two basal (Fig. 5 G, N) and sometimes intercalary (Fig. 5 J) cells of the suspensor divide by vertical walls. Although in a majority of the seeds the suspensor is appreciably long, in some it is very short and consists of only a few cells (Fig. 5 L, M, O).

SEED COAT

The seed coat is formed by both the integuments, each of which consists of two layers of parenchymatous cells (Fig. 6 A, E). The cells of the outer layer of the outer integument are slightly larger and contain vacuolate cytoplasm and large nuclei. Conversely, the inner epidermis of the inner integument consists of small cells with dense cytoplasm and relatively small nuclei. Except for the compression of the inner layer of the outer, and outer layer of the inner integument, the integuments maintain the same structure until the time of fertilization (Fig. 6 B, F).

Soon after fertilization, tannin is deposited in the outer layer of the outer and to a lesser extent in the inner layer of the inner integument in the form of small darkly staining granules. The cells of the outer epidermis of the outer integument increase three times their original size (Fig. 6 C, G). At the globular stage of the embryo (Fig. 6 D, H) the outer epidermis of the inner and then the inner epidermis of the outer integument lose their identity. The tannin granules coalesce and

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Fig. 6. *Delosperma cooperi*: (*ii*, inner integument; *nu*, nucellus; *oi*, outer integument). — A—D: Longisections of ovules and seeds at various stages of development (diagrammatic). — E: Region *E* marked in A enlarged to show integuments at megaspore mother cell stage. Both integuments comprise two layers of parenchymatous cells each. — F: Portion marked *F* magnified from B. Cells of outer layer of the outer integument have enlarged whereas those of other layers have elongated tangentially. — G: Sector *G* labelled in C enlarged to show seed coat at linear proembryo stage. Cells of outer layer of outer integument have not only enlarged but also contain tannin. — H: Segment *H* denoted in D magnified to depict enormous enlargement of cells of the outer epidermis of outer integument and obliteration of outer layer of inner integument. Tannin abounds in cells of outer layer of outer integument and inner layer of inner integument. — A ×67, B—D ×112, E—H ×710.

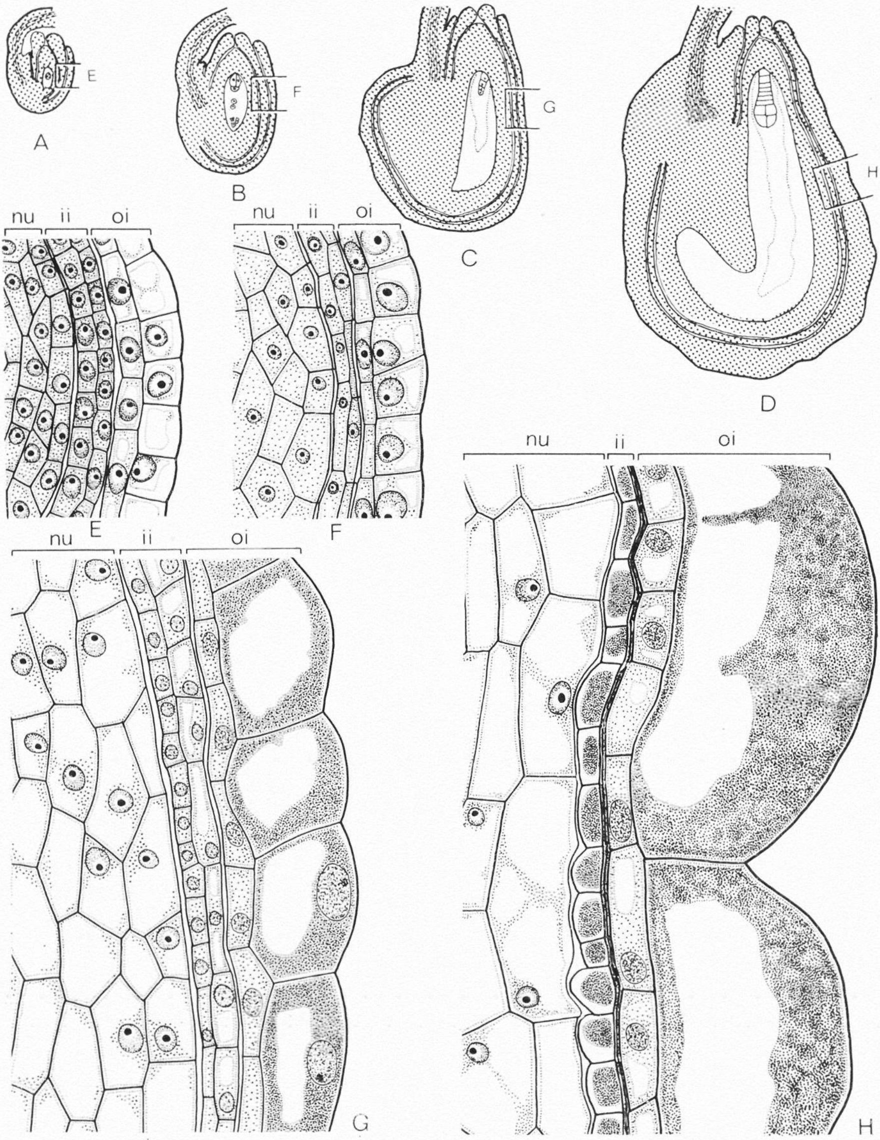

Fig. 6.

form a darkly staining mass. In the mature seed only the outer layer of the outer integument and the inner layer of the inner integument persist, the cells of the former increase enormously in size while those of the latter protrude into the nucellus.

DISCUSSION

MEGASPORANGIUM. The ovules in *Aptenia*, as in all other investigated mesembryanthemus, lack an aril. It is interesting that the reports of its occurrence in *Trianthema monogyna* (BHARGAVA 1935), *Sesuvium portulacastrum* (KAJALE 1940), *Mollugo oppositifolia* (RAGHAVAN & SRINIVASAN 1940), *Glinus lotoides, Gisekia pharnaceoides, Orygia decumbens* and *Mollugo nudicaulis* (NARAYANA 1962) pertain only to species belonging to the subfamily *Molluginoideae* and the tribes *Sesuvieae* and *Aizoeae* of the subfamily *Ficoideae*. The taxonomic significance of this character is, therefore, evident.

MEGASPOROGENESIS. As in *Tetragonia tetragonoides* (PRAKASH, 1964) and *Trianthema monogyna* (BHARGAVA 1935), in *Aptenia* too some archesporial cells perist below the megaspore mother cell. However, unlike *Hereroa hesperantha* (PRAKASH 1966) where a supernumerary archesporial cell may develop into a megaspore tetrad and *Delosperma cooperi* (KAPIL & PRAKASH 1966) where it forms an embryo sac, in *Aptenia* it is not discernible in later stages.

FEMALE GAMETOPHYTE. *Aptenia* conforms to the usual behaviour in the family by showing a Polygonum type of development. The only exceptions are *Delosperma cooperi* (KAPIL & PRAKASH 1966) showing five types of embryo sacs and *Mesembryanthemum pseudotruncatellum* (SCHMID 1925) with an Adoxa type of development.

ENDOSPERM. In both species chalazal portion of the endosperm is weakly haustorial as indicated by the accumulation of cytoplasm and many large nuclei in that portion. Such a situation is also encountered in *Gisekia pharnaceoides* (JOSHI and RAO 1936), *Trianthema monogyna* (BHARGAVA 1935), *T. portulacastrum* (DNYANSAGAR & MALKHEDE 1963) and *Mollugo nudicaulis* (BHARGAVA 1934). The horse-shoe-shaped endosperm in *Delosperma cooperi* conforms to the general pattern in the *Aizoaceae*, but its folded nature in *Aptenia cordifolia* is unique. Again, while cell formation occurs throughout the endosperm in *Delosperma,* it is restricted only to the micropylar part in *Aptenia*. In both the endosperm is almost completely consumed in the mature seed.

EMBRYO. That the Solanad type of embryogeny is constant throughout Aizoaceae is borne out by its occurrence also in *Aptenia* and *Delosperma*. The long and massive suspensors with greatly enlarged basal cells, exhibited by both these plants, also seem to be a characteristic feature of the family. Indications of budding of the suspensor are furnished by a couple of young seeds of *Aptenia*. However, as in *Trianthema portulacastrum* (DNYANSAGAR & MALKHEDE 1963), these buds do not mature into embryos and the ripe seeds are monoembryonate.

SEED COAT. The first detailed contribution towards our knowledge of the seed coat in the *Aizoaceae* is by NARAYANA (1962). However, this is mainly confined to members of the subfamily *Molluginoideae*. According to him each of the two integuments comprises two cell layers excepting *Trianthema decandra* where the outer integument is 3-layered. Only the outer epidermis of the inner integument degenerates at maturity and tannin is deposited in the outer layer of the outer integument and the inner epidermis of the inner integument. The remarkable uniformity in the structure of the Aizoaceous seed coat is fully borne out by the present work.

STATUS OF VARIOUS TAXA WITHIN THE AIZOACEAE

BENTHAM & HOOKER (1862—1883) divided the *Aizoaceae* into three tribes, viz. *Mesembryeae* comprising members with tubular calyx and adnate ovary; *Aizoideae* consisting of genera with tubular calyx but non-adnate ovary; and *Mollugineae* with those possessing 5-partite calyx and superior ovary.

ENGLER and PRANTL (1889) split the *Aizoaceae* into two subfamilies — *Molluginoideae* and *Ficoideae* — depending on the nature of the perianth and the ovary. In the former the ovary is superior and the perianth is 5-partite whereas the latter are characterized by a superior or inferior ovary and a tubular perianth.

HUTCHINSON (1926) considered the differences between the two subfamilies to be of sufficient importance to warrant family status and erected the *Molluginaceae* and the *Ficoidaceae*. He maintained the same view in the revised edition of his book (HUTCHINSON 1959).

In 1947 SCHWANTES (quoted in JACOBSEN 1960) proposed that the mesembryanthemums should be taken out of the *Aizoaceae* because of their peculiar fruits, adnation of calyx tube with the ovary, and the petaloid staminodes, and be called the *Mesembryanthemaceae*. HERRE & VOLK (1950; quoted in JACOBSEN 1960) supported this idea. Later SCHWANTES (1960) changed his opinion because of the discovery of *Aizoanthemum,* an intermediate form between *Aizoon* of the *Ficoidaceae* and *Mesembryanthemum,* and suggested the reunion of the two families into one.

Considering the characters of the flowers and fruits, FRIEDRICH (1955) erected yet another family, the *Tetragoniaceae* to include *Tetragonia* and *Tribulocarpus* formerly included in the *Ficoidaceae.*

In ENGLER's revised edition of "Syllabus der Pflanzenfamilien" MELCHIOR (1964) recognized the *Molluginaceae* and *Aizoaceae* as two independent families under the order *Centrospermales.*

Most of the investigators on the palynology (ERDTMAN 1952), floral anatomy (SHARMA 1962) and embryology have tried to justify HUTCHINSON's viewpoint. For example, JOSHI and RAO (1936) delimited *Aizoaceae* from the *Molluginaceae* on the basis of embryological characters. According to them the presence of a 2-layered outer integument, and periclinal divisions in the cells of the nucellar epidermis, and the absence of aril and starch in the embryo sac are characteristic features of the *Molluginaceae* whereas the former possess a 3-layered outer integument, aril and starch in the embryo sac but the cells of the nucellar epidermis do not divide. These differences were also taken into account by TAKHTAJAN (1959) and MALCHIOR (1964) who raised the two subfamilies to the rank of independent families. However, recent investigations make it increasingly difficult to maintain the embryological differences enunciated by JOSHI and RAO (1936). Some members of the *Molluginoideae* like *Gisekia* and *Orygia* show a 3-layered outer integument and possess an aril (NARAYANA 1962) whereas genera like *Aptenia, Delosperma* (present work), *Hereroa* and *Tetragonia* (PRAKASH 1966) of the *Ficoideae* have a 2-layered outer integument and lack an aril. Moreover, starch is present in *Glinus* (NARAYANA & LODHA 1961) and *Orygia* (NARAYANA & LODHA 1963) of the *Molluginoideae* and is absent in the ficoid member *Tetragonia tetragonoides* (PRAKASH 1964). The behaviour of the nucellar epidermal cells is similar in both the subfamilies.

ERDTMAN's suggestion that colpate and colporoidate pollen grains appear to be restricted to the *Molluginoideae* and *Ficoideae* respectively,

Table 1. Morphological characters of *Ficoideae* and *Molluginoideae*.

	Ficoideae	*Molluginoideae*
Habit	Succulent or semi-succulent herbs	Herbs, rarely succulent
Leaves	Alternate or opposite, entire	Alternate or opposite, entire
Flower	Bisexual, actinomorphic	Bisexual, actinomorphic
Perianth	Segments united to form a tube	Segments almost free
Stamens	Staminodes present or absent	Staminodes absent
Ovary	Inferior or superior	Superior
Anther tapetum	Secretory, cells with 2-many nuclei	Secretory, cells binucleate
Cytokinesis in microspore m. cell	Simultaneous	Simultaneous
Pollen grain	3-celled	3-celled
Ovule	Bitegminal, crassinucellar, anacampylotropous and arillate	Bitegminal, crassinucellar, anacampylotropous and arillate
Obturator	Present	Present
Nucellus	Persistent, forms perisperm	Persistent, forms perisperm
Archesporium	1 to several-celled	Single-celled
Embryo sac	Mostly Polygonum type	Polygonum type
Endosperm	Nuclear, caecum present	Nuclear, caecum present
Embryo	Solanad type, suspensor massive	Solanad type, suspensor massive

has not been supported by Rao et al. (1965) who, after studying four species of the former and three of the latter, came to the conclusion that palynology can be of little help in the systematics of the family.

The morphological and embryological characters of the subfamilies *Ficoideae* and *Molluginoideae* are compared in Table 1. (For literature see Bhargava 1934, 1935; Cocucci 1961; Dnyansagar & Malkhede 1963; Huber 1924; Joshi & Rao 1936; Kajale 1940; Kapil & Prakash 1966; Lebègue 1955; Narayana 1962; Narayana & Lodha 1961, 1963; Prakash 1964, 1966; Raghavan & Srinivasan 1940).

As would be seen, most of the morphological and embryological features are common to both the groups. The only consistent morphological difference between them is that the perianth lobes are fused in the *Ficoideae* but free in the *Molluginoideae*. However, this alone can hardly justify the raising of the two subfamilies to the rank of independent families.

Although there is no significant embryological difference between the mesembryanthemums and the members constituting the *Aizoaceae*, the former are distinct from both *Molluginoideae* and *Ficoideae* in having (*1*) predominantly succulent plant body, (2) dedoublement of the stamens, of which the outer whorls become staminodes, (*3*) inferior ovary with a peculiar parietal placentation derived from the axile condition during ontogeny, (*4*) absence of aril, and (*5*) the characteristic fruit. — It may, therefore, be concluded that this taxon need not be removed from the *Aizoaceae* but should be given the status of a subfamily *Mesembryanthemoideae* instead of that of a family as suggested by SCHWANTES.

Further, *Tetragonia* also differs from other *Aizoaceae* in the presence of (*1*) secondary flowers in 25 percent of cases (*2*) 6 to 9-loculed ovary, (*3*) single pendulous ovule in each locule, (*4*) druses in the nucellus, (*5*) inner layer of the inner integument is well developed rather than the outer layer of the outer integument, and (*6*) an indehiscent fruit. — In all these features it stands apart from other members of the *Aizoaceae*. These warrant the erection of an independent subfamily *Tetragonioideae* to be included under the *Aizoaceae* (see also MELCHIOR 1964).

Briefly then, (*1*) in spite of certain differences with the *Aizoaceae*, there is no justification for raising the *Molluginoideae* to the status of a family, (*2*) the differences of the mesembryanthemums and *Tetragonia* from the other members of the family *Aizoaceae* only warrant the erection of two subfamilies *Mesembryanthemoideae* and *Tetragonioideae* rather than two independent families.

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On the Pollen Morphology of Trigonobalanus (Fagaceae)

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ABSTRACT

Pollen diagnoses — including descriptions of the fine relief of the exine surface as revealed by electron microscopy — of the two species so far referred to the new fagaceous genus *Trigonobalanus* FORMAN are given. Some pollen morphological differences between the two species may or may not be adduced in favour of referring them to separate genera or subgenera. Attention is drawn to risks in connexion with attempts to determine pollen to family, genus or even species without considering the fine relief of the exine surface etc.

INTRODUCTION

The recent discovery of a new fagaceous genus, *Trigonobalanus* FORMAN, has aroused considerable interest. A preliminary account of the pollen morphology was included in Mr. FORMAN's paper "*Trigonobalanus,* a new genus of *Fagaceae,* with notes on the classification of the family" (Kew Bulletin 17: 381—396, 1964). At the request of Mr. FORMAN I give here a more detailed description of the pollen morphology.

DESCRIPTIONS

Trigonobalanus doichangensis (A. CAMUS) FORMAN. — Thailand, Chiengmai Province, Doi Nang Ka, 19 Nov. 1930; Put 3474; BM.

Pollen grains 3-colporate (stray grains 4-colporate), goniotreme, spheroidal (about 23×22 μ). Apocolpia diameter about 5 μ. Amb triangular with usually slightly convex sides.

Colpi about 20×1.5 μ, often constricted equatorially (Fig. 2 D; Fig. 3 C, D); their non-equatorial parts sometimes somewhat sunken (Fig. 3 C, D). Each os consisting of a series of transversely elongated openings ("orilla") increasing in size towards the interior of the pollen grain. Outermost orillum about 2.0×5.5 μ (Fig. 2 B, F; Fig. 3 A), innermost orillum about (2—3)×8 μ (Fig. 2 B, F; Fig. 3 B).

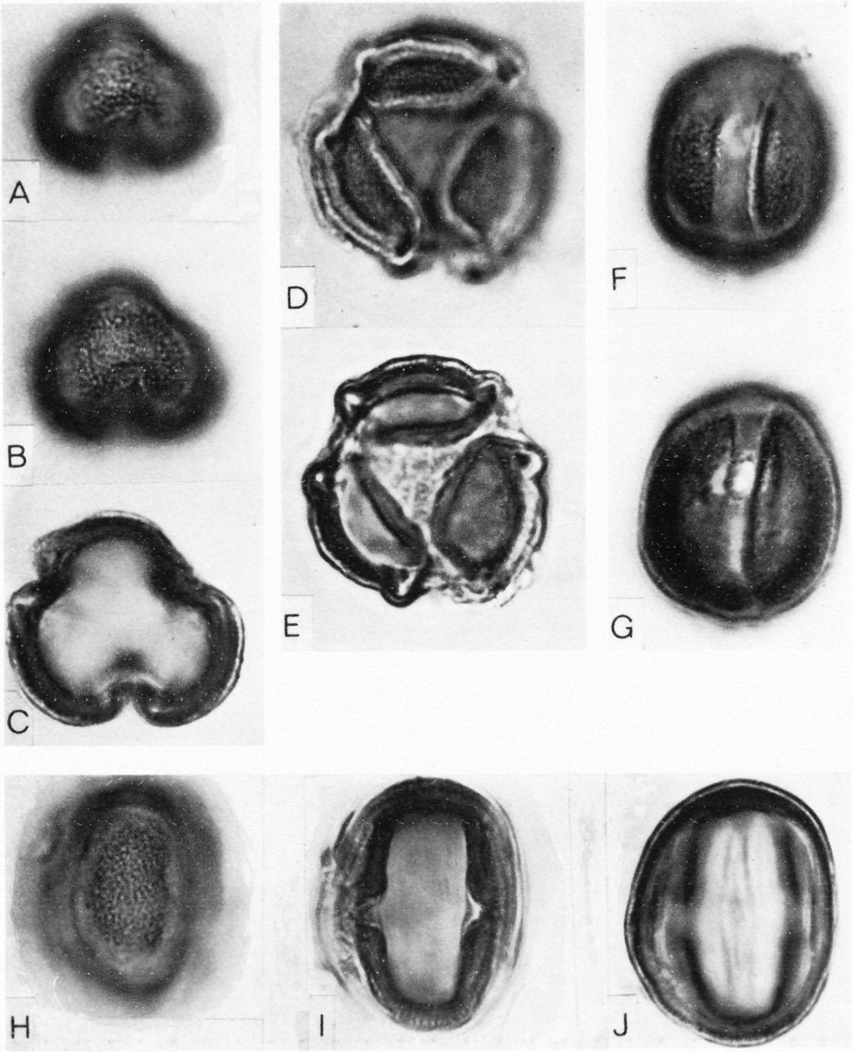

Fig. 1. *Trigonobalanus verticillata* FORMAN — A—C, polar view, three successive foci (C, optical cross section). — D, E syncolpate grain, two successive foci. — F, G, lateral view, two successive foci. — H—J, lateral view (a mesocolpium faces the observer), three successive foci. ×1400. — K. E. SAMUELSSON photo.

Exine about 2—2.5 μ thick in apocolpia. Sexine pertectate, in apocolpia probably slightly thicker than nexine, in mesocolpia slightly thinner. Tectum surface not quite smooth (Fig. 2 G). Infratectal bacules densely spaced, about 0.3 μ long. Nexine distinctly lamellate (Fig. 2 G; the orilla seem to be encompassed by special lamellae, Fig. 2 B, F).

Some details in Fig. 2 A seem to indicate a possible occurrence of (para-)syncolpate pollen grains.

Trigonobalanus doichangensis (A. CAMUS) FORMAN. — Thailand, Chiengmai Province, upper slope of Doi Chang, between 1260 m and 1765 m., 11 Jan. 1922; J. F. ROCK 1755; K, isotype.

Pollen grains of the same type as those in PUT 3474, 3-colporate, goniotreme, spheroidal (about 22×24 μ).

Trigonobalanus verticillata FORMAN. — North Borneo, Mt. Kinabalu, on steep ridge of Liwagu River, 1.350 m; 2 Sept. 1961; CORNER 2645; K.

Pollen grains 3-colporate (exceptionally 4-colporate, with colpi converging in pairs), peritreme, subprolate (23×19 μ). Apocolpia diameter about 9 μ. The three mesocolpial parts of the amb are more convex than the corresponding parts in *T. doichangensis*. Each part sometimes exhibits two small lateral, almost semicircular parts and a central large, less convex part (Fig. 1 C, upper left hand aperture; Fig. 1 E).

Colpi about 20×(1.5—)2 μ with pointed ends, their membrane smooth or nearly so, surrounded by narrow lateral mesocolpial areas faintly delimited from the rest of the mesocolpial exine by shallow grooves passing through those parts of the amb where the semicircular, smaller parts of the amb make contact with the three larger, less convex parts of the same. One syncolpate grain observed (Fig. 1 D, E; colpi encompassed by arcus-like thickenings). Ora rounded to slightly transversely elongated (diameter about 6 μ; in one grain something like an oral operculum was seen); their contour less distinct than that of the ora in *T. doichangensis*. The ora do not, in contradistinction to those in *T. doichangensis,* exhibit a distinct series of orilla (cf. Fig. 1 F, G, I).

Exine about 2.5 μ thick or slightly more. Sexine pertectate, considerably thinner than nexine. Tectum surface slightly undulating; the "waves" are densely beset with low "microverrucae" (Fig. 4 A; diameter about 0.4 μ, height 0.4 μ). Thickness of tectum usually slightly less than length of infratectal bacules. Nexine more compact than in *T. doichangensis*; signs of splitting can, however, be seen particularly at the colpi margins (Fig. 1 C, E).

Trigonobalanus verticillata FORMAN. — Celebes, Ond. Bonen Binuang, Pena (Mamasa), altitude about 1100 m; 13 May 1937; Netherl. Ind. Forest. Service bb. 22621; SING.

Pollen grains of the same type as those in Corner 2645 but some-

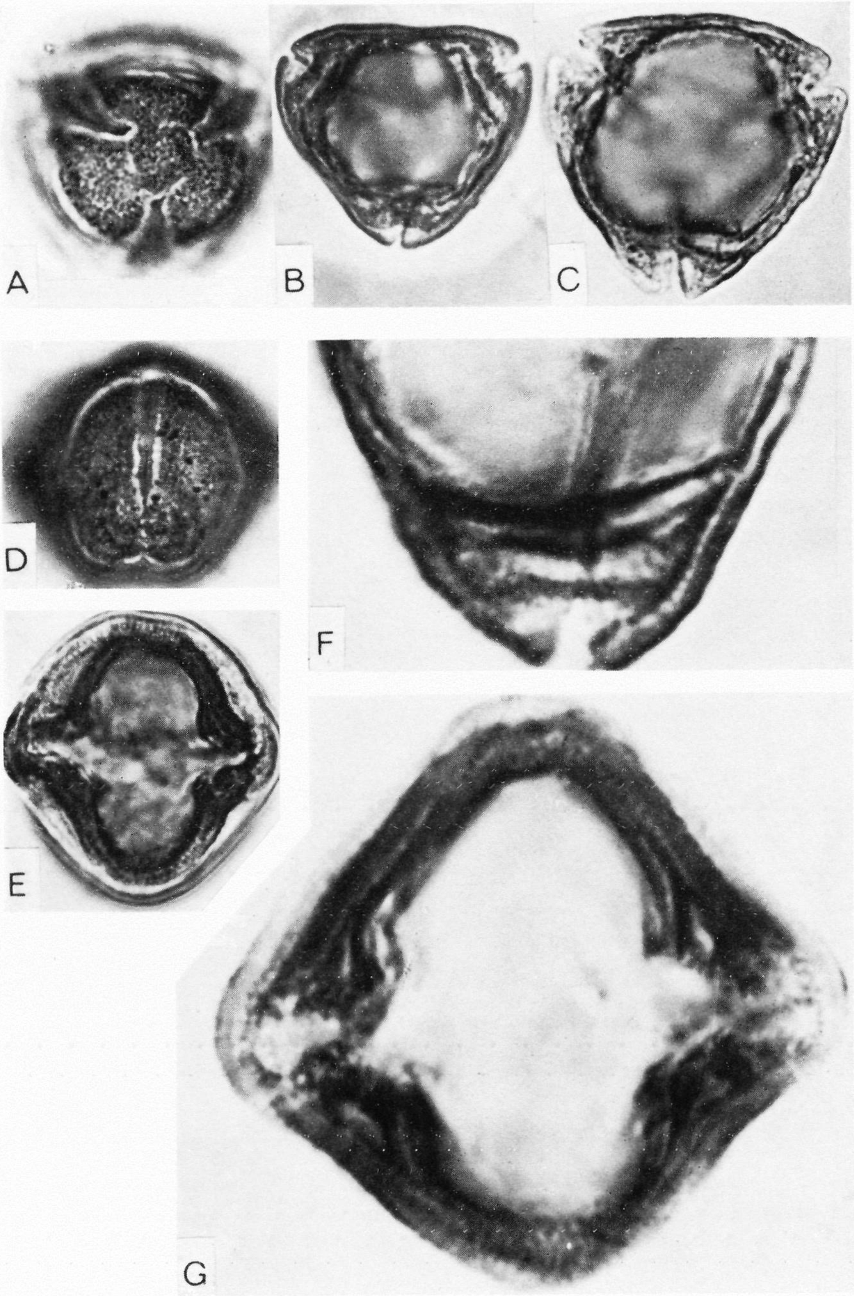

Fig. 2. *Trigonobalanus doichangensis* (A. Camus) Forman — A—C, polar view, three successive foci. — D, E, G, lateral views. — F, colpus (faintly indicated) and upper ± horizontal contour of three orilla. ×1500 (A—E), ×3000 (F—G). — K.E.S. photo.

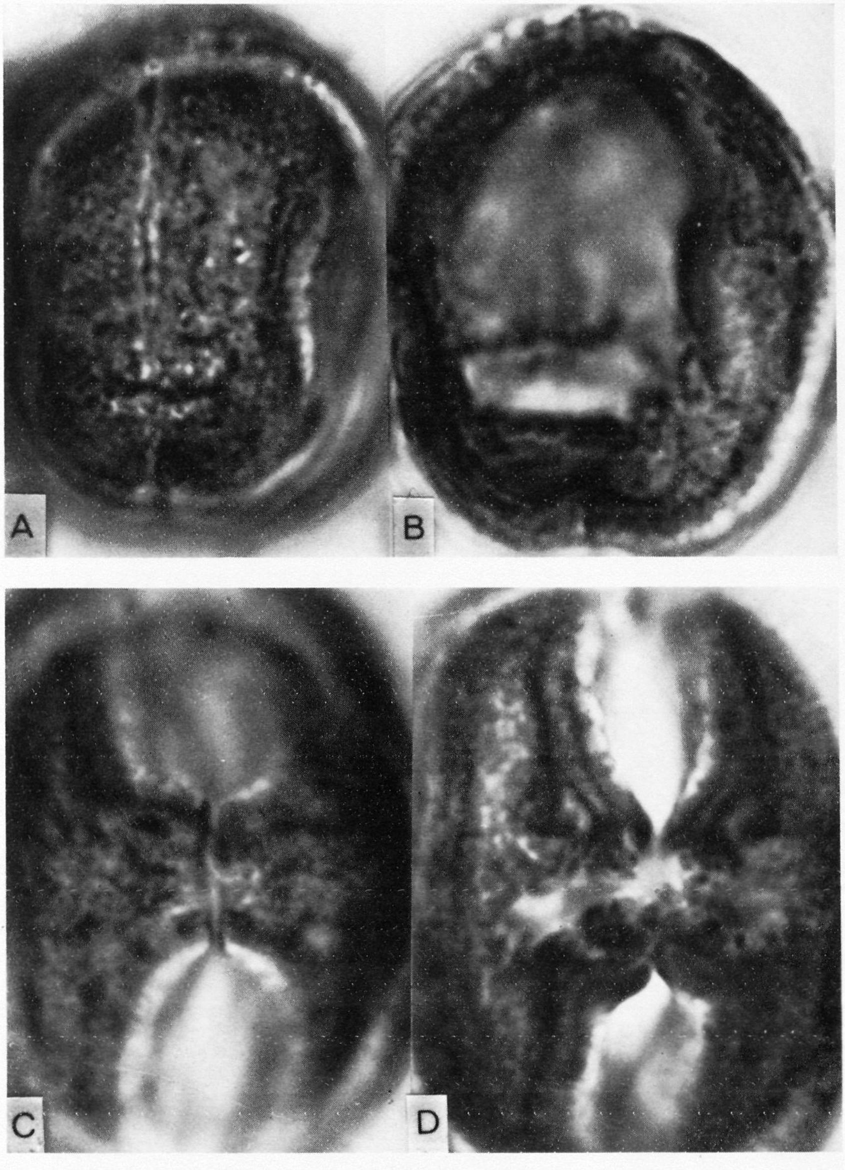

Fig. 3. *Trigonobalanus doichangensis* (A. Camus) Forman — Pollen grains in lateral view. Pattern probably more *Quercus*- than *Castanopsis*-like (cf. Figs. 4, 5). ×3000.

what larger (about 28×21.5 μ). Transverse margins of ora thickened. Tectum in some grains probably slightly thicker than length of infratectal bacules.

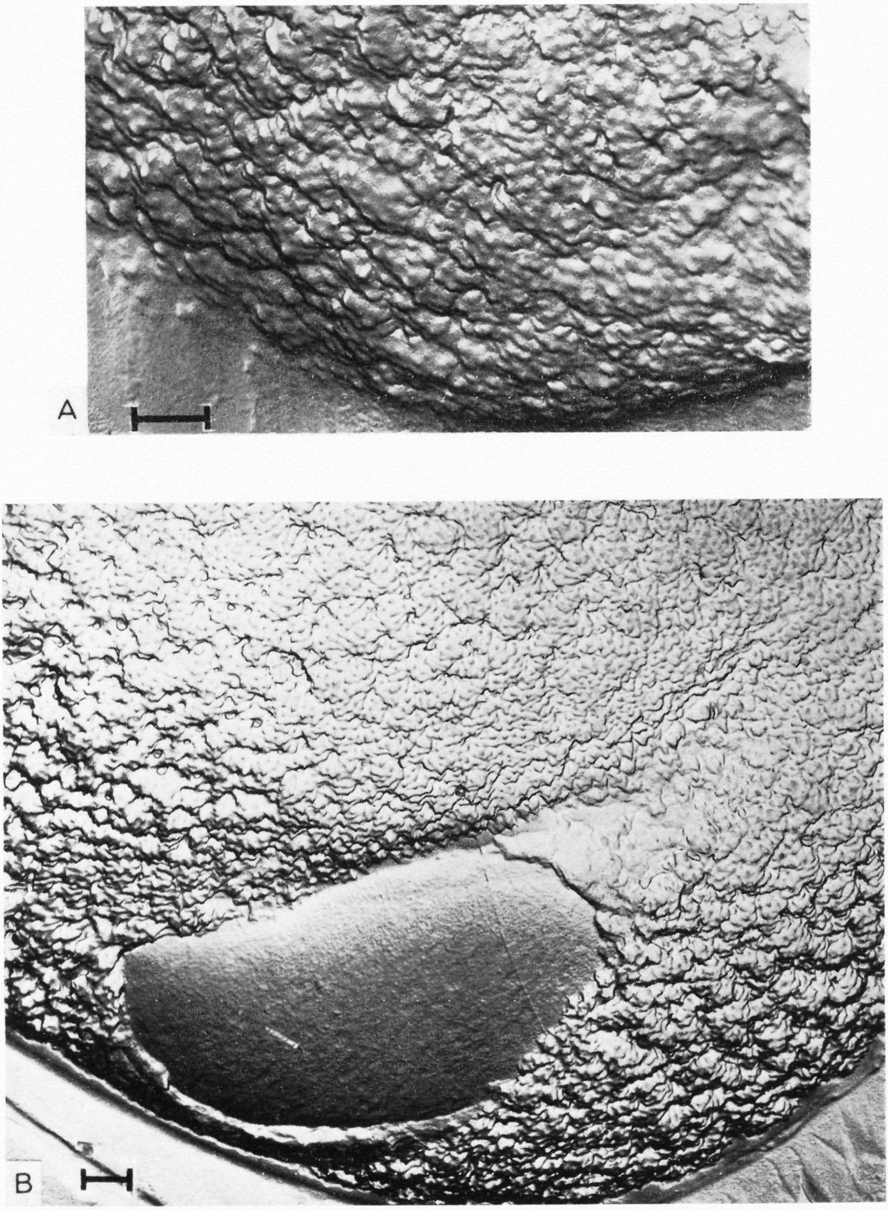

Fig. 4. A, *Trigonobalanus verticillata* FORMAN. Fine relief (2-stage replica; EMG TAKEOKA and STIX 1961). — B, *Quercus salicina* BLUME, fine relief showing verruca-like processes (beset with microspinules) and, according to TAKEOKA (letter, May 1967), scattered puncta (small circles particularly in the upper left hand corner). Two-stage replica; EMG TAKEOKA 1958. ×10,000 (A), ×6500 (B).

DISCUSSION

From my correspondance with Mr. FORMAN I gather that, *ab initio,* he was not inclined to regard "*Quercus doichangensis* A. CAMUS" as congeneric with "CORNER 2645" (*Trigonobalanus verticillata*). In his published account (FORMAN 1964), however, he referred "CORNER 2645" as well as *Quercus doichangensis* to *Trigonobalanus.* I agree with Mr. FORMAN that it is better to wait for a detailed monograph of the pollen morphology in the *Fagaceae* prior to using pollenmorphological data in an intricate taxonomical context. My personal impression when studying the pollen grains in *Trigonobalanus* was — and still is — that the pronounced differences between the two species can be adduced in favour of their being referred to separate genera if other reasons for doing so are at hand.

It is interesting to note that *T. verticillata* shares some characteristics with the *Castaneoideae.* The male inflorescences are rigid, the cupules contain more than one fruit, and the fruits are 3-angled as those in *Castanopsis chrysophylla.* On the other hand the fine relief (Fig. 4 A) of the exine in *T. verticillata* is distinctly different from that in *Castanopsis chrysophylla* (Fig. 5 A—C) but fairly similar to that in *Quercus salicina* (Fig. 4 B; cf. also the thin sections of *Quercus robur* pollen in ERDTMAN et al. 1963, Pl. 51: 2, 3; for legend see l.c. p. 25, line 3 from below). In *T. doichangensis* the male inflorescences are flexuose in conformity with those in the *Quercoideae* and the cupules usually contain one fruit only. Thus both fine relief details and certain features revealed by ordinary photon microscopy can be adduced in favour of referring *Trigonobalanus verticillata* and *T. doichangensis* to the *Quercoideae.* In addition it seems to be possible to adduce certain details in favour of referring *T. doichangensis* to a special genus, separate from *Trigonobalanus,* or, alternatively, to a special section within *Trigonobalanus.*

Mr. FORMAN (l.c. p. 395) has pertinently pointed out some resemblances between *Trigonobalanus* and the fossil species *Fagus succinea* found in Eocene (or Oligocene?) Baltic amber. Among the not very informative illustrations of pollen grains from this amber (POKROVSKAJA & ZAUER 1959) are, i.a., illustrations of "*Castanea* sp." and "*Quercus* sp. I and II". None of these can however be suspected of representing pollen grains of *Trigonobalanus verticillata.* For further illustrations of old Tertiary *Castanea*-like and *Quercus*-like pollen grains — among

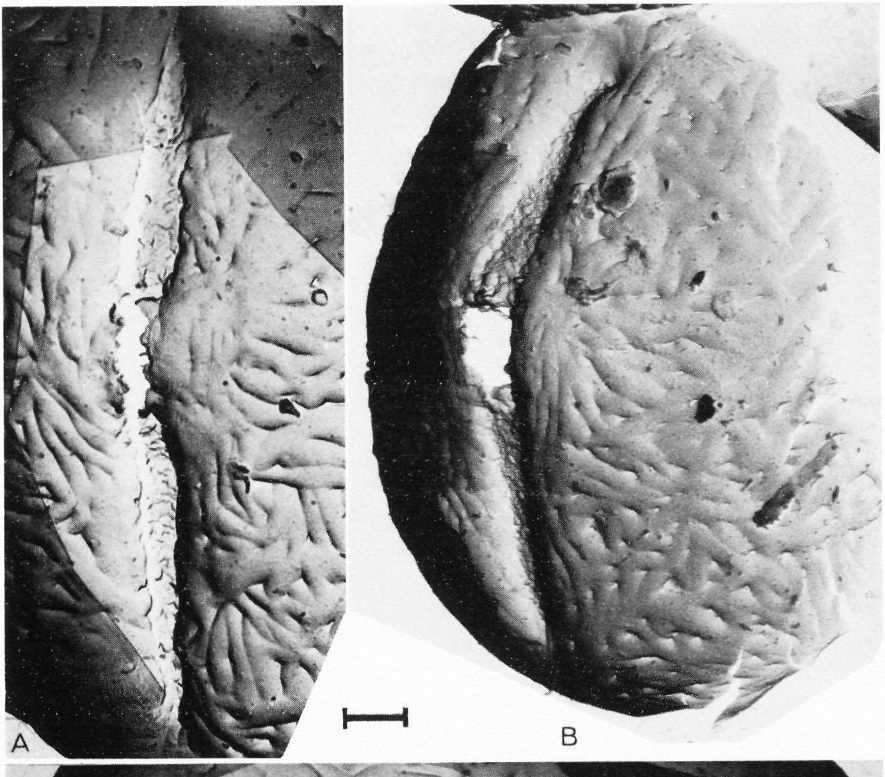

Fig. 5. *Castanopsis chrysophylla* (Hook.) Spach, fine relief; EMG Dunbar. ×8500.

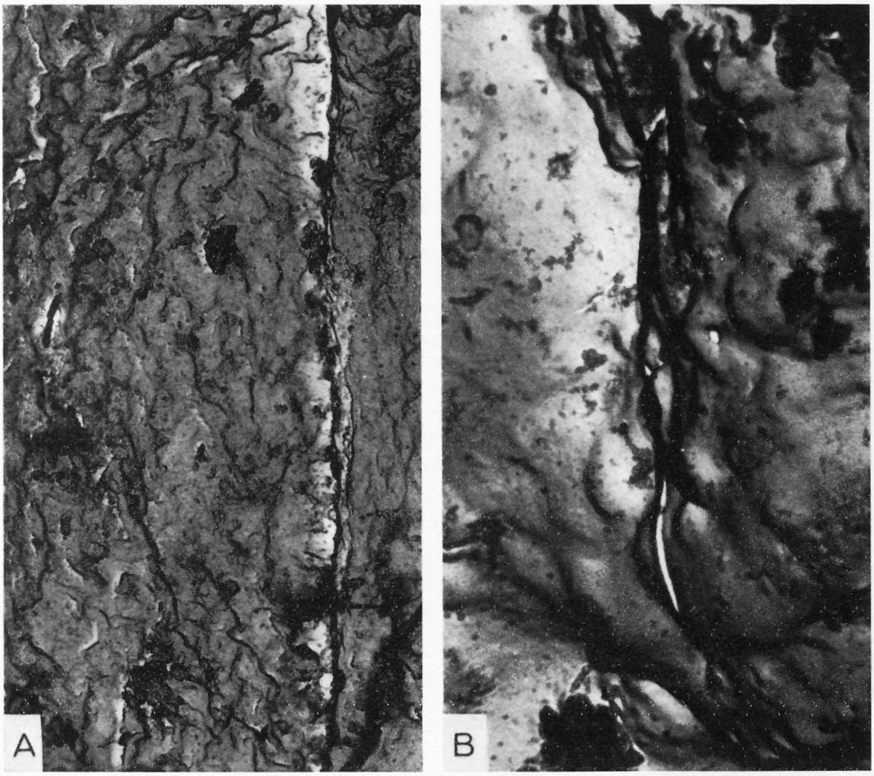

Fig. 6. A, *Trigonobalanus doichangensis* (A. CAMUS) FORMAN. Fine relief (PRAGLOWSKI and DUNBAR 1967). ×6500. — B, *Lithocarpus brevicaudata* (SKAN) REHDER. Fine relief (PRAGLOWSKI and DUNBAR 1967). ×17000.

the latter some grains similar to those in *T. doichangensis* — see, e.g., POTONIÉ et al. 1950, POTONIÉ 1951, and KRUTZSCH 1962.

In conclusion I wish to draw attention to KUPRIANOVA's paper on the pollen morphology of the *Amentiferae* (KUPRIANOVA 1965). Certain discrepancies are to be found between her descriptions and illustrations of *Trigonobalanus* pollen and those given above: the lamellation of the nexine and the occurrence of orilla in *T. doichangensis* are not indicated and the sexine in *T. verticillata* is, as can be inferred from the illustrations, held to be comparatively thicker than shown in Fig. 1 C, E, J in the present paper.

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ADDENDUM

The fine relief in *Trigonobalanus doichangensis* (Fig. 6 A) seems to be more *Quercus*- than *Castanopsis*-like. The same is probably the case with the fine relief in *Lithocarpus brevicaudata* (Skan) Rehder as far as can be judged from an, alas, not very good replica (Fig. 6 B). In another replica of the same species a number of verrucae (amb circular; diameter 0.2—0.5 μ) and a great number of still smaller verruca-like processes (diameter about 50—100 nm) can be seen.

The fine relief characteristics shown in Figs. 4—6 provide a warning against hasty attempts to determine many fossil pollen grains, etc., with the aid of photon microscopy only.

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The Application of Ordination to Bryophyte Communities on a Snowdonian Cliff

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ABSTRACT

The technique of ordination is briefly described and its application to bryophyte studies discussed. A study is described in which the technique was used to investigate the distribution of bryophytes on the ledges of a mountain cliff and their correlation with environmental factors. It is concluded that ordination is a suitable technique for objective description of the small heterogeneous units in which bryophytes usually occur.

INTRODUCTION

Detailed studies of bryophyte ecology are limited. Much information available is based on personal experience summarised in floras such as WATSON (1955). Specific studies have been made, e.g. TALLIS (1959) and BIRSE (1958), but are infrequent in the literature. Ecologists have usually ignored bryophytes unless their contribution to a community is immediately apparent. However further studies of bryophyte ecology, in addition to their intrinsic interest, would provide valuable background information to communities dominated by vascular plants. Ordination is a flexible method for objective analysis of quantitative or qualitative data enabling description of the community and correlation of species distributions with environmental gradients.

Continental phytosociologists have developed a classificatory system for description of plant communities. The lists of species defining the associations are subjectively selected and heterogeneous samples excluded. In relatively uniform vegetation the opinions of different observers coincide. However, in communities occurring in discontinuous small units, such as bryophytes frequently do, these phytosociological methods are not applicable, as pointed out by MCVEAN & RATCLIFFE (1962). The procedures described below are particularly suited for study of such small units.

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Bryophyte communities are continuously variable although certain groups of species occur more frequently than others. GOODALL (1954 c) has emphasised the importance of treating vegetation as continuously variable rather than imposing arbitrary divisions upon it. Consequently he advocated the use of ordination rather than classification. Each sample, or stand, is regarded as a point in a multidimensional system in which the distances between points are determined by each species comprising the samples.

In the ordination procedures discussed, distance between stands is calculated by comparison of species content of the stands. The individual points of the multidimensional system are then projected on to two dimensions so that the distance between points reflects the difference in species composition. Stands with similar species composition will be represented as adjacent points in the two dimensional representation. When individual species, comprising the stands, are plotted on to the points those with similar amplitudes will be limited to similar segments of the scatter of stand positions of ordination. Consequently the distribution of species can be examined in relation to the overall trend in the samples established by the positions of the stands in the ordination. Environmental factors measured in the stands may also be plotted on to the points. As species tend to follow similar gradients as environmental factors, the latter will often coincide with the principal vegetational trend. Correlation between species and environmental factors can therefore be established.

An experienced observer applies a similar analytical procedure. A large number of factors concerning a field site are recorded by the brain and an analysis made with reference to previous experience. The site is then located as a point in the reference system of the observer. A large amount of information is used to obtain a simple answer. Ordination parallels this process enabling summarisation of complex data from which ecological conclusions can then be drawn.

Two stages are involved in the calculation of an ordination of the type discussed.

1. Coefficients of similarity are calculated providing estimates of distances between stands by summation of differences in species contents. Coefficients are calculated between all combinations of stand pairs. Various coefficients have been proposed to obtain accurate estimates of distance, several of which are discussed by AUSTIN and ORLOCI (1966).

2. As the distances between all stands are now known, their positions on successive axes may be obtained by geometric constructions. The positions of the stands on successive axes are then used as coordinates to define the stands in two dimensions, representing a projection of the multidimensional system. Several methods have been suggested for the most efficient utilisation of the coefficients and ORLOCI (1966) has summarised the present position.

The recent work referred to above applies complicated mathematical techniques but the method of BRAY and CURTIS (1957) is relatively easy to use. Details of the procedure have been given in many recent papers but the original paper contains the most readily comprehensible description. GREIG-SMITH (1964) gives further details of more recent methods and discusses ordination as a quantitative technique. VAN GREENEWOUD (1965) has shown that, although this method has disadvantages the results are comparable with other techniques. Computor programmes for the BRAY & CURTIS (1957) method and for the procedures of ORLOCI (1966) are available from M. P. Austin, Department of Botany, University College North Wales, Bangor.

DESCRIPTION OF THE SITE

An example of the use of ordination in bryophyte studies is described below. These formed part of a wider investigation, reported elsewhere (BUNCE 1965) into the distribution of cliff communities and their relation to environmental factors.

The study was carried out on Ysgolion Duon (National Grid Reference S.H. 6763), a cliff in the Carneddau mountain group of Snowdonia at an altitude between 600 m and 900 m. Geologically the cliff is composed of rhyolite and dolerite. The latter is relatively base rich and, unless heavily leached, gives rise to a low base status brown earth of between pH 5.0 and 5.6 (JENKINS 1964). Rhyolite weathers to produce a base deficient soil of usually between pH 4.0 and 4.5.

The climate of Snowdonia due to its position on the western seaboard of Britain, is a combination of high atmospheric humidities and relatively mild temperatures. Detailed discussion of the climate of the area is given by RATCLIFFE (1959). The cliff has a north-easterly aspect resulting in a higher humidity and lower temperature regime than the surrounding grassland (BUNCE 1965).

The bryophyte flora is mainly of species with widespread lowland distribution in Britain although many of these species are particularly

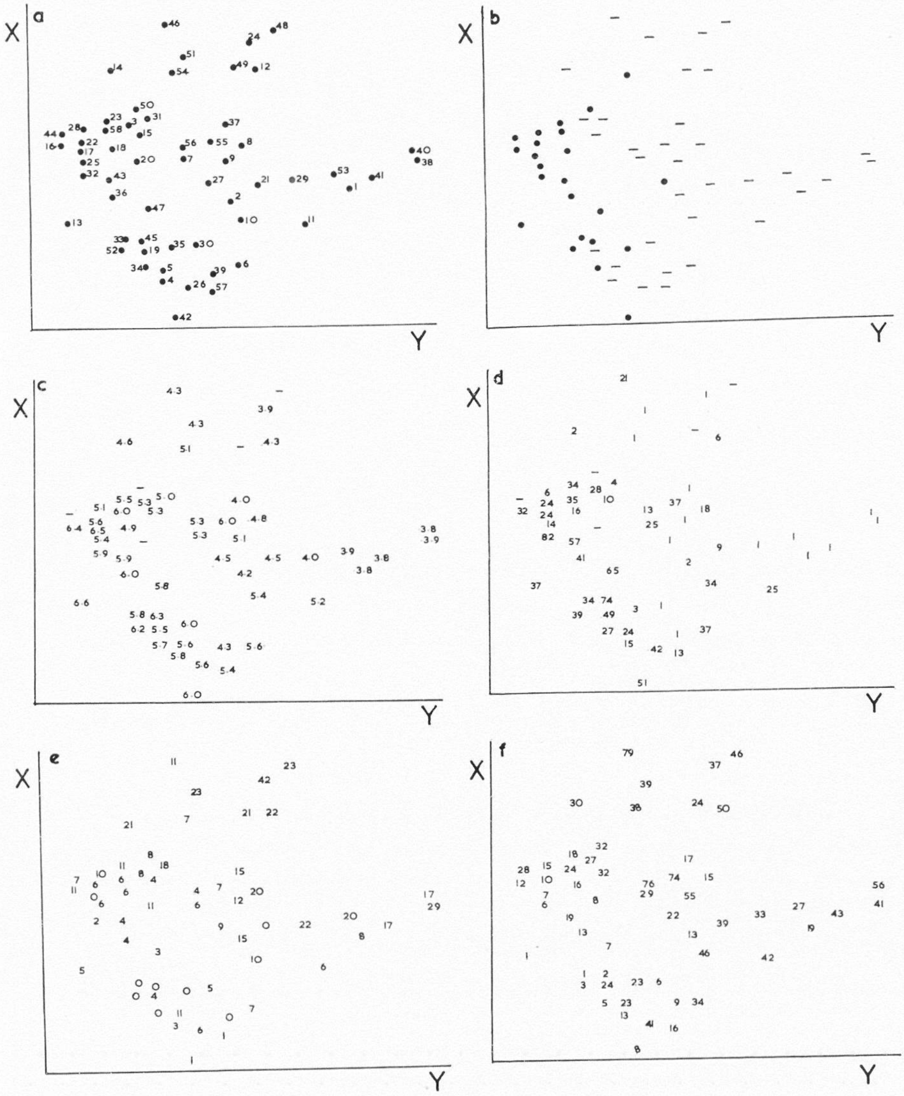

Fig. 1. Stand positions, distribution of three environmental factors and bryophyte life form on the X and Y axes of the ordination. — (a) stand positions; (b) stands with water saturated soils; (c) pH; (d) exchangeable calcium (ppm/unit volume of soil); (e) tall turf life form (total frequency); (f) weft life form (total frequency). In (c) and (d): — = sample not analysed.

abundant in north-western Britain e.g. *Rhytidiadelphus loreus* (HEDW.) WARNST. and *Dicranum majus* (SM). Arctic-alpine species e.g. *Anthelia julacea* (L.) DUM. and *Gymnomitrium concinnatum* (LIGHTF.) CORDA are also represented. The presence of extreme oceanic species e.g. *Herberta hutchinsiae* (GOTTSCHE) EVANS and *Anastrepta orcadensis* (HOOK.) SCHILLN. is a further feature of Snowdonian bryophyte floras. A list of all species recorded from the cliffs is given by BUNCE (1965) and vascular plants also discussed.

METHODS

Although saxicolous bryophytes grow on open rock surfaces, communities of vascular plants are limited to rock ledges. As these are separated by bare rock they are natural units for sampling cliff vegetation. Fifty eight ledges were therefore sampled on the main cliff of Ysgolion Duon and on two cliffs directly below the summit of Carnedd Dafydd. As the ledges are often on very steep rock faces, the collection of data was difficult and frequency estimates only were therefore obtained from 25 quadrats, 12.5 sm sq. on each ledge sampled.

Small hepatics were excluded because of the difficulty of field identification. Species of *Sphagnum* were grouped together and *Thuidium delicatulum* (HEDW.) MITT. was present but not separated from *Thuidium tamariscinum* (HEDW.) B., S. & C. *Polytrichum* species were confused and therefore combined, although *P. commune* HEDW. was the most frequent.

The ordination was constructed on the frequency data from vascular plants and bryophytes using computer programmes written for the weighted similarity coefficient and principal components procedure of ORLOCI (1966). Similar results were obtained from an ordination calculated using the BRAY & CURTIS technique (BUNCE 1965).

Although successive coordinates may be projected from the multidimensional system, representing different views, the first pair of coordinates, on the X and Y axes are usually the most informative. This was so in the present study and results are considered in relation to points plotted from the coordinates on these axes.

Although the ordination was constructed on floristic data it is advantageous to discuss environmental gradients and then to relate species distributions to these. For ease of interpretation the species frequencies are divided into 5 classes, —

1=1—5, 2=6—10, 3=11—15, 4=16—20 and 5=21—25.

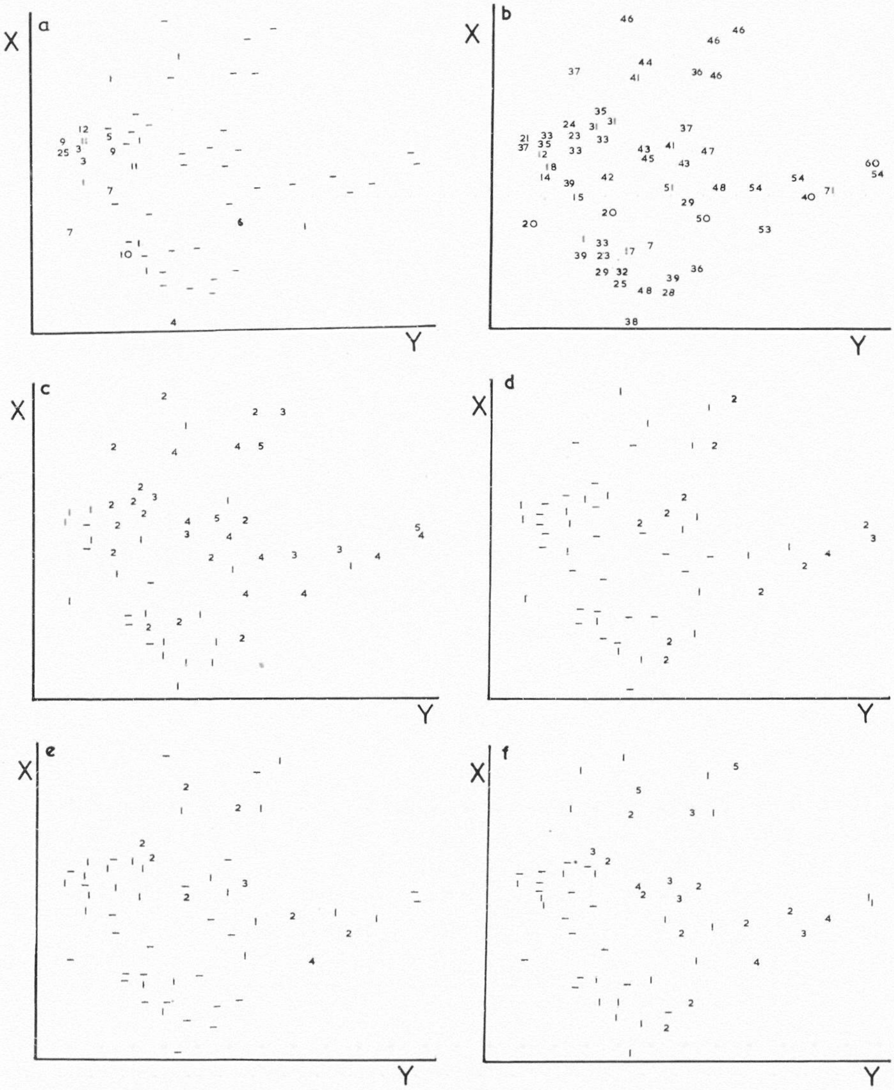

Fig. 2. Distribution of bryophyte life form, relative bryophyte/vascular plant frequency and selected species on the X and Y axes of the ordination. — (a) thalloid mat life form; (b) relative bryophyte/vascular plant frequency; (c) *Rhytidiadelphus loreus*; (d) *Dicranum scoparium*; (e) *Diplophyllum albicans*; (f) *Hypnum cupressiforme*.

RESULTS

Two groups of environmental factors showed similar gradients when plotted on the stand ordination (Fig. 1).

1. Moisture. Water saturated soils (Fig. 1) are limited to a well defined segment on the stand position. Gradients of humidity and soil moisture follow the same pattern (BUNCE 1965).

2. Nutrient status. pH, exchangeable calcium (Fig. 1) and exchangeable magnesium are intercorrelated and follow similar gradients to moisture (BUNCE 1965).

The principal axis of the vegetational data therefore corresponds to an environmental gradient from dry oligotrophic to wet eutrophic conditions. Topographically the correlation between water and base status is related to the gully and buttress system on the cliff. The gullies have a constant nutrient supply in the ground water and have eutrophic ledges whereas the buttresses have no such fresh source of nutrients and have dry oligotrophic conditions. Other environmental factors e.g. exchangeable potassium, did not have gradients corresponding to the principal vegetational axis.

Several recent studies have led to the establishment, under certain conditions, of correlation between bryophyte life form and environmental conditions. As life forms may be regarded as response by the plant to the complete environment they represent an important feature of bryophyte communities. The life forms were classified on the criteria of GIMINGHAM and ROBERTSON (1950), with certain modifications suggested by BIRSE (1958). Frequencies of the different life forms were summed for each stand and expressed as percentage of the total frequency of bryophytes in each stand. The distribution of wefts, tall turfs and thalloid mats in the ordination are given in Figs. 1 and 2. Short turfs are also quite frequent on the cliff (up to 25 % of the total bryophyte frequency) but did not show a regular pattern of distribution. Compact turfs, open turfs, cushions, whorled branch wefts and dendroid life forms also occur on the ledges but are not discussed, as sufficient numbers were not present for distribution patterns to be established.

Wefts are most frequent in the dry habitats of the cliffs. As RICHARDS (1932) has emphasised however, changes in relative humidity are usually accompanied by changes in light intensity and it is therefore difficult to separate the two factors. BIRSE (1958) found that illumination was the dominant factor controlling the distribution of bryophyte life forms. Although light intensities were not measured, the wet stands have dense growth and broad leaved species such as *Filipendula ulmaria* (L.) MAXIM. in summer and consequently the bryophyte layer is heavily shaded. These stands are generally in gullies which are hence out of direct light. Therefore light intensity on the cliffs is probably inversely correlated with humidity. Hence, although in the present study the weft life form is correlated with humidity, light intensity is probably also involved.

The distribution of tall turfs follows a similar pattern to the wefts whereas thalloid mats are limited to a small group of very wet, heavily shaded stands. It appears therefore that the same complex of environmental factors is affecting the distribution of the most frequent life forms on the cliffs. It is interesting that the distribution of bryophyte life forms follows the principal trend in the vegetation established on data from both vascular plants and bryophytes. Bryophytes are therefore integrated with vascular plants in their response to the environment and their importance to the ecologist emphasized.

A further general feature of the distribution of bryophytes on the cliff is that they are more important components of the vegetation in oligotrophic than eutrophic stands. Fig. 2 demonstrates this aspect of the vegetation by comparison of the percentage of total bryophyte frequencies of the total frequency with all species for each stand.

SPECIES DISTRIBUTIONS

The distributions of species attaining highest frequencies in the oligotrophic stands of the ordination are shown in Fig. 2. These species also grow in pockets of acid humus on otherwise eutrophic ledges as shown by the wide range of low values over the ordination. *Rhytidiadelphus loreus*, although absent from the very wet stands, is the most frequent bryophyte on the cliffs, reaching high frequencies over a wide range of edaphic conditions. However, it is most abundant in oligotrophic stands. *Dicranum scoparium* HEDW. and *Hypnum cupressiforme* HEDW. (Fig. 2) attain high frequencies in acid stands although occurring in small numbers over a wide range of stands. *Diplophyllum albicans* (L.) DUM. (Fig. 2) and *Rhacomitrium lanuginosum* (HEDW.) BRID. (Fig. 3) are limited to extreme oligotrophic stands. *Rhytidiadelphus squarrosus* (HEDW.) WARNST. (Fig. 3) occurs under a wide range of conditions although always as low frequencies. *Polytrichum* species were most frequent in stands containing *Rhytidiadelphus loreus* and

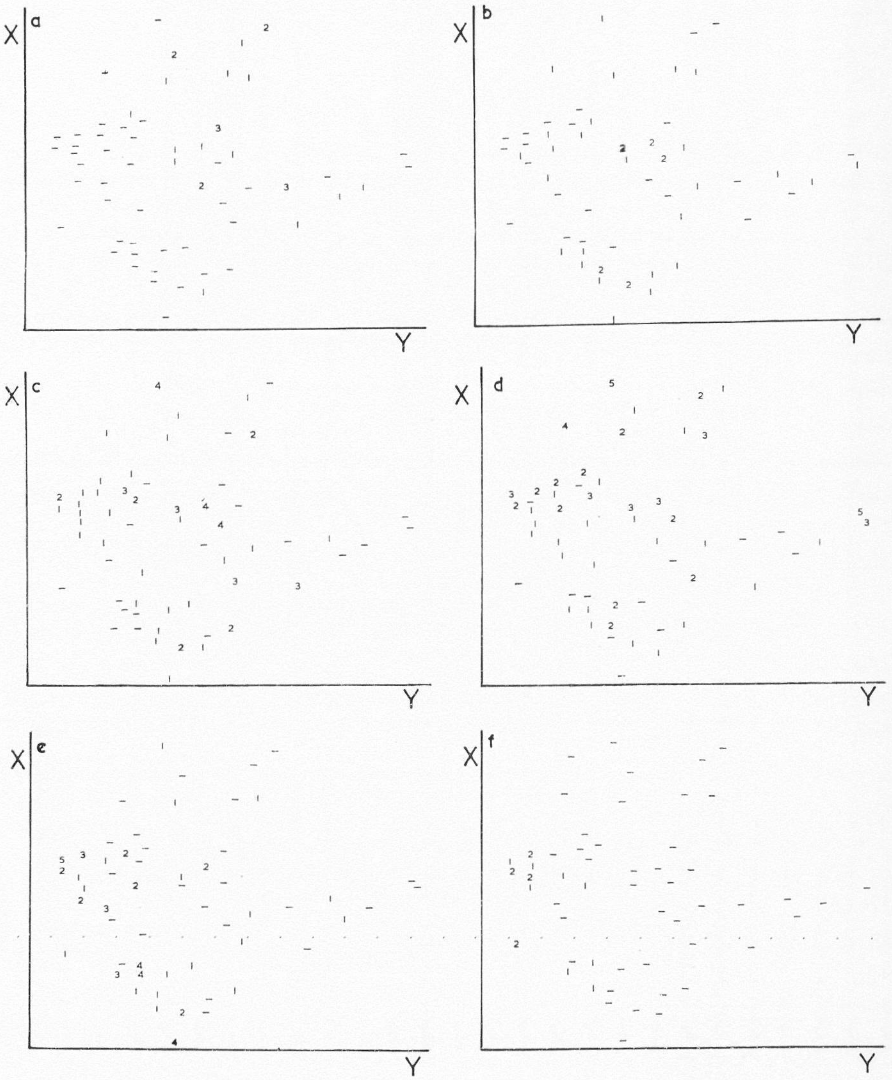

Fig. 3. Distribution of selected species on the X and Y axes of the ordination. — (a) *Rhacomitrium lanuginosum*; (b) *Rhytidiadelphus squarrosus*; (c) *Thuidium tamariscinum*; (d) *Hylocomium splendens*; (e) *Mnium punctatum*; (f) *Riccardia pinguis*.

as *P. commune* was the commonest species, this pattern reflects closely the range of this plant.

A number of other species, e.g. *Campylopus atrovirens* (SCHULTZ) BRID., *Herberta hutchinsiae* and *Rhacomitrium fasciculare* (HEDW.)

Brid., were present in less than four stands but were limited to oligotrophic conditions. Although these species occupy very different habitats they have been grouped together in the present study due to the limitations of the sampling technique.

Hylocomium splendens (Hedw.) B. & S. and *Thuidium tamariscinum* (Fig. 3) follow similar distributions in the ordination centred on the mesotrophic stands. However, both species have a wide range of tolerance. *Rhytidiadelphus triquetrus* (Hedw.) Warnst. and *Dicranum majus* were present in low numbers in similar stands to *Hylocomium* and *Thuidium*.

The distribution of *Mnium punctatum* Hedw. (Fig. 3) is centered on the eutrophic stands. Other species occurring occasionally in similar stands were *Mnium undulatum* Hedw., *Hookeria lucens* (Hedw.) Sm. and *Fissidens adianthoides* Hedw. A further group of species, e.g. *Riccardia pinguis* (L.) S. F. Gray (Fig. 3) and including *Philonotis fontana* (Hedw. Brid., *Metzgeria furcata* (L.) Dum., *Marsupella emarginata* (Ehrh.) Dum. and *Scapania undulata* (L.) Dum., is limited to the very wet stands.

From the description of species distributions on the cliffs, although some species have similar amplitudes, e.g. *Thuidium* and *Hylocomium*, a wide range of distribution patterns is present.

Consequently it is impossible to define particular communities of bryophytes on the cliffs.

DISCUSSION

An immediate criticism of ordination is that similar results may be obtained without recourse to statistical procedures. Where bryophyte communities are composed of few species, field observations can establish their relationships. However, where a large number of species occur in many combinations in diverse habitats, then the ordination procedures described enable trends within communities to be objectively determined. The methods of the continental phytosociologists are not suitable for study of the fragmented units in which bryophytes frequently occur. Ordination is particularly useful in preliminary surveys as the calculations may be made rapidly with the use of a computer. Working hypotheses may be set up providing a basis for more detailed investigations.

A further advantage of ordination is that species-environmental correlations may be established in conjunction with phytosociological analysis. In the present study, bryophytes were included in a wider investigation and shown to be integrated with vascular plants in their response to the environment. The value of further intensive studies of bryophyte ecology would therefore be an important contribution to knowledge of communities in which they have often been neglected.

ACKNOWLEDGEMENTS

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Moss Pigments
6. On the Pigmentation of Sphagnum Species

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ABSTRACT

The "morphological colour" of *Sphagnum* species can in most cases be explained by the occurrence and relative amounts of brown, red and (in some species) reddish-violet pigmented matter, which can be isolated by acid extraction and chromatography. The distribution and relative amounts of these three pigment fractions in different species is discussed. The value of the colour as a taxonomic character is commented on.

The "morphological colour" is a complex phenomenon depending on many factors. In addition to the pigments themselves, their manner of occurrence and distribution is very important for their promoting role. Pigments may be dissolved in the cell sap, associated with plastids or other structures in the cell, built into the cell wall and so on. Moreover, the colour may differ considerably when the plant is dry and when it is wet. This is particularly the case with Sphagna with their peculiar anatomy having small "chlorophyllous cells" between relatively big intercellular spaces (the "hyaline cells") the main purpose of which is to store water. Therefore, when dry, most *Sphagnum* species are whitish, and in some languages even the name "white mosses" is used as a trivial collective name for the order. This difference in colour between the dry and the wet states is easy to understand, since the conditions for reflection and absorption of light may change drastically. The violet shining tinge of some species, for instance of *S. plumulosum* (*S. subnitens*) and *S. subfulvum*, is sometimes difficult to observe in the wet plant.

In *Sphagna* as well as in other moss species it is first and foremost the reddish pigmentation which has attracted most attention. It has been known for a long time that this pigmentation is found in two forms (PAUL 1908 p. 63; HERZFELDER 1921 p. 355).

In the first case the reddish pigments are dissolved in or in some other way associated with the cell sap, and hence are easily accessible by simple extraction procedures. However, the number of species known, in which the reddish pigments are present in this way, is fairly limited. In these few species — some species of the section *Pallentiformia* of the genus *Bryum* — in which these pigments have been isolated and their chemical structure determined, the pigments have been proved to be glycosides of luteolinidin (BENDZ, MÅRTENSSON & TERENIUS 1962 p. 1183, BENDZ & MÅRTENSSON 1963 p. 266), an anthocyanidin rare in higher plants.

In the other case the reddish pigmentation is more or less strongly bound to the cell wall and extraction is not successful unless hydrolyzing agents are used to remove pigmented building blocks from the cell wall material. In the genus *Sphagnum* several species are characterized as reddish, or — as we prefer to call them — reddish-violet, and there are reasons to suggest that they all have their pigmentation in the cell wall.

Since the reddish-violet pigmentation has been proved to be very complex and to be closely associated with other kinds of pigmentation, we will first review some facts about the "morphological colour" within the genus *Sphagnum*.

The "morphological colour" of most species growing under constant habitat conditions, is fairly constant. The variation with habitat conditions, however, may be very pronounced, and most of the "coloured" species may therefore be met with as more or less green. Often it is difficult to give a description of the colour without adding "negative definitions" such as "never reddish-violet" and so on.

The development of pigments or pigmented tissues is a result of a chain of complicated biochemical reactions, which we as yet know very little about. As to the reddish-violet pigmentation its dependence on the ecological conditions has been studied by several authors (PAUL 1908 p. 63; HERZFELDER 1921 p. 355; GOODMAN & PATON 1954 p. 740; PATON & GOODMAN 1955 p. 561; ROTHE 1963 p. 331) and the optimal conditions for pigment formation is well known, particularly from the detailed investigations of the colouring of the cell membranes, carried out by RUDOLPH (1963 a p. 153; 1963 b p. 72; 1963 d p. 16; 1964 p. 250).

Green colour, caused predominantly by chlorophylls is the normal one in several species, for example *S. fimbriatum, S. squarrosum, S. girgensohnii, S. riparium, S. palustre,* and *S. wulfianum.*

A brown colour may be more or less pronounced in species such as

S. fuscum, S. jensenii, S. lenense, S. lindbergii, and *S. teres*. The arctic type of *S. fimbriatum* is generally brownish. It should be pointed out that brown colour almost always is characteristic for old dead parts of the tufts which serve mainly as wicks.

Most of the reddish-violet species occur within the section *Acutifolia*, of which the very common *S. nemoreum* is the species most studied. In section *Sphagnum* (*Palustria*), *S. magellanicum* (*S. medium*) has generally been considered to be the single reddish-violet species. However, it can not be excluded that species such as *S. centrale* and *S. papillosum* may have a reddish-violet tinge.

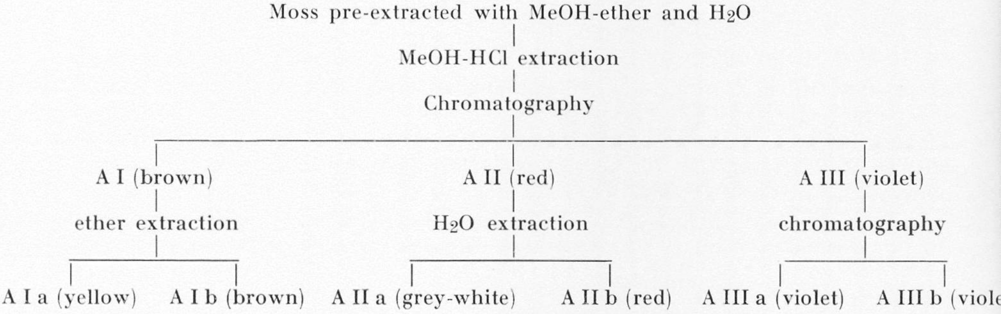
Several species such as *S. subsecundum* and *S. compactum* may have a yellowish colour. This colour is difficult to relate to any certain pigment since, as far as we know, carotenoids, flavonoids or other yellowish pigments do not seem to occur in amounts sufficient to predominate and give a yellowish colour to the plant. There are reasons to believe that the yellowish colour is of mixed origin.

We will add a fifth colour group, the red one. It should not be confused with the conventional red of the handbooks and floras. The latter is named reddish-violet by us. The red colour often is limited to some branches and the stem as in *S. recurvum* var. *parvifolium* (*S. angustifolium*). Lowalpine cushions of *S. compactum* as well as autumn specimens of *S. fuscum* may have this reddish tinge.

It seems that the "morphological colour" of *Sphagnum* species can be explained to a great extent by a simplified model based on three basic pigmenting matters. (The yellow and green groups will not be mentioned further.)

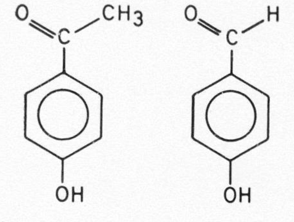
From the studies of the pigmentation of reddish-violet species (mainly *S. magellanicum* and *S. nemoreum*) it has been proved (ROTHE 1963 p. 331, RUDOLPH 1963 b p. 72; 1965 p. 178; BENDZ, MÅRTENSSON & NILSSON 1966 a p. 215) that chromatography of the products obtained by acid extraction procedures gives three crude colour fractions. These three fractions are obtained fairly independently of the chromatographic procedure applied. We will name the fractions the *red*, the *brown* and the *violet* respectively. Before we comment on these main fractions we will point out that the brown and red fractions are also obtained from species which are not reddish-violet, and sometimes their brown (and red) fractions may be isolated in appreciable amounts (e.g. *S. fuscum*). This unexpected general occurrence of the brown and red fractions was the reason of investigating several species. The procedure is given below and the results are summarized in Table 1.

The different fractions obtained from intensely reddish-violet *S. nemoreum* are evident from Scheme 1.

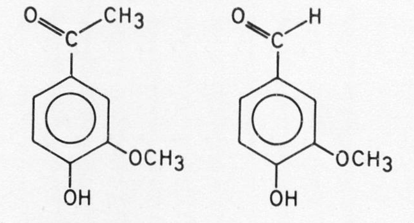


Scheme 1. Isolation of pigments from *S. nemoreum*.

The fraction which we name the *brown* one, varies continuously in colour from yellowish, light brown to almost black. It consists mainly of polymeric material. The paler products are somewhat soluble in ether but the colour changes to brown on storing, treatment with acids, or by warming, probably due to continued polymerization. Unless carefully worked up, this fraction is generally obtained as a dark product even when isolated from green specimens. As far as we can see, these products differ mainly in their degree of polymerization (Bendz, Mårtensson & Nilsson 1966 a p. 215). The brown fraction seems to be of the same type in all species investigated, and has been found to occur in all. It is obviously a more or less changed "*Sphagnum* lignin" fraction, released from the cell wall by hydrolytic cleavage of carbohydrate-phenol bonds. Spectral comparisons with lignins from higher plants and oxidative degradations of polymers from *S. nemoreum* reveal some similarities but also important differences (Nilsson & Tottmar 1967). A common comparison between lignins from various plant sources concerns the relative abundances of the following phenolic building blocks:



p-Hydroxyphenyl units



Guaiacyl units

The investigations gave the ratio p-hydroxyphenyl : guaiacyl 2.5 : 1 for the *S. nemoreum* polymer. No syringyl units were found. The results differ somewhat from earlier investigations of varying *Sphagnum* material (e.g. FARMER & MORRISON 1953; 1964; LINDBERG & THEANDER 1952).

The *red* fraction generally is of comparatively faint colour. Only traces of the red component has been found in green species, but in brown and reddish-violet specimens its concentration may be considerable. In some species such as *S. compactum* and *S. fuscum* its concentration may be so high that it gives the plants a reddish tinge. Sometimes the branches and stem of *S. recurvum* var. *parvifolium* (*S. angustifolium*) are red for the same reason.

It is mainly the red fraction of *S. nemoreum* that has been chemically studied. It has been found to be of the same general type as the brown one, the main difference being the red chromophore. The origin of this chromophore is as yet unknown. It conceivably consists of a pigment built into the "lignin" during its biosynthesis, but can also be thought of as being formed by secondary changes of the "normal lignin". Direct studies of the polymeric material give no direct information on this point, but enzymatic co-polymerization of anthocyanidin pigments and lignin precursor substances (in progress in this laboratory) suggests that pigments of this type can be built into lignin. Oxidative degradations of the red polymer gave a somewhat lower ratio p-hydroxyphenyl : guaiacyl (2 : 1) than that of the brown one.

Spectroscopic studies (Table 1) show that the red fraction of reddish-violet species and that of red and brown species differ in that the red fraction of the reddish-violet species has an absorption maximum at 525 nm whereas the latter show only end absorption. A few red species with a strong chromatographic red fraction have an inflection in the visible region but no defined maximum. It is interesting to note the differences between two specimens of *S. warnstorfii*. One pale reddish-violet specimen (20, Table 1) gave a red fraction with no maximum, while the intensely reddish-violet specimen (21, Table 1) had a maximum at 525 nm.

The differences in absorption of the red fraction from the reddish-violet species and the red fractions from other species would *a priori* lead to the suggestion that the built-in chromophores are of different origin. The results from *S. warnstorfii* specimens, however, reasonably suggest that there is a difference only in abundance of the same chromophore (at least in different specimens of the same species).

Table 1. Distribution of red and violet cell wall pigments in *Sphagnum* species. Intensity estimated from appearance on chromatography; —=not detected; (+)= dubious; +=faint; ++=relatively strong; +++=intense.

Section		Species	Red (λ max, nm)	Violet (λ max, nm)
Sphagnum	1	*S. magellanicum*	+++ (525)	+++ (550)
,,	2	*S. centrale*	+ (e)[a]	—
,,	3	*S. centrale*	(+)	—
,,	4	*S. papillosum*	++ (e)	(+)[b]
,,	5	*S. imbricatum*	+ (e)	—
Rigida	6	*S. compactum*	++ (420, i)[c]	—
Squarrosa	7	*S. squarrosum*	+	—
,,	8	*S. teres*	+ (e)	—
Subsecunda	9	*S. inundatum*	+ (e)	—
,,	10	*S. subsecundum*	++ (410, i)	—
Cuspidata	11	*S. pulchrum*	+ (e)	—
,,	12	*S. obtusum*	+ (e)	—
,,	13	*S. lindbergii*	++ (510, i)	—
,,	14	*S. majus*	+ (e)	—
,,	15	*S. lenense*	++ (e)	—
Acutifolia	16	*S. subfulvum*	(+) (e)	—
,,	17	*S. subnitens* (*S. plumulosum*)	++ (e)	+[b]
,,	18	*S. nemoreum*	+++ (525)	+++ (540)
,,	19	*S. quinquefarium*	+ (e)	—
,,	20	*S. warnstorfii*[d]	+ (e)	+[b]
,,	21	*S. warnstorfii*[e]	+++ (525)	+++ (540)
,,	22	*S. fuscum*	++ (e)	—
,,	23	*S. russowii* (*S. robustum*)	++ (e)	+[b]
,,	24	*S. fimbriatum*	+ (e)	—

a: (e) means end absorption in the visible region; b: bleached out on chromatography;

c: (i) means inflection in the visible region; d: pale reddish-violet specimen; e: intensely reddish-violet specimen.

The conventional Wiesner test for lignin (red colouration with phloroglucinol and concentrated hydrochloric acid) has been performed on the species listed in Table 1, and all species were found to give a positive reaction.

The violet fraction of *S. nemoreum* has been separated into two pigments with the same chromophore. Its ultraviolet and infrared spectra show striking similarities to those of anthocyanidins. The pigments are very sensitive to the pH, and a thorough investigation of the pH dependence is now in progress. Here we will mention only that within a pH-interval of about 2—7 there are transformations and equilibria between a reddish-violet, a yellow and a blue form. The reddish-violet form is stable at low pH-values (pH about 1). At intermediate values this changes rapidly through a blue form to a yellow component, in equilibrium with the reddish-violet one. At pH 4—6 the yellow form predominates, and at somewhat higher pH there seems to be an equilibrium between the blue and the yellow components. From the solution at pH 5.5 (only yellow component) the reddish-violet colour can be regenerated by making the solution strongly acidic (pH 0.5).

The yellowish range of the violet pigment is interesting since it happens that the colour bleaches out on chromatography. This fact raises the question as to whether the faint colour of some specimens of the species characterized as reddish-violet is due only to the pH. The pH of water from the squeezed moss is around 3—4. The possibility that red and brown and yellow species contain the violet pigment in a "latent" yellow form must, however, be excluded since, in the strongly acid solution used in the isolation, the pigments should be "developed" which is not the case. Thus it is highly probable that the reddish-violet specimens only can synthesize violet pigment.

As mentioned above, luteolinidin is the only anthocyanidin detected in mosses so far. This pigment has hitherto been found only in some mosses, ferns and a few higher plants (BENDZ *et al.* 1962; HARBORNE 1966 p. 2438). The hydroxylation pattern of the luteolinidin molecule deviates from the more common anthocyanidins in a way which may be expected to influence its chemical properties importantly as has been discussed by BENDZ, MÅRTENSSON & NILSSON (1967). In this connection it may be mentioned that as far as we have checked them, moss species do not give positive proanthocyanidin tests (BENDZ, MÅRTENSSON & NILSSON 1966 b p. 277). These results are in agreement with two earlier investigations by other authors (BATE-SMITH & LERNER 1954 p. 130; CAMBIE et al. 1961 p. 731).

It it as yet too early to draw any definite taxonomic conclusions from the results reported here. Although the brown and red colouring matters discussed in this paper obviously are closely related to each other, we know almost nothing about their biosynthesis. That the colour determined by the brown and red fractions is of limited, relative value as distinguishing character is clear. On the other hand it is difficult not to believe that the brownish colour in some species is based on genetical differences compared with those which are generally green. In contrast to these pigmentations the reddish-violet seems to be limited to certain species. In spite of that it is obvious that its value as a distinguishing character also should not be exaggerated. In any case we can not recommend it as a single distinguishing character on the species level. For instance, in the case of distinguishing the closely related

S. girgensohnii and *S. russowii* use of characters other than the colour should be stressed more than earlier.

ISOLATION OF PIGMENTS

The dried and pulverized moss material was pre-extracted with methanol-ether (1 : 1, v/v) to remove lipoid compounds, simple phenols etc. The pigments were extracted in the dark at room temperature during four to eight days with methanol - 1 % conc. HCl. After evaporation of the solvent the mixture was separated by chromatography on a cellulose column with *n*-butanol-acetic acid-water (6 : 1 : 2, by vol.) as solvent. The violet fraction was eluted with methyl cellosolve - 1 % conc. HCl.

SPECTROPHOTOMETRY

The ultraviolet and visible spectra were recorded on a Bausch & Lomb Spectronic 505 spectrophotometer, using methanol — 0.01 % conc. HCl as solvent.

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LIST OF LOCALITIES

1. *S. magellanicum* BRID. — Upl., Uppsala, Nåsten, 19.X.1963, O. MÅRTENSSON & E. NILSSON.
2. *S. centrale* C. JENS. — Jmt., Kall sn., in rich fen by Kallsjön, north of Kallrör, 6.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
3. *S. centrale* C. JENS. — Upl., Uppsala, Nåsten, 18.IX.1966, E. NILSSON. Det. O. MÅRTENSSON.
4. *S. papillosum* LINDB. — Sk., Nöbbelövs sn., Gislövshammar, boggy ground close to the sea, 3.VIII.1954, E. NYHOLM.
5. *S. imbricatum* RUSSOW — Sk., Örkelljunga, Krångelbygget, moist soil close to Vita sjön, 16.VIII.1965, A. C. CRUNDWELL & E. NYHOLM.
6. *S. compactum* DC. — Vstm., Ljusnarsberg sn., moist soil under Calluna by the lake Grästjärn south-east Finnfall, 18.IX.1966, E. NYHOLM.
7. *S. squarrosum* CROME — Upl., Uppsala, Nåsten, 18.IX.1966, O. MÅRTENSSON & E. NILSSON.
8. *S. teres* (SCHIMP.) ÅNGSTR. — LyL., Tärna sn., Kirjisjaure, 13.VIII.1966, O. MÅRTENSSON.

9. *S. inundatum* RUSSOW — Srm., Utö, Stora Sand, depression in the wood, 5.VII.1966, A. C. CRUNDWELL & E. NYHOLM.
10. *S. subsecundum* NEES — Jmt., Kall sn., fen by Rutsvallen on north side of the lake Anjan, 6.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
11. *S. pulchrum* (BRAITHW.) WARNST. — Dlr., Orsa sn., by a pool in a peat bog beside mainroad 81, about 3 km north Kvarnberg, 12.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
12. *S. obtusum* WARNST. — Vstm., Rytterne sn., Åholmen, wet soil Carex sp., 22.IX.1966, E. NYHOLM.
13. *S. lindbergii* SCHIMP. — Dlr., Orsa sn., by a pool in a peat bog beside mainroad 81, about 3 km north Kvarnberg, 12.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
14. *S. majus* (RUSSOW) C. JENS. (*S. dusenii* WARNST.) — Jmt., Kall sn., poor fen by Rutsvallen north of the lake Anjan, 6.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
15. *S. lenense* H. LINDB. — R., central part of western Tajmyr, Mamontontova river, affluent to the river Shrenka at Lower Tajmyr, at the lake, 1.VIII.1949, Leg. B. A. TICHOMIROV. Det. L. SAVICZ-LYUBITSKAYA.
16. *S. subfulvum* SJÖRS — Dlr., Orsa sn., in peat bog about 13 km north of Kvarnberg by mainroad 81, 12.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
17. *S. subnitens* RUSSOW & WARNST. (*S. plumulosum* RÖLL) — Vstm., Vikers sn., moisted rocks by Älvlången, in ravine of the small stream coming from Grytsjön, 19.VIII.1966, E. NYHOLM.
18. *S. nemoreum* SCOP. — Upl., Uppsala, Nåsten and Hjd., Tännäs sn., Rödviken, 400 m north of the lake Rogen, 4.VIII.1966, E. NILSSON. Det. O. MÅRTENSSON.
19. *S. quinquefarium* (BRAITHW.) WARNST. — N., Nord-Tröndelag, Inndalen, moist sloping ground by Hjellfossen, 5.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
20. *S. warnstorfii* RUSSOW — Jmt., Alsen sn., in rich fen between Nordbyn and Truvbacken, 8.VIII.1966, A. C. CRUNDWELL & E. NYHOLM.
21. *S. warnstorfii* RUSSOW — LyL., Tärna sn., Gäutajaure, Sundet, 4.VIII.1966, O. MÅRTENSSON.
22. *S. fuscum* (SCHIMP.) KLINGGR. — Upl., Uppsala, Nåsten, 18.IX.1966, O. MÅRTENSSON & E. NILSSON.
23. *S. russowii* WARNST. (*S. robustum* Röll) — Sk., Ö. Broby sn., Nordanå, moist depression in coniferous forest, 3.XI.1966, E. NYHOLM.
24. *S. fimbriatum* WILS. — Sk., Glimåkra, Vesslarp, moist soil by lake, 23.VI. 1965, E. NYHOLM.

NOTE. The nomenclature followed is according to the revised nomenclature of *Sphagnum* species by ISOVIITA (1966). The collections are in the Uppsala Museum.

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Eleocharis, Subser. Eleocharis in North America

Taxonomical Comments and Chromosome Numbers

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ABSTRACT

Out of six species within subser. *Eleocharis* (syn. *Palustres* (C. B. CLARKE) SVENSON) accepted by SVENSON (1957), the following ones are subdivided into two taxa after cytological and morphological studies: *E. fallax* WEATHERBY s. lat. into *E. fallax* WEATHERBY (2n=42) and *E. ambigens* FERN. (2n=46; 45; 44); *E. macrostachya* BRITTON s. lat. into *E. macrostachya* BRITTON (2n=38) and *E. perlonga* FERN. & BRACK. (2n=18); *E. smallii* BRITTON s. lat. into *E. smallii* BRITTON (2n=16) and a taxon, the correct name of which is still unknown (2n=36). — Species within the complex of *E. kamtschatica* (C.A.M.) KOM. (2n=46; 42) are discussed and *E. sachalinensis* (MEINSH.) KOM. and *E. komarovii* ZINSERLING (illeg. syn. *E. triflora* KOM. non BÖCKLR.) are regarded as synonyms. — The following taxa are also discussed: *E. erythropoda* STEUD. (2n=18; 19; 20), *E. halophila* (FERN. & BRACK.) FERN & BRACK. (2n=38; 37).

INTRODUCTION

In order to be able to correlate the cytological and taxonomical experiences of European *Eleocharis* with North American representatives of the same group, the author has endeavoured to obtain living plants from North America. Several botanists have kindly sent diaspores, and about 60 samples of *Eleocharis* have thus become available for cytological studies. In this paper, the representatives of subser. *Eleocharis* [syn. subser. *Palustres* (C. B. CLARKE) SVENSON 1929 p. 128] will be discussed. The number of samples cultivated of this subseries are about 55.

In the actual group, studies of such a restricted material as the one available will give few definite results and few possibilities of discussing the variation. Furthermore, all taxa of interest have not been available for study. The correlation between cytological and morphological characters and the study of the nomenclatural types have, however, given such interesting results that a preliminary report seems justifiable.

The somatic chromosome numbers have been determined in root tips prepared by the paraffin method. The fixative used is a 1:1 mixture of LEVITSKY's fixative or the Svalöv modification of NAVASHIN's fixative. The "idiogram formulas" (cf. STRANDHEDE 1965 p. 11) used are a representation of the karyotypes by the symbols of letters: L=long chromosomes, M=medium-sized chromosomes, S=short chromosomes.

Morphological and biometrical observations have been made on plants cultivated in the Botanical Garden in Lund, where they have grown under uniform conditions. The achene lengths are always given excluding the style bases. The identity of taxa recognized has been confirmed by comparison with nomenclatural type specimens except for *E. erythropoda*. The abbreviations of herbaria, where types are kept are according to Index Herbariorum (1964).

Within the North American taxa of subser. *Eleocharis,* the relations between taxonomy and chromosome numbers are complicated. The taxonomical treatises published are further numerous and often controversial. Thus, FERNALD & BRACKETT (1929) recognized eight species in North America, among which the European species also occur. According to GLEASON (1952), *E. smallii, E. macrostachya,* and *E. palustris* seem to be phases of a single large species, which he called *E. palustris* (L.) R. & S. It is also of interest to note that GLEASON regarded *E. ambigens* as a distinct species, while SVENSON (1947, 1957) considered it to be a synonym of *E. fallax*. A regional, taxonomical treatment of the complex was made by MOHLENBROCK & DRAPALIK (1960), and a more complete revue at the recent taxonomical status of the group was presented there.

On the basis of morphology and geographical distribution, six species of subser. *Eleocharis* (subser. *Palustres*) were accepted by SVENSON (1947, 1957). Dr. SVENSON has kindly determined several samples of the material studied by me. Because of the discrepancy between his determinations on morphological grounds and my cytological findings, my attention was drawn to the taxonomical complexity of North American representatives.

E. erythropoda

Within *E. erythropoda* STEUD. (1855 p. 76) the most common chromosome number is 2n=18 (idiogram formula 4 L+4 M+10 S; Fig. 1 A. The chromosome number 2n=19 occurs in plants from six collections. One collection (Fig. 1 B; coll. no. US 01) has the idiogram formula 4 L+4 M+11 S and, thus, one supernumerary S chromosome. The other five collections (coll. nos. US 16, US 20, US 52, US 53, Ca 02) have one supernumerary L chromosome (Fig. 1 C) and the idiogram formula 5 L+4 M+10 S. Two of the collections with 2n=19 include also plants with 2n=18 (coll. no. Ca 02), or 2n=20 (coll. no. US 16).

One sample has 2n=20 (Fig. 1 D; coll. no. US 45). Here, size differences occur especially between different long (L) and medium-sized (M) chromosomes, and the idiogram formula may be written 2 L_1+ 2 L_2+3 M_1+2 M_2+11 S. This complexity of chromosome numbers and idiogram formulas recalls the conditions found in European taxa (STRANDHEDE 1965).

The variation in chromosome number of *E. erythropoda* is not correlated to any morphological characters. All samples investigated are morphologically similar. I have not seen nomenclatural type specimen of *E. erythropoda,* but the type specimens of its synonyms *E. calva* TORR. and *S. glaucus* TORR., both kept in NY, belong morphologically to the same taxon as the cytologically investigated specimens of *E. erythropoda.*

E. kamtschatica

E. kamtschatica (C.A.M.) KOMAROV (1927 p. 207), known from E Asia and, in North America, from Canada and Alaska, has been available for cytological studies only from two localities in Japan. One of the samples has 2n=46 (Fig. 1 E) and the other 2n=42 (Fig. 1 F). The idiogram formulas of the two cytotypes may be written 8 L+8 M+30 S (2n=46) and 8 L+12 M+22 S (2n=42). It is difficult to make a definite arrangement of the chromosomes into the three classes as obvious differences in lengths occur in all classes.

The surprising fact that there are two chromosome numbers with quite different idiogram formulas may indicate that a taxonomical subdivision is possible within the species. The two collections investigated were determined as to name by Dr. J. OHWI in Japan. None of the plants has produced ripe fruits in culture, and it has thus been impossible for me to verify the determination.

Some species described are closely related to or synonymous of *E. kamtschatica.* One of them is *E. pileata* A. GRAY (1859 p. 417) from Japan. The sheet with the type specimen, kept in GH, is a mixture. The specimen to left is "biglume" and rather similar to forms of *E. palustris* (L.) R. & S. ssp. *palustris* (cf. STRANDHEDE 1966). The middle and right specimens are "uniglume" and similar to *E. kamtschatica. E. pileata* is usually treated as a synonym of *E. kamtschatica* (cf. OHWI 1944, SVENSSON 1957, and KOYAMA 1961).

Another two species within the group are *E. sachalinensis* (MEINSH.) KOMAROV (1931 p. 266) and *E. komarovii* ZINSERLING (1935 p. 81). I have made a close morphological study of the nomenclatural type specimens kept in LE and, in my opinion, all belong to the same species, *E. kamtschatica,* though ZINSERLING (1935 p. 80) regards them as readily distinguishable species. The original collection of *E. kamtschatica* (C.A.M.) KOM. marked "Typus!" in LE includes two specimens. Both are uniglume but too undeveloped to give any valuable information in details.

An interesting observation has, however, been made on the labels of KOMAROV's dried material (LE) of *Eleocharis* from Kamtschatka. Two samples were collected on August 23, 1909, by V. KOMAROV at the Usona crater. One of them, collected in the vicinity of the springs, was determined as *E. kamtschatica* by KOMAROV. The other one, an isotype of *E. triflora* KOM. and thus of *E. komarovii* ZINSERLING, was collected in the vicinity of the hot springs. The two mentioned samples seem only to be modifications of the same strain. I have seen plants of European *E. palustris* modified in the same direction when they grow in dry localities.

I consider, therefore, that *E. sachalinensis* (MEINSH.) KOM., *E. komarovii* ZINSERLING and its illegitimate synonym *E. triflora* KOM. non BÖCKLR. should be treated as synonyms of *E. kamtschatica* (C.A.M.) KOM. (cf. OHWI 1944 pp. 44—45, and KOYAMA 1961 p. 97).

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The Complex of E. fallax and E. halophila

This complex includes taxa with encircling basal glumes of the spikelets (i.e. uniglume taxa). They are morphologically rather similar to each other and also to the European *E. uniglumis* (LINK) SCHULT.

E. uniglumis commonly has 2n=46. The same chromosome number has been found in two North America samples (see Appendix). A definite analysis of the karyotypes is difficult to obtain, as the chromosomes within the classes are not of equal lengths (Fig. 1 G). Thus, there are obvious differences in lengths between the long chromosomes and this class has been subdivided into three groups in the idiogram formula (Tab. 1); viz., G (giant), L (long), and L-M (intermediate) chromosomes. Another sample with 2n=44 and 2n=45 in different plants

Table 1. Analysis of specimens cultivated and nomenclatural type specimens of *E. ambigens*, *E. fallax*, and *E. halophila*.

Taxon	2n	Idiogram formula	Achenes			Style basis			Number of flowers per 10 mm.	Stomatal length (μ)	Collection numbers
			length (mm.)	width (mm.)	surface	length (mm.)	width (mm.)	shape			
E. ambigens	46	2 G+2 L+2 L–M+ +6 M+34 S	1.2–1.3	1.1	somewhat reticulate	0.2–0.3	0.6	mamillate	47	—	1926
	46		1.4–1.5	1.1	somewhat reticulate	0.5	0.6	convex	50	65	US 17
			1.3	1.1	somewhat reticulate	0.3–0.4	0.6	mamillate	51	61	Type specimen
E. fallax	42	6 L+10 M+26 S	1.3	1.0	reticulate	0.5	0.4	conical	31	67	US 34, plant 06
			1.2–1.3	1.0–1.1	reticulate	0.4–0.5	0.5	conical	34	56	Type specimen
E. halophila	38	6 L+10 M+22 S	1.5–1.7	1.2	smooth	0.6	0.4	conical	25	54	US 34, plant 04
			1.6	1.2	smooth	0.5	0.4	conical	20	61	Type specimen

and one with 2n=45 are morphologically similar to the specimens with 2n=46.

In morphological characters, all the plants of these four samples correspond to the type specimen of *E. ambigens* FERN. (1935 p. 394) kept in GH.

According to the North American Flora (SVENSON 1957), *E. ambigens* is a synonym of *E. fallax* WEATHERBY (1922 p. 23). The nomenclatural type specimen of *E. fallax,* kept in GH, is morphologically rather different from that of *E. ambigens* mentioned above. It is, however, similar to experimental material with 2n=42 (Fig. 1 H). The idiogram formulas and morphological differences observed between *E. ambigens* and *E. fallax* are shown in Tab. 1. *E. ambigens* has dense spikelets; small achenes, with somewhat sculptured surfaces; and markedly low, mamillate style bases. *E. fallax* has loose spikelets; small, markedly sculptured achenes; and often conical style bases.

On the bases of the observations and available data, it seems desirable to recognize *E. fallax* and *E. ambigens* as different taxa.

E. halophila (FERN. & BRACK.) FERN. & BRACK. in FERNALD (1935 p. 395) has 2n=38 (Fig. 1 I); however, two collections studied have 2n=37 (Fig. 1 J). The idiogram formula of 2n=38 is 6 L+10 M+22 S; that of 2n=37 is 6 L+10 M+21 S.

E. halophila is morphologically very similar to some forms of European *E. uniglumis*. It has loose spikelets with rather few achenes. It is distinguished from *E. fallax* and *E. ambigens* by having larger achenes with less reticulate surfaces (Tab. 1). (Nomenclatural type specimen in GH.)

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The Complex of E. macrostachya

According to SVENSON (1939), who was able to recognize a dozen races, *E. macrostachya* BRITTON in SMALL (1903 p. 184) is a complex taxon. Part of the variation obviously depends on the occurrence of different chromosome races. Thus, the very few collections available for cytological studies have two different chromosome levels: 2n=18 (Fig. 1 K) and 2n=38 (Fig. 1 L). BERNARDINI (1959) reported 2n=20 for this species. According to his figures, the idiogram formula can be written 6 L+4 M+10 S.

Only four collections of the 18 chromosome cytotype have been available for cytological studies. Three of them originating from Lake Vera in California have 2n=18. The idiogram formula of this cytotype

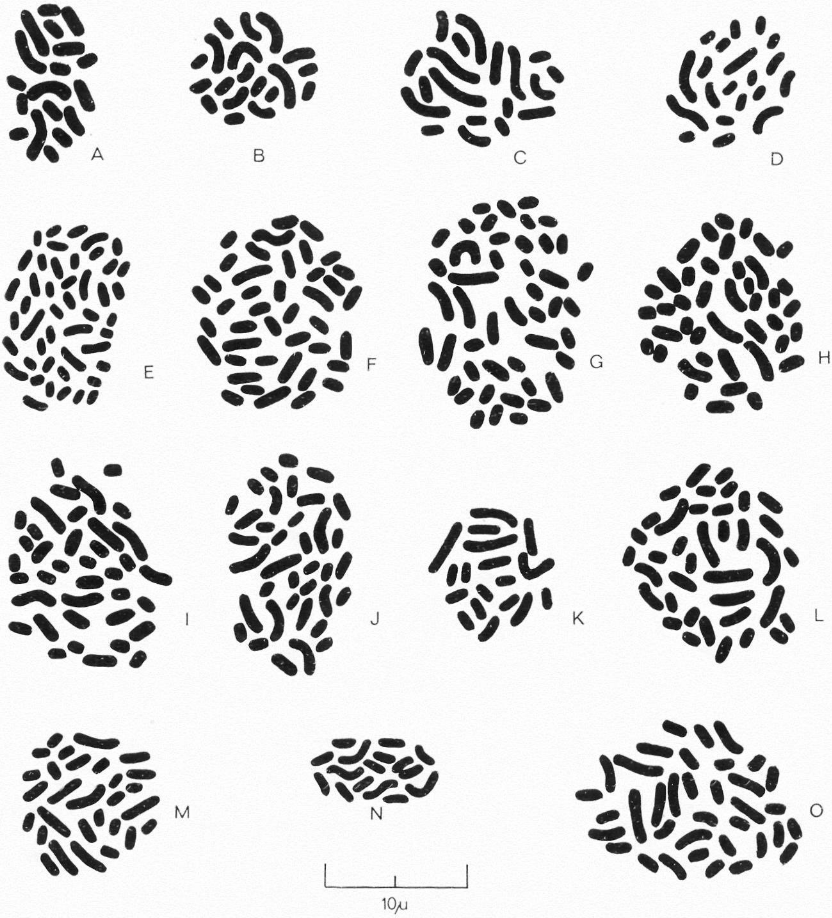

Fig. 1. Root mitoses showing chromosome numbers in some North American species of *Eleocharis*. — *E. erythropoda* (A—D), A: 2n=18 (no. Ca 1103), B: 2n=19 with four L chromosomes (no. US 0112), C: 2n=19 with five L chromosomes (no. US 1603), D: 2n=20 (no. US 4501). — *E. kamtschatica* (E—F), E: 2n=46 (no. As 0701), F: 2n=42 (no. As 0903). — G: *E. ambigens*, 2n=46 (no. 192609). — H: *E. fallax*, 2n=42 (no. US 3406). — *E. halophila* (I—J), I: 2n=38 (no. US 3404), J: 2n=37 (no. US 4001). — K: *E. perlonga*, 2n=18 (no. US 0902). — L: *E. macrostachya*, 2n=38 (US 2204). — M: The hybrid suggested *E. perlonga*×*macrostachya*, 2n=29 (no. US 3102). — *E. smallii* s. l. (N—O), N: *E. smallii* s. str., 2n=16 (no. US 1303), O: 2n=36 (no. Ca 0309). The last two figures of each collection number refer to plants within the collection.

is similar to that of *E. erythropoda*: 4 L+4 M+10 S. The fourth sample originates from Lancaster County, Nebraska, and in the same cross sections of the root tips, 2n=18 and 2n=19 have been found. The karyotype of 2n=19 has an extra S chromosome.

The 18 chromosome cytotype corresponds morphologically to *E. perlonga* FERN. & BRACK. (1929 p. 70). The specimens are characterized by their usually very long spikelets, normally reaching about 3 cm in culture. The base of the spikelets is normally completely encircled by the collar-shaped, basal scale. The mean values of the stomatal lengths vary between 52 and 56 microns. The achenes are c. 1.3 mm long and c. 1.1 mm wide. The shape of the style base is conical, and its length is the same as the width.

The type specimen of *E. perlonga,* which is kept in NY, is in the flowering stage and corresponds, in the characters mentioned, to the cultivated material with 18 chromosomes. The longest spikelet of the type specimen is about 4 cm, and the stomatal length is 51 microns.

The idiogram formula of the 38 chromosome race may be written as 6 L+10 M+22 S. It is thus similar to that of *E. halophila* (Tab. 1) and to that of the European *E. palustris* ssp. *vulgaris* WALTERS (1949 p. 194) with the same chromosome number (cf. STRANDHEDE 1965 p. 45). All the material available for cytological studies originated from one locality, viz., the Willamette River, Oregon (coll. nos. US 21, US 22).

These collections of *E. macrostachya,* as determined by Dr. H. K. SVENSON on morphological characteristics, have spikelets with one or two sterile, encircling or non-encircling basal scales. The achenes are 1.4—1.5 mm long, and strikingly broad: c. 1.3 mm. The style base is broader than it is high. The mean value of the stomatal length is 61 microns.

The type specimen of *E. macrostachya* BRITTON (NY) corresponds only in part to the material with 2n=38, viz., in the shape of the spikelets and the stomatal length, which is 63 microns. The spikelets have two, non-encircling basal glumes. The fruit is smaller and not as broad as that of the specimens in culture, and thus rather similar to that of *E. perlonga.* The length is 1.2—1.3 mm and the width 0.9 mm. The style base is higher than it is broad in contrast to the experimental material.

Thus, the correlation between the experimental material with 2n=38 and the type specimen is not quite satisfactory, and they obviously belong to two different strains within the species. According to experiences from European *Eleocharis,* the fruit differences observed may be found within the limits of cytotypes with 2n=38. Further, the type specimen of *E. macrostachya* has large cell dimensions, and the long stomata also indicate that the type belongs to a cytotype with a chromosome number markedly higher than 2n=18. The correlation between the stomatal length and the chromosome number has been demonstrated earlier in European taxa of subser. *Eleocharis* (cf. WALTERS 1949, STRANDHEDE 1960, 1961).

Considering the different chromosome numbers and the morphological differences observed, it seems incorrect to regard *E. perlonga* FERN. & BRACK. as a synonym of *E. macrostachya* BRITTON (cf. SVENSON 1957). It should be possible to use the existing names in such a way that *E. perlonga* represents the 18 chromosome taxon and *E. macrostachya* the 38 chromosome one.

According to specimens studied with 2n=38, morphological distinction between *E. halophila* and *E. macrostachya* is somewhat uncertain. I have received several specimens determined to *E. macrostachya* that I consider to range within the variation of *E. halophila*. These samples are not listed in the Appendix, and I must leave that problem until more material have been studied.

An interesting sample of plants has been sent from the Mather Experimental Station in the Sierra Nevada, California. Mixed with 18 and 38 chromosome plants, there were also plants with 2n=29 (Fig. 1 M). The 18 and 38 chromosome plants have not yet produced any spikelets, but they are vegetatively rather similar to *E. perlonga* and *E. macrostachya*. The 29 chromosome plants have an encircling basal scale and are vegetatively similar to *E. perlonga*. The fruit setting in the 29 chromosome plants seems to be somewhat reduced, and it seems probable that these plants are hybrids, possibly between *E. perlonga* and *E. macrostachya*. Such a hybridization may be one cause of the intergrading races of *E. macrostachya* s. lat. observed by SVENSON (1939). It would also be a parallel to the conditions in European *E. palustris* (L.) R. & S., where ssp. *palustris* (2n=16) may produce 27 chromosome, natural hybrids with ssp. *vulgaris* WALTERS (2n=38) (cf. STRANDHEDE 1965, 1966).

The Complex of E. smallii

Within specimens that are morphologically characterized as *E. smallii* BRITTON (1903 p. 23) two cytotypes occur, viz., 2n=16 (idiogram formula 4 L+12 M) (Fig. 1 N) and 2n=36 (idiogram formula 4 L+8 M+24 S) (Fig. 1 O). Plants of these chromosome races are very similar, but a few morphological characters make it possible to distinguish them. Thus, cultivated plants of the 16 chromosome type have small fruits (1.2—1.5 mm) and short stomata (39—48 microns). Plants of the 36 chromosome type have longer fruits (1.6—1.7 mm) and longer stomata (55—60 microns). The style bases are often rounded in both cytotypes, but within the 16 chromosome group one collection has high and narrow style bases.

The type specimen of *E. smallii* Britton (NY) corresponds in most details to the 16 chromosome type. The achenes are 1.2—1.3 mm long, and the stomata 41 microns. The style bases are rounded, as in most of the samples cultivated. Svenson (1939 p. 64) considered the type specimen pathogenic, but I think it is a quite normal form, modified by growing in rather deep water.

To judge from the collections available, the 16 chromosome group of *E. smallii* is very similar to European *E. palustris* ssp. *palustris,* which also has 2n=16 and the same idiogram formula (cf. Strandhede 1960, 1961, 1965).

It is too early to say how closely related the two cytotypes of *E. smallii* are. Perhaps, the conditions are similar to those of European *E. palustris* where two cytotypes also occur (cf. above). The name *E. smallii* Britton can obviously be referred to the 16 chromosome strains. No scientific name has yet been found for the 36 chromosome strains but, since a usable combination probably exists, no proposal for a new name will be made in this preliminary report.

SUMMARY

Species in The North America Flora (1957)	Corresponding taxa recognized in the present paper	Chromosome number (2n)
E. erythropoda Steud.	*E. erythropoda* Steud.	18; 19; 20
E. kamtschatica (C.A.M.) Kom.	*E. kamtschatica* (C.A.M.) Kom.	42; 46
E. fallax Weatherby s. lat.	*E. fallax* Weatherby s. str. *E. ambigens* Fern.	42 46; 45; 44
E. halophila (Fern. & Brack.) Fern. & Brack.	*E. halophila* (Fern. & Brack.) Fern. & Brack. s. str.	38; 37
E. macrostachya Britt. s. lat.	*E. perlonga* Fern. & Brack. *E. macrostachya* Britt. s. str.	18 38
E. smallii Britt. s. lat.	*E. smallii* Britt. s. str. Taxon with unknown name	16 36

E. sachalinensis (Meinsch.) Kom. and *E. komarovii* Zinserling (syn. *E. triflora* Kom. non Böcklr.) are regarded as synonyms of *E. kamtschatica* (C.A.M.) Kom.

APPENDIX. CYTOLOGICALLY INVESTIGATED SAMPLES DISCUSSED IN THE TEXT

Semicolon between two chromosome numbers means that the numbers have been determined in different plants of the sample; comma means that the numbers have been found in the same root tip.

The identification numbers of the samples (coll. no.) are given in parentheses followed by the number of plants in which the chromosome numbers have been determined.

E. erythropoda

$2n=18$	The experimental area of the University, Bowling Green State University, Bowling Green, Ohio, U.S.A.; leg. N. Wm. Easterly. (coll. no. US 18) — 4 plants.
$2n=18$	Open marsh area; spontaneous in the Botanical Gardens, Ann Arbor, Michigan, U.S.A.; leg. & det. M. T. Hall. (coll. no. US 35) — 6 plants, (coll. no. US 36) — 9 plants.
$2n=18$	On loamedge of high riverbank, ½ mile W of Fort Saskatchewan, Alberta, Canada; leg. H. Turner (no. 11575). (coll. no. Ca 09) — 2 plants.
$2n=18$	On sandbar near Fort Saskatchewan, Alberta, Canada; leg. H. Turner (no. 11576). (coll. no. Ca 10) — 2 plants.
$2n=18$	Research Station, Lethbridge, Alberta, Canada; leg. R. W. Peake. (coll. no. Ca 11) — 4 plants.
$2n=18$	East fork of Jaemez River, Santa Fe National Forest, New Mexico, U.S.A., alt. 9100 feet; cultivated at Univ. of Nebraska greenhouse; leg. J. V. Bernardini & J. C. Anway (no. 155). (coll. no. US 49) — 2 plants.
$2n=18$	Marsh-area stream bank, Fall River by town park of Hot Springs, South Dakota, U.S.A.; leg. J. V. Bernardini & J. de Noyelles (no. 303). (coll. no. US 51) — 2 plants.
$2n=18$	J. V. Bernardini no. 133*. (coll. no. US 58) — 2 plants.
$2n=18;\ 19$	Ile Ste-Thérèe, en face de Varennes, Montreal, Canada; leg. A. Löve. (coll. no. Ca 01) — 1 plant, (coll. no. Ca 02) — 2 plants.
$2n=19$	Sandy shore on W side of Munro Lake, Cheboygan County, Michigan, U.S.A.; leg. & det. R. M. Johns. (coll. no. US 01) — 6 plants.
$2n=19$	Mt. Orab, 35 miles E Cincinnati, Lake Grant, Ohio, U.S.A.; leg. D. W. Battin. (coll. no. US 20) — 1 plant.
$2n=19$	J. V. Bernardini no. 304 B. (coll. no. US 52) — 2 plants.
$2n=19$	J. V. Bernardini no. 304 C. (coll. no. US 53) — 3 plants.
$2n=19;\ 20$	Sandy shore of Shenandoah River, Stanley, Virginia, U.S.A.; leg. & det. H. K. Svenson. (coll. no. US 16) — 4 plants.
$2n=20$	J. V. Bernardini no. 281. (coll. no. US 45) — 1 plant.

E. kamtschatica

$2n=42$	Odoriki, Chôsei-mura, Chôsei-gun, Chiba Prefecture, Japan; leg. J. Itô, det. J. Ohwi, sent by N. Tanaka. (coll. no. As 09) — 8 plants.

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* Owing to a long stay abroad, Dr. Bernardini has not been able to give further particulars on the origins of some samples that I have received from him.

$2n=46$ Karuizawa in Shinano, Honshu, Japan; leg. & det. J. Ohwi. (coll. no. As 07) — 1 plant.

E. fallax

$2n=42$ Brackish marsh, Plum Island, Newburyport, Massachusetts, U.S.A.; leg. H. K. Svenson (coll. no. US 34, intermingled with *E. halophila*) — 4 plants.

E. ambigens

$2n=46$ On gravel terrace of Shenandoah River, near airfield, Rockingham County, Virginia, U.S.A.; leg. H. K. Svenson. (coll. no. US 17) — 4 plants.

$2n=46$ Back Bay, Princess Anne County, Virginia, U.S.A.; leg. H. K. Svenson (coll. no. 1926) — 4 plants.

$2n=44$; 45 Brackish marsh, Allen's Fresh, Wicomico River, Charles County, Maryland, U.S.A.; leg. H. K. Svenson. (coll. no. US 38) — $2n=44$: 2 plants, $2n=45$: 5 plants.

$2n=45$ J. V. Bernardini no. 313. (coll. no. US 56) — 2 plants.

E. halophila

$2n=38$ Brackish marsh, Plum Island, Newburyport, Massachusetts, U.S.A.; leg. & det. H. K. Svenson. (coll. no. US 34, intermingled with *E. fallax*) — 3 plants.

$2n=37$ Clay-muck borders of hatching ponds at Gretna Fish Hatchery; 5 miles S of Interstate Hwy 80 on Nebraska Hwy 31, Sarpy County, Nebraska, U.S.A.; leg. J. V. Bernardini (no. 278 & no. 277). (coll. no. US 39) — 2 plants, (coll no. US 40) — 2 plants.

E. perlonga

$2n=18$ Lake Vera, about 3 miles NW of Nevada City, Nevada County, California; leg. W. B. McHenry, sent by J. M. Tucker. (coll. no. US 09) — 5 plants, (coll. no. US 10) — 1 plant, (coll. no. US 11) — 6 plants.

$2n=18$, 19 Border on pasture pond at the end of SE runway of Arrow Airport, Lincoln, Lancaster County, Nebraska, U.S.A.; J. V. Bernardini (no. 296). (coll. no. US 43) — 1 plant.

E. macrostachya

$2n=38$ Sandy bank, Willamette River, 1 mile S of Corvallis, Oregon, U.S.A.; leg. & det. K. L. Chambers. (coll. no. US 21) — 6 plants, (coll. no. US 22) — 2 plants.

The putative hybrid *E. perlonga*×*E. macrostachya*

$2n=29$ Mather Experimental Station (alt. 4600′), Sierra Nevada, Toulumne County, California, U.S.A.; leg. J. Clausen. (coll. no. US 31) — 2 plants (coll. no. US 32) — 4 plants.

E smallii s. str.

$2n=16$ In shallow water at edge of creek, $^{1}/_{2}$ mile S of Fort Saskatchewan, Alberta, Canada; leg. G. H. Turner (no. 11572). (coll. no. Ca 06) — 3 plants.

$2n=16$ In empty slough in grain field, $^{1}/_{2}$ mile SE Fort Saskatchewan, Alberta, Canada; leg. G. H. Turner (no. 11573). (coll. no. Ca 07) — 3 plants.

$2n=16$ Research Station, Lethbridge, Alberta, Canada leg. R. W. Peake. (coll. no. Ca 12) — 4 plants.

$2n=16$ Swampy shore of Douglas Lake at Ingleside, Cheboygan County, Michigan, U.S.A.; leg. R. M. Johns. (coll. no. US 03) — 6 plants.

$2n=16$ Wet peaty sandflat in very shallow water, Concord, near north end of Bateman's Pond, Middlesay County, Massachusetts, U.S.A.; leg. & det. R. J. Eaton (no. 5150). (coll. no. US 13) — 3 plants.

$2n=16$ In shallow water on shoulder of gravel dyke, Concord, Great Meadows, middle dyke, Middlesay County, Massachusetts, U.S.A.; leg. & det. R. J. Eaton (no. 5154). (coll. no. US 15) — 3 plants.

$2n=16$ Brackish shores of South River, near Annapolis, Maryland, U.S.A.; leg. & det. H. K. Svenson. (no. US 19) — 3 plants.

$2n=16$ J. V. Bernardini no. 302. (coll. no. US 54) — 2 plants.

Taxon with unknown name but within the morphological ranges of *E. smallii* s.l.

$2n=36$ Stony shore along a rapid of the Devil's river, Canton Rolland, Prov. Quebec, Canada; leg. Fr. L. Lévesque (no. 611005—2551), sent by Á. Löve. (no. Ca 03) — 6 plants.

$2n=36$ C. Experimental Farm, Plant Research Institute, Ottawa, Ontario, Canada; leg. J. A. Calder. (no. Ca 04) — 3 plants, (no. Ca 05) — 2 plants.

$2n=36$ In shallow water at Sparrow's Swale (Finster Marsh), Cheboygan County, Michigan, U.S.A.; leg. & det. R. M. Johns. (no. US 04) — 6 plants.

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On the Weed Flora of Aswan, Egypt

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ABSTRACT

Sixtyseven species of weeds of 26 families are recorded from the Aswan area, Egypt. Of them 14 species were not recorded from Egyptian Nubia. *Clitoria ternatea* L. and *Cassia occidentalis* L., both known from Sudan, are new records to the Upper Nile Valley of Egypt. Apparently, any intrusions to the weed flora of Aswan are to be expected from the south.

During two excursions to Aswan, in November 1963 and December 1964, the writer collected weeds from the following localities: the eastern side of the Nile banks in town, the Plant Island, the western side near Aga Khan Mausoleum and the Aswan Dam area, east and west of the Nile.

Sixtyseven species were recorded, comprising 26 families. Fourteen of these species are not listed among the flora of the Nile region in Egyptian Nubia (Boulos 1966), viz. *Wahlenbergia cervicina, Ceruana pratensis, Coronopus niloticus, Cyperus longus, Cyperus michelianus* var. *pygmaeus, Echinochloa crus-galli, Setaria glauca, Setaria verticillata* var. *ambigua, Clitoria ternatea, Trigonella laciniata* var. *bicolor, Sida alba, Oxalis corniculata, Sutera glandulosa* and *Datura stramonium*.

The occurrence of *Clitoria ternatea* L., 'Kordofan Pea', in Aswan is a new record for the Nile Valley south of Cairo to the Egyptian-Sudanese boundary. In Egypt, the plant was known to have occurred very rarely in the Gebel Elba region (Täckholm et al. 1956 pp. 318—319) near the Red Sea, about the same latitude as Wadi Halfa. According to Andrews (1952 p. 177), *C. ternatea* is widespread in the Sudan, both wild and cultivated.

Cassia occidentalis L., a new species to the flora of Egypt (Boulos 1966 p. 203, T. XIII) was recorded for the first time as a weed in the fields of Aniba village, Egyptian Nubia. Andrews (1952 pp. 116—117) reports on *C. occidentalis* as widespread in Sudan, particularly near villages.

The presence of both *Clitoria ternatea* and *Cassia occidentalis* in the Upper Nile Valley of Egypt could be attributed to their probable intrusion from the south, i.e. from the Sudan. It is not likely that the very rare *Clitoria ternatea* could have succeeded in crossing the vast Eastern Desert, in particular the mountainous county, from Gebel Elba near the Red Sea Coast to the Nile at Aswan. This supports a previous comment by the writer (BOULOS 1966 p. 185), that any intrusions to the weed flora of the Egyptian Nubia are to be expected from the south. However, there are more species to be added to the present list, as this study was confined to late autumn and early winter.

Specimens of all the plants collected are kept in the Herbarium of the Botany Department, Faculty of Science, Cairo University (CAI) and the Herbarium of the Desert Institute, Mataria, Cairo (CAIH).

Aizoaceæ

Glinus lotoides L.

Amaranthaceæ

Amaranthus ascendens LOIS.

Asclepiadaceæ

Oxystelma esculentum R. BR. var. *alpini* N. E. BR.

Boraginaceæ

Echium rauwolfii DEL.
Heliotropium ovalifolium FORSK.

Campanulaceæ

Wahlenbergia cervicina A. DC.

Chenopodiaceæ

Chenopodium album L.

Compositæ

Ambrosia maritima L.
Ageratum conyzoides L.
Ceruana pratensis FORSK.
Conyza dioscorides (L.) DESF.
Conyza linifolia (WILLD.) TÄCKH.
Cotula anthemoides L.
Eclipta alba (L.) HASSK.
Pulicaria crispa (FORSK.) BENTH. et HOOK. F.
Senecio aegyptius L.
Sonchus oleraceus L.
Xanthium brasilicum VELLOZO

Convolvulaceæ

Convolvulus arvensis L.

Cruciferæ

Coronopus niloticus (DEL.) SPRENG.
Eruca sativa MILL.
Lepidium sativum L.

Cucurbitaceæ

Colocynthis vulgaris SCHRAD.

Cyperaceæ

Cyperus longus L.
Cyperus michelianus (L.) LINK. var. *pygmaeus* (ROTTB.) ASCHERS. et GRAEBN.
Cyperus rotundus L.
Fimbristylis bis-umbellata (FORSK.) BUB.

Euphorbiaceæ

Chrozophora plicata (VAHL) A. JUSS. ex SPRENG.
Euphorbia peplus L.
Euphorbia pilulifera L.
Euphorbia prostrata AIT.
Euphorbia prunifolia JACQ.

Gramineæ

Brachiaria eruciformis (SIBTH. et SM.) GRISEB.
Cynodon dactylon (L.) PERS.
Dactyloctenium aegyptium (L.) RICHT.
Dichanthium annulatum (FORSK.) STAPF
Digitaria sanguinalis (L.) SCOP. var. *aegyptiaca* (RETZ.) HENR. as subsp.
Echinochloa colonum (L.) LINK
Echinochloa crus-galli (L.) BEAUV.
Eragrostis aegyptiaca (WILLD.) DEL.
Eragrostis cilianensis (ALL.) VIGN.-LUT.
Eragrostis diplachnoides STEUD.
Heleochloa schoenoides (L.) HOST.
Imperata cylindrica (L.) BEAUV.
Polypogon monspeliensis (L.) DESF.
Setaria glauca (L.) BEAUV.
Setaria verticillata (L.) BEAUV. var. *ambigua* (GUSS.) RICHT.
Sorghum virgatum (HACK.) STAPF

Leguminosæ

Cassia occidentalis L.
Clitoria ternatea L.
Lotus arabicus L.
Medicago hispida GAERTN.
Melilotus indicus (L.) ALL.
Trigonella laciniata L. var. *bicolor* SCHWEINF.

Malvaceæ
  Sida alba L.

Oxalidaceæ
  Oxalis corniculata L.

Papaveraceæ
  Argemone mexicana L.

Portulacaceæ
  Portulaca oleracea L.

Primulaceæ
  Anagallis arvensis L.

Rosaceæ
  Potentilla supina L.

Sapindaceæ
  Cardiospermum halicacabum L.

Scrophulariaceæ
  Sutera glandulosa ROTH.

Solanaceæ
  Datura stramonium L.
  Solanum nigrum L.

Tiliaceæ
  Corchorus olitorius L.

Typhaceæ
  Typha australis SCHUM. et THONN.

Verbenaceæ
  Phyla nodiflora (L.) GREENE

ACKNOWLEDGEMENTS

Professor VIVI TÄCKHOLM of Cairo University kindly determined some species.

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Brief Articles and Reports

Elodea canadensis vid Bottniska Vikens nordkust

Abstract. — Two finds of *Elodea canadensis* from the northern shore of the Gulf of Bothnia — where the species has not earlier been found — are reported: Sweden. Province of Norrbotten. Parish of Råneå, Strömsund, living fragments in the sea-drift 29.VIII.1957 Erik Julin (Hb. ips.). — Parish of Nedertorneå, Salmisviken, fairly large, fixed carpets on a depth of $^1/_2$—1 $^1/_2$ metres beneath the normal waterlevel 6.VIII.1967 Erik Julin (Hb. ips.).

Discussions on the biology of propagation and dispersion are given for the species.

Trekvarts sekel har förflutit, sedan O. B. Santesson upptäckte *Elodea canadensis* i trakten av Luleå, där den 1893 och 1894 (möjligen redan 1892) ymnigt växte i Skurholmsfjärden och dess fortsättning norr om Lulsundet, Björkskatafjärden (Birger 1910 p. 6). Sedan dess har det tydligen gått långsamt med artens spridning längs kusten norrut. Den nordligaste finska lokalen, vid Haukipudas, ett par mil norr om Uleåborg, ligger något sydligare och ungefär lika långt från gränsälven som ovannämnda svenska lokal.

Elodea »förökar sig hos oss som bekant endast på vegetativ väg. Äfven ytterst obetydliga skottfragment äro reproduktionsdugliga» (Sernander 1901 pp. 166—167). Sådana bildas lätt, då arten är mycket bräcklig och blott svagt rotad. Effekten härav blev den nästan explosivt förlöpande, tidiga utbredningen över stora delar av Europa (Luther 1951 p. 165).

Mathiesen & Nielsen (1956 p. 15) uppmätte vid *Elodeas* yttre gräns i Randers Fjord en salthalt av inemot 1 $^0/_{00}$. Luther (op. cit. p. 168) fann vid Ekenäs en salinitet av normalt knappt 2,5 $^0/_{00}$ vid artens yttre gräns. Strandvattnet vid Norrbottenskusten når ju inte på långt när så höga saltvärden (Julin & Pekkari 1956 p. 356), och något salinitetshinder för vattenpestens spridning längs denna kust torde ej föreligga.

Först 1957 anträffades *Elodea* på en något nordligare punkt, nämligen vid Strömsund i Råneå. Albert och Svante Pekkari samt förf. fann där i riklig mängd fullt levande skottfragment i en driftvall vid havsstranden. Däremot kunde vi inte konstatera fastsittande *Elodea*. Det stora antalet och den påfallande vitaliteten tydde emellertid på att skottfragmenten härrörde från fyndplatsens omedelbara grannskap.

Under den svåra nordliga stormen den 6 augusti 1967 råkade jag befinna mig i min f.d. sommarstuga vid Salmisvikens norra strand (Nedertorneå sn, c. 7 km W om Torne älvs mynning). Stormen drev ut havsvattnet ur viken, så att ett rekordartat lågt vattenstånd uppstod. Jag tog tillfället i akt att inspektera den blottlagda havsbottnen och fann till min häpnad stora mattor av fastsittande, steril *Elodea.*

Det får anses tämligen säkerställt, att *Elodea* kommit in i Salmisviken först efter 1960. Under hela 1950-talet vistades jag där varje sommar och studerade ofta växtligheten i vattnet. Under samma tid kan viken sägas ha stått under en tämligen kontinuerlig observation också tack vare mina ämneskolleger och elever vid Haparanda läroverk samt många gästande botanister. Till den trettonde internationella limnologkongressen i Finland 1956 gjordes en noggrann inventering av Salmisvikens flora. Följande elodeider antecknades: *Butomus umbellatus* (steril), *Callitriche hermaphroditica, C. verna, Myriophyllum alterniflorum, Nitella flexilis, Potamogeton Friesii, P. gramineus, P. perfoliatus, P. pusillus, P. zosterifolius, Ranunculus peltatus* och *R. trichophyllus* var. *eradicatus,* men ingen vattenpest (JULIN & PEKKARI op. cit. 352).

Det förefaller, som om den tydliga avmattning i vitalitetshänseende, som *Elodea canadensis* undergått efter sitt första dramatiska uppträdande i Europa, tagit sig uttryck inte bara i minskad luxuriation och ett utglesnande av de äldre bestånden utan även i avtagande spridningsintensitet med en långsammare utbredning som följd.

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ERIK JULIN

Fortsatt invasion på Skåne-kusten av Atriplex sabulosa

Skåne har under det senaste decenniet kunnat glädja sig åt en invasion av nya arter västerifrån.

Det började med *Iris spuria,* som man nu kan finna litet varstans utmed hela kusten från Falsterbo till Barsebäck. Sedan kom *Juncus maritimus,* som sedan det första fyndet kraftigt utvidgat sina domäner i Skanörs-området.

Det ser nu ut som om även *Atriplex sabulosa* är i färd med att utvidga sitt område inom landskapet. WEIMARCK anger i Skånes flora 1963 som då känd fyndort Dalabadet i Trelleborg. I Botaniska Notiser av år 1966, volym 119, omtalas arten (sid. 114) från Skäldervikens strand i Ängelholm nära gränsen till Strövelstorps socken. Vid ett besök å denna strand i september 1966 kunde jag konstatera, att *Atriplex sabulosa* växte också betydligt längre söderut, nära Vegeåns mynning, i mycket livskraftiga kolonier.

Nu kan jag anmäla en ny fyndort. Vid besök för badning å stranden mellan Strandbaden och Höganäs den 12 augusti upptäcktes strax söder om den s.k. smärgelskivfabriken *Atriplex sabulosa* växande utefter en sträcka av cirka 50 m i stora, kraftiga bestånd. Då jag sedan över 30 år tillbaka regelbundet besöker denna badplats om sommaren och har vegetationen å densamma under kontinuerlig uppsikt, kan jag intyga, att arten inte funnits där tidigare. Så mycket roligare är det därför, att den redan kunnat få så gott rotfäste på denna lokal. Dess vidare öden kommer att följas uppmärksamt.

Beläggexemplar har tagits för vidare befordran till Botaniska Museet.

Vid sidan av *Atriplex*-bestånden fann jag ett vackert individ av *Beta maritima*.

HELGE RICKMAN

Leucorchis albida (L.) E. Mey. åter funnen i Skåne

Vid inventeringsarbete innevarande år (1967) i Linderöds socken i Skåne påträffades *Leucorchis albida*, vityxne, på en tidigare icke uppgiven fyndort. Växtplatsen är en betesmark (naturbete av hagmarkstyp), som till stor del är trädbevuxen. Det ganska unga trädbeståndet tyder på igenväxning på grund av minskad röjning och betesgång. Någon betning förekommer dock fortfarande. Vityxnet växte i utkanten av en glänta, där enstaka buskar förekom (*Juniperus communis, Corylus avellana, Rhamnus frangula* och *Quercus robur*). Träden, som omgav gläntan, var mest björkar (*Betula verrucosa*). Vegetationen i gläntan framgår för övrigt i sina huvuddrag av tabell 1. Fältskiktet dominerades fläckvis av ris (kolumn 6) men annars av gräs (kolumn 5). Det parti, där *Leucorchis* fanns (kolumn 1—4), utgjorde en övergångszon till kärrmark. Denna senare hade ett slutet trädskikt av al (*Alnus glutinosa*) och björk, och vidare noterades därifrån *Potentilla palustris, Viola palustris, Carex echinata, C. panicea, Juncus conglomeratus, J. effusus, Polytrichum commune* och *Sphagnum palustre*.

En jämförelse med de vegetationsanalyser av sydsvensk ljunghedsvegetation hos DAMMAN (1957), där han noterat *Leucorchis* (*Habenaria*) *albida* visar en ganska stor överensstämmelse mellan här skildrad vegetation och dels DAMMANS »Agrostis variant» (1957 sid. 380), dels hans »moist variant» (1957 sid. 384). Dessutom har DAMMAN noterat *Leucorchis* från två lokaler med en mera extrem ljunghedstyp, där ljungen är helt dominerande och övriga arter fåtaliga och sparsamma (1957 sid. 376).

De typer av vegetation, som beskrivits här i tabell 1 och hos DAMMAN (op. cit), är inom Skånes »skogsbygder» inte ovanliga och har helt säkert varit vanligare förr. Trots detta är »denna ört så rar, at jag aldrig sedt henne tilförene wildt wäxande» (LINNAEUS 1751 sid. 153). Under tiden för den på-

Tabell 1. Linderöd, 700 m SV Bösarp.

	1	2	3	4	5	6
Quercus robur juv.	1	1	1	1	–	–
Calluna vulgaris	–	2	–	–	1	2
Vaccinium myrtillus	2	1	–	1	1	4
— *vitis-idaea*	1	1	2	2	×	2
Achillea millefolium	–	–	–	–	×	–
Arnica montana	–	–	–	–	2	–
Campanula rotundifolia	–	–	–	–	×	–
Convallaria majalis	1	1	2	1	–	–
Galium saxatile	2	2	1	1	2	–
Hypericum maculatum	–	–	–	–	×	–
Lathyrus montanus	2	2	2	1	1	–
Leucorchis albida	r	r	r	r	–	–
Maianthemum bifolium	×	2	–	–	–	–
Potentilla erecta	1	1	1	1	2	1
Succisa pratensis	1	1	2	2	2	–
Trientalis europaea	1	2	1	1	–	1
Trifolium medium	–	–	–	–	1	–
Agrostis tenuis	4	3	3	4	3	–
Anthoxanthum odoratum	–	1	1	1	2	–
Carex panicea	1	–	–	1	–	–
— *pilulifera*	–	×	1	1	–	–
Deschampsia flexuosa	2	3	2	2	2	2
Festuca ovina	–	1	–	1	3	–
Luzula campestris	–	–	–	×	1	–
Molinia caerulea	2	3	2	2	–	–
Nardus stricta	1	1	1	–	2	–
Sieglingia decumbens	1	–	1	1	2	–
Climacium dendroides	–	–	–	×	–	–
Dicranum polysetum	1	–	–	–	–	–
Hylocomium splendens	2	1	–	–	1	2
Mnium affine	1	–	–	–	–	–
Pleurozium schreberi	2	3	2	1	1	3
Polytrichum commune	2	–	1	1	1	–
Rhytidiadelphus squarrosus	×	–	1	2	2	–

Utanför dessa rutor noterades inom denna vegetation: *Anemone nemorosa, Hieracium pilosella, Solidago virgaurea, Briza media, Juncus squarrosus.* — Varje kolumn representerar en ruta om 4 m². Siffrorna anger skattning enl. BRAUN-BLANQUETS skala (Gesamtschätzung). Analysen utförd 1 sept. 1967.

gående Skåneinventeringen (se WEIMARCK 1963 sid. V—VII) har *Leucorchis* tidigare endast påträffats på ett fåtal lokaler i socknarna Hjärnarp, Linderöd, S. Rörum (DAMMAN op. cit.) och Matteröd (insaml. av G. NILSSON 1949).

I ARESCHOUGS flora från 1881 (sid. 409) uppräknas ett flertal fyndorter och arten förefaller inte att ha varit någon raritet då. Längre tillbaka i tiden måste man räkna med att undersökningen av och kännedomen om Skånes flora var så fragmentarisk, att någon rättvisande bild av olika arters förekomst i landskapet är omöjlig att framställa.

Den första uppgiften om *Leucorchis* i Skåne finns hos LECHE (1744; jfr WEIMARCK 1958 sid. 88), men av allt att döma är det mycket få ställen på vilka arten återfunnits upprepade gånger. Intressant i detta sammanhang är uppgiften hos ROSÉN (1749; jfr WEIMARCK 1958 sid. 90) om denna art: »nära Lund . . . mot Räften», vilket kan tolkas som Kungsmarken i S. Sandby, där den insamlats åtskilliga gånger, senast 1933 (jfr B. ULF 1952).

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Jan Ericson

Meddelanden

Professors namn

Professors namn har tilldelats förste trädgårdsintendenten, docent NILS HYLANDER, Uppsala.

Utmärkelse

Hans Wallengrens minnesmedalj i guld har utdelats till Lektor HERVID VALLIN, Hälsingborg, för hans stora insatser i samband med naturskyddet av Hallands Väderö.

Disputationer

I Lund

16.5. 1967, SVEN SNOGERUP: »Taxonomy, variation and evolution in *Erysimum* sect. *Cheiranthus*.»

17.5. 1967, LARS OLOF BJÖRN: »The effect of light on the development of root plastids.»

18.5. 1967, SVEN BJÖRK: »Ecologic investigations of *Phragmites communis*. Studies in theoretic and applied limnology.»

20.5. 1967, CHARLES A. PANTON: »The breeding of lucerne, *Medicago sativa* L., for resistence to *Verticillium albo-atratum* RKE. et BETH.»

23.9. 1967, GERTRUD NORDBORG: »Studies in genus *Sanguisorba* sect. *Poterium*.»

I Uppsala

16.5. 1967, TOM FLENSBURG: »Desmids and other benthic algae of Lake Kävsjön and Store Mosse, SW Sweden.»

17.5. 1967, OVE ERIKSSON: »Studies on graminicolous *Pyrenomycetes* from Fennoscandia.»

Forskningsbidrag

Statens Naturvetenskapliga Forskningsråd har för botanisk forskning beviljat skiftande belopp för bl.a. följande ändamål: Forskning inom vedsvamparnas taxonomi i Canada (J. ERIKSSON); Skogsvetenskaplig forskning inom Örkeneds socken (GUNHILD WEIMARCK); Undersökingar av vikarismförhållanden inom vissa växtgrupper i kapfloraområdet (R. DAHLGREN); Elektronmikroskopiska studier av botaniskt material (F. FAGERLIND); Undersökningar rörande epifytvegetationen på kvistar av lövträd (G. DEGELIUS); Undersökningar över differentiering i geografiskt isolerade växtpopulationer i Egeis och för insamling av botaniskt material i Grekland 1967 (H. RUNEMARK); Fältundersökning av algvegetationen i Ö. Medelhavet (T. LEVRING); Utarbetandet av fröflora över Nordens fanerogamer (GRETA BERGGREN); Cytotaxonomiska och anatomiska undersökningar (O. HEDBERG); Cytologisk bearbetning av botaniskt material från Grekland (H. RUNEMARK); Studier över algerna och deras miljö med särskild hänsyn till bottenvegetationen (M. WAERN och H. SJÖRS); Genetiska och cytologiska studier inom växtgruppen *Bryophyta* (S. O. STRANDHEDE); Undersökning av sedimentations- och nedbrytningsprocesser i vattendränkta myrmarker (H. SJÖRS); Studier av kromosompolymorfism hos *Elymus*-arter (W. K. HENEEN); Fältstudier i S. Ethiopien och Kenya 1967 (O. HEDBERG).

Botanisk litteratur
(Botanical Literature)

ASPT-IOPB Index of Current Taxonomic Research. Compiled by R. C. Jackson. — Regnum Vegetabile 43. Utrecht 1966. 72 pp. Price (for members of the International Association for Plant Taxonomy) Sw. Cr. 10.60 (postgiro 43 35 39, Göteborg).

The preface of this index states that it "is the third issue of the Index of Current Taxonomic Research, the purpose of which is to prevent duplication of research time and effort and to act as a reference source for all botanists who might seek specialists in a particular plant group. The first Index was published in 1960 as a project sponsored by The American Society of Plant Taxonomists (ASPT); it included only American and Canadian projects. The second Index was published in 1964, and it included a number of research projects reported by members of the International Organisation of Plant Biosystematicists (IOPB) in addition to those by members of ASPT".

The present third issue claims to "develop the compilation into a periodical review of research projects in plant taxonomy" and to "give a reasonable knowledge of research in the field in all parts of the world". Such an index of current and planned projects in systematic botany should have been welcomed not only by the young student but also by the experienced botanist. Both categories will be severely disappointed when studying Mr. Jackson's report.

……

If he is right 98 per cent of all research in botanical taxonomy is performed in the U.S.A. The European countries seem to be definitely undeveloped in this field. Sweden is said to have three active plant taxonomists: two nongraduate students at Lund (both working on grasses; one of them has now emigrated to Turkey) and one post-graduate student at Uppsala (working on *Koenigia*). In fact, Lund has at least 25 current research projects in taxonomic botany, several of which have resulted in important monographs, e.g. in *Aspalathus* (*Leguminosae*). Uppsala is a well-known centre of research in mycology and lichenology, but no Swedish botanist in these fields is mentioned. Stockholm and Gothenburg have a considerable number of active plant taxonomists, some of whom with a world-wide reputation. None has been listed in this Index.

The scarce information concerning non-American botanists is to some extent compensated by the fact that Mr. Jackson has happened to create a number of taxa hitherto unknown in plant taxonomy. The lichenologists meet with the new families *Bacidiaceae* (type genus *Haematomma*; a genus usually recorded in the *Lecanoraceae*) and *Thelidiaceae* (type genus *Staurothele*). After some lines the latter genus has returned to its old place in the *Verrucariaceae*. *Lecanoraceae* (genus *Ochrolechia*) is listed as well under the lichens as under the higher plants. The angiosperm genus is spelt "*Ochrolichia*", but it is said to be revised by the same monographer!

A 2nd revised edition of "International directory of specialists in plant taxonomy with a census of their current interests" (Regnum vegetabile 13, Utrecht 1958) would have been a welcome aid to all botanists working in taxonomy and related fields. It is incredible that the International Bureau for Plant Taxonomy has sponsored such a monstrosity as the present volume.

OVE ALMBORN

Index to European Taxonomic Literature for 1965 compiled by R. K. BRUMMITT. — Regnum vegetabile 45. Utrecht 1966. 166 pp. Price (for members of I.A.T.P.) Sw. Cr. 15.80 (postgiro 43 35 39, Göteborg).

The issue of "Flora Europaea" (Vol. 1, 1964, Vol. 2 in press) is a great event in botanical taxonomy. It will certainly also promote research in related fields of botany. A noteworthy by-product from the workshop of the Flora is the present index. It is said to be "the first of a proposed series of volumes to be published annually which it is hoped will provide a convenient index to current literature relevant to the study of the systematics of vascular plants of Europe and adjacent regions. The aim is to list firstly references to papers and books and secondly all new names proposed."

The first sections cover topics not dealing with particular groups of plants, i.e., papers of general interest: biography, bibliography, floras, phytogeography etc. The rest of the index is arranged in taxonomic groups beginning with Pteridophytes and Gymnosperms. The angiosperm families are arranged alphabetically. All genera are met with in an alphabetical sequence. New names and combinations are listed under the relevant genus or family, sometimes with the remark "non rite publ.".

The need for such a compilation of current taxonomic literature is obvious. The wellknown "Index Kewensis" which, however, lists new species only has hitherto been one of the chief literary sources of the taxonomic botanist. The A.E.T.F.A.T. Index which since 1953 has covered literature on African vascular plants has in several respects served as a model to the present volume.

It is a pleasure to state that Dr. BRUMMITT has completed a careful and skilful work using the rich treasures of literature found at Kew Gardens and at the British Museum (Nat. History). A check with the wellknown indexes listing botanical literature in Sweden and Denmark, (ARNE HOLMQVIST, "Swedish Botanical Bibliography 1965, Bot. Not. 119: 498, 1966 and ALFRED HANSEN, Dansk botanisk litteratur i 1963, 1964 og 1965, Bot. Tidsskr. 62: 265, 1967) has revealed very few omissions.

An Appendix lists some 400 periodicals, from where references have been compiled. A minor remark: The Swedish journals "Svensk Botanisk Tidskrift" and "Opera Botanica" are quoted as published at Stockholm. The former is printed at Uppsala, the latter is edited and printed at Lund.

Ove Almborn

International Code of Botanical Nomenclature. Adopted by the Tenth International Botanical Congress, Edinburgh, August 1964. — Regnum Vegetabile 46. Utrecht 1966. 402 pp. Price (for members of I.A.P.T.) Sw. Cr. 31.60 (postgiro 43 35 39, Göteborg).

One hundred years have elapsed since Alphonse De Candolle issued the first rules of international nomenclature ("Lois de la nomenclature botanique adoptées par le congrès international de botanique tenu à Paris en août 1867", Paris 1867). The Vienna Congress in 1905 was the starting point of the modern trend towards stabilization of the botanical nomenclature. The 20th century has seen several new versions of the Code of Botanical Nomenclature embodying the alterations made at the International Botanical Congresses. The present generation of taxonomists have been well familiar with the "Stockholm Code" (1952) the "Paris Code" (1956), and the "Montreal Code" (1961). All recent editions have been issued by the International Bureau for Plant Taxonomy and Nomenclature. The major part of the editorial work has been performed by Professor J. Lanjouw and Professor F. A. Stafleu at the University of Utrecht.

The present "Edinburgh Code" is based on the decisions reached by the Nomenclature Section of the 10th International Congress in 1964. The same chief editors have completed a work which, to 95 per cent, is a true copy of the 1961 version. The numbers of the 75 articles and the letters of the recommendations under each article are the same. One has to study the code much in detail to find any major deviations compared to the Montreal Code. Art. 29 (Names of plants in cultivation), Art. 40 (Names of hybrids) and Art. 59 (Names of fungi with a pleomorphic life cycle and of fossils assigned to form genera) have been considerably remodelled. The "names of hybrids and some special categories" have also been treated in Appendix I (somewhat changed). Appendices II ("Nomina familiarum conservanda") and III ("Nomina generica conservanda et rejicienda") contain only a minor number of alterations.

This apparent stability in the field of botanical nomenclature is explained by the fact that the decisions of the Edinburgh Congress involved very few changes of the botanical nomenclature. Most of the many proposals concerning modifications of the Code were rejected, referred to the Editorial Committee or postponed to next Congress. In some major questions eagerly discussed in Edinburgh, e.g. "Stabilization of names of plants of economic importance" (i.e. adoption of a certain number of nomica specifica conservanda), "Superfluous names" (Art. 63), and "Ambiguous Names" ("long-persistent sources of error", sec. Art. 69), the Section of Nomenclature demonstrated "a fundamental disagreement". Cf. the Synopsis of Proposals (Regnum Vegetabile vol. 30), the Report of the 10th International Botanical Congress, Edinburgh 1964, Nomenclature section (Regnum vegetabile vol. 44) and the elucidative brief survey by Dr. STAFLEU in Taxon 13: 8 (1964): "Nomenclature at Edinburgh".

It is needless to state that the Code is indispensible to all serious workers in botanical taxonomy, even to those who regard nomenclature as a necessary evil. The reviewer would question, however, if the present shape of the Code is the most appropriate one. Is it necessary to retain complete versions in English, French and German in the same volume? The knowledge of English is no doubt so widespread among plant taxonomists that the first of these versions would seem to be sufficient. Part of the 135 pages containing the two other versions might have been used to give a more comprehensive supply of examples illustrating the consequences of the Rules. A condensed style and somewhat scarce references to nomenclatural pratice make the Code a fairly difficult book to many beginners in plant taxonomy. University teachers who give courses on botanic nomenclature would appreciate a semipopular textbook discussing the articles and recommendations of the Code. An effort was made by H. ST. JOHN, "Nomenclature of Plants", New York 1958, (reviewed in Bot. Not. 113: 465. 1950), which, in the reviewer's opinion, should have included more detailed comments to the Rules and solutions of (at least most of) the many nomenclatural "cases" quoted.

The concluding chapters "Guide for the determination of types" and "Guide to the citation of botanical literature" give useful advice but could have included a more comprehensive set of examples. There are some discrepances between the Code and the "Flora Europaea" concerning recommendations for the abbreviation of titles of books and periodicals, e.g. "Am. Journ. Bot." and "Michx. Fl. Bor.-Am." sec. the Code vs. "Amer. Jour. Bot." and "Michx, Fl. Bor. Amer.", sec. Flora Europaea. Such remarks can certainly be considered as trifles, but there is no doubt that many botanical authors would have welcomed a closer coordination of the recommendations given in these two standard works.

OVE ALMBORN

HASSELROT, K.: Västergötlands Flora (Förteckning över kärlväxter). — Lund 1967 (Distributör: Statens Naturvetenskapliga Forskningsråd, Stockholm Va), 175 sidor, 1 karta. Pris 26 kr.

H. har under 18 år samlat lokaluppgifter för kärlväxter från Västergötland. Uppgifterna är grundade på dels litteraturcitat, dels opublicerade muntliga el. skriftliga meddelanden från en rad medhjälpare och dels herbarieuppgifter från bl.a. de större svenska botaniska museerna. Vidare har H. själv bidragit med växtlokaler från främst Skaraborgs län. Denna verksamhet har resulterat i en lokallista för områdets kärlväxter, »Västergötlands Flora». Avsikten synes ha varit att revidera och komplettera A. RUDBERGS Förteckning över Västergötlands fanerogamer och kärlkryptogamer (1902).

Med en populärt hållen växtgeografisk översikt avskriven från N. ALBERTSONS, Västergötlands växtvärld (Natur i Västergötland 1951), med smärre strykningar och egna tillägg, inleder H. sin flora. Rubriksättningen i detta kap. ger ofta ofullständig ledning till de olika avdelningarnas innehåll. Under »Alvar och kontinental torrängsvegetation» behandlas förutom de i nämnda naturtyperna även lundar, fuktängar och kalkkärr i ett av H. gjort tillägg, däremot är torrängsvegetationen på de intressanta *Stipa*-kullarna synnerligen styvmoderligt behandlad, sannolikt beroende på att ALBERTSON här hänvisade till en uppsats av FRIDÉN i samma verk. Ur detta kap. kan man inhämta flera ganska överraskande upplysningar: om *Betula nana* skrivs bl.a. (s. 16) »vilken i Sverige har sina huvudförekomster på småländska höglandet»; (s. 16) »den för södra Sverige unika fjällarven»; (s. 18) »I fuktängar och kalkkärr prunkar . . . kärr- och skogsknipprot (*Epipactis palustris* resp. *helleborine*).

I förordet framför H. sitt amatörskap som förklaring och ursäkt »till de brister, som givetvis vidlåder detta arbete». Vid en genomläsning av boken blir man ideligen påmint om detta och irriteras av de talrika sakliga och formella svagheterna. En noggrann redaktör hade med säkerhet kunnat råda bot för flertalet av bristerna. En bok med denna titel skulle kunnat fylla ett ackumulerat behov av nya floristiska uppgifter från ett växtgeografiskt intressant landskap. Boken innehåller flera arter och nyare lokaluppgifter än RUDBERGS förteckning.

Källförteckningen (s. 20) är oöverskådlig på grund av att författarnamnen ej givits en annan stilsort än den övriga texten. Tryckorter och sidhänvisningar är utelämnade och titlarna ofta förkortade. Listan är ofullständig. Ej blott genom att den utelämnat en rad (främst äldre) arbeten utan även flera sådana som senare citeras i artförteckningen t.ex. SYLVÉN 1963 s. 65. Vid några av titlarna har varken tidskrift el. årtal (el. blott endera) utsatts, vilket gör dem mycket svårspårade. Ett kronologiskt ordnande av arbetena under författarna har troligen varit avsikten, jfr under SKÅRMAN och WESTFELDT. Efter ett flertal titlar påpekas att arbetena är akademiska avhandlingar (»Ak. avhandling, Akad. avh., Gradualavh.»). Upplysningar om den tidskrift de ev. ingår i saknas. Påpekandet utelämnas dock helt t.ex. efter HÅRD AV SEGERSTADS och OSVALDS avhandlingar. Förkortningarna på tidskrifter och böcker varierar, således förkortas Svensk Botanisk Tidskrift SBT (oftast) men även BT. I listan har införts flera ovidkommande upplysningar. Helt oförstående ställer jag mig inför sättet att redovisa N. HYLANDERS arbeten, »Nordisk kärlväxtflora 1953. Gradualavh. 1943. Nordisk kärlväxtflora I, II (1953, 1966)» och G. SAMUELSONS arbeten, »Ett flertal floristiska uppsatser». I källförteckningen förekommer även uppgifter som rätteligen borde införts i nästkommande förteckning, jfr FRIES H. När de i källförteckningen upptagna arbetena citeras i artförteckningen anges efter de enskilda lokalerna oftast endast t.ex. Alb, Skå el. Wt, utan årtal, för att finna citatet får man leta genom 11, 15, resp. 15 arbeten.

Finns det någon rimlig anledning till dubbelhänvisningarna i den följande förteckningen över »meddelare och samlare»? I listan återkommer flera meddelare under samma förkortningar som i källförteckningen. Anmärkningsvärt är att L. FRIDÉN ej upptas i denna lista, då han med sin mångåriga och rika floristiska kunskap om landskapet sannolikt kunde haft många uppgifter att lämna.

Under rubriken »Förklaringar till artförteckningen» möter uppgiften att nomenklatur och artbegränsning följer HYLANDERS, Förteckning över Nordens växter I (1955) (ej i källförteckningen), jämsides med påståendet att »Förteckningen avser att vara så aktuell som möjligt». I förkortningslistan upptas under rubriken »Frekvensbeteckningar» även de egenhändiga förkortningarna av namnen på de herbarier H. hämtat uppgifter från (bl.a. MH=Mariestads läroverks herbarium, jfr MaH. s. 24). Inte mindre än sju olika frekvensbeteckningar har använts. Under »övriga förkortningar» upptas förkortningar av namnen på tidskrifter t.ex. F&Fl=Flora och Fauna, och SBT=Sv. Bot. Tidskr. Förklaring ges ej till det kryptiska o.h.o.d. (s. 149, under *Melampyrum arvense,* sannolikt uttytt, och här och där).

Artförteckningen (ss. 33—169) är uppställd med familjerna som avdelande rubriker. De »inhemska» arterna är satta med halvfet stil, medan hybrider, utgångna, osäkra och tillfälliga arter står med kursiv stil (förklaring till olikheterna meddelas ej), liksom socknar och kommuner. När det gäller de tillfälliga arterna har H. ej varit konsekvent; sålunda står t.ex. *Lilium bulbiferum* och *martagon* (s. 47) med fet stil medan *Tulipa silvestris, Fritillaria meleagris* och *Ornithogalum umbellatum* är kursiverade. Vidare är det svårt att förstå motiveringen till att *Koeleria pyramidata* (s. 53), *Rumex mexicanus* (s. 79), *Polygonum bistorta* (s. 80), *P. patulum* (s. 81), *Cerastium brachypetalum* (s. 85) m.fl. står med fet stil, flera rena adventiver. Varieteter och underarter är stundom kursiverade, stundom halvfeta, ibland satta med ordinär stil. I samband med dessa skall nämnas att H. ofta utelämnar auktorsbeteckningen på arten, när ett infraspecifikt taxon anföres efteråt (bl.a. på ss. 56, 79, 83, 85, 105, 108). Auktorer är konsekvent utelämnade på alla synonymer, på taxa som inkluderats i ett annat taxon, liksom på alla *Taraxaca*. Besynnerlig är auktorsbeteckningen på t.ex. *Potentilla anserina* (s. 105) och *Erophila brevipila* v. *procumbens* (s. 150), liksom bruket att ibland anföra frekvensbeteckningen före synonymerna (s. 163). Vad beträffar arterna förefaller förteckningen tämligen fullständig. Vid några företagna stickprov har det emellertid visat sig att flera saknas, bl.a. många tidigare odlade och ofta förvildade arter t.ex. *Galanthus nivalis, Muscari botryoides, Lilium flavum* (någon motivering till varför de skulle ha utelämnats saknas), jämte den mera tillfälliga *Leonurus marrubiastrum* (belägg i LM). *Rumex sanguineus* är utelämnad trots förekomster i Götaälvsområdet, liksom *Rosa sherardii* med sedan gammalt kända lokaler i Skövdetrakten. *Gagea spathacea* anges som ej förekommande i området trots att som närmaste förekomst uppges Nödinge, en socken, som enl. förteckningen över kommuner och socknar ingår i området. Vad beträffar nomenklaturen har i stort Hylanders Förteckning följts (bl.a. med alla de felaktiga *eu*-formerna på underarterna). Vad däremot beträffar inordnandet av arterna under släktena saknas ofta denna följsamhet; under t.ex. *Polygonum* och *Campanula* är arterna till synes helt godtyckligt instoppade. Nyare rön angående artavgränsningar har sällan beaktats, således är t.ex. *Cardamine palustris* inkluderad i *C. pratensis, Ranunculus aquatilis* helt utelämnad, liksom *Callitriche platycarpa* (jfr Weimarck, Skånes Flora 1963). Uppgifter om artfynd el. herbarieuppgifter har ofta tydligen godtagits utan att bestämningarna har kontrollerats, nämnas skall endast *Epipactis atrorubens,* som uppgivits av Sylvén från Kinnekulle, enl. ex. i "LM" är det *E. helleborine*. I kritiska släkten kan exemplen mångfaldigas (allt enl. stickprov i LD). Påpekas skall i detta sammanhang att inga uppgifter från LD finns med i förteckningen fr.o.m. *Umbelliferae*. Vidare har enl. uppgift i detta herbarium endast etiketterna avskrivits och avskriften skickats till H. Vid kontroll visade sig att uppgifter från LD skulle ha tillfört t.ex. *Leonurus cardiaca* ytterligare tre lokaler från Västergötland. Vid citering av herbariematerial anger H. oftast endast lokalen följd av museets förkortning. Inkonsekvenserna, när det gäller frekvensbeteckningarna, är talrika. Antalet angivna lokaler för en art, som betecknats som sällsynt, kan vara flera än för en art som betecknats mindre allmän. Stundom anges för en art (t.ex. *Tilia cordata* s. 121), att den är »s. på slättbygderna i Ska», men en lokalförteckning för arten från just detta område saknas. I ett arbete av denna art skulle man med tanke på de snabba förändringar som skett med floran de senaste åren välkomnat uppgifter om florans nuvarande utseende i provinsen. För flera sällsynta arter anföres enbart en el. få lokaler ev. följda av ett årtal, mera sällan (men det förekommer) en uppgift om arten fortfarande finns kvar. Ofta har H. själv ställt samma fråga, »nu?» (s. 150). I något fall saknas lokaluppgift el. insamlare helt, jfr *Salsola ruthenica* s. 83. Feltrycken är många. En svårighet att hitta vissa arter i listan har uppkommit genom att avstånden mellan arterna växlar, t.ex. *Equisetum fluviatile* s. 34, *Luzula campestris* s. 49. Lätt misstolkade el. otympliga formuleringar förekommer på flera ställen, jfr *Hedera* s. 129 »Blommar annars på få lok.», *Digitalis purpurea* s. 149 »sällan långlivad», *Artemisia campestris* s. 161 »saknas el. okänd i vissa tr.», *Gentianella campestris* s. 137 »ensam sedd i Dala», *Cichorium intybus* »ts. o. fv., mest i vallar. Ej bofast i Vg.» Slarvig verkar framställningen bl.a. i samband med *Rosa*-hybriderna s. 107, där *R. mollis* ersätter *R. villosa* på ett par ställen, trots att H. angett den förra som en synonym till den senare.

På s. 170 följer en förteckning över vissa adventivväxter. Det är svårbegripligt varför de arter, som här uppräknas, inte kunde medtagits i sitt systematiska sammanhang i artförteckningen, då den senare redan innehåller ett flertal arter med samma tillfälliga prägel som de här uppräknade. Med denna förteckning tycker jag att H. passerar gränsen för vad det ev. handikap, som är amatörens, kan ursäkta. På de två sidorna förteckningen omfattar saknar 12 arter auktorer; punkter har utelämnats på flera av auktorsförkortningarna; 2 arter har helt felaktiga auktorer (t.ex. *Erodium cygnorum* L., skall vara Nees); minst 7 latinska namn är felstavade (*Bupleurum lacinifolium* istället för *lancifolium*, *Centaurea calotropa* istället för *calcitrapa*, *Eupforbia* och *Hordium*); ibland är inte ortnamnen kursiva däremot artnamnen; den alfabetiska ordningen mellan släkten och arter är flerstädes omkastad.

Förteckningen över i Västergötland fridlysta växter är ofullständig (jfr t.ex. HYLANDERS Förteckning).

Som avslutning skall nämnas att registret upptar sju släkten som för övrigt ej nämns i boken — man hänvisas till ett tankestreck. Det senare gäller även *Andromeda*, trots att detta släkte medtagits. Under *Anthriscus* hänvisas man till s. 170, men arterna står på s. 130. Då arter ur ett släkte förekommer såväl i artförteckningen som i den följande förteckningen över vissa adventivväxter finns inga dubbelhänvisningar (jfr t.ex. *Erodium*).

ÖRJAN NILSSON

PIERRE BOURRELLY: Les Algues d'eau douce. Initiation à la Systématique. Tome I: Les Algues Vertes. — Éditions N. Boubée & C^ie^, Paris 1966. 511 pp. 117 planches. Prix 100 F.

Il ne fait aucun doute que le volume vert, récemment publié par le Dr Bourrelly, éminent phycologue français, est un grand évènement pour tous ceux qui étudient les algues d'eau douce. Le présent volume est le premier d'une série de trois. Les deux autres traiteront des *Chrysophyta, Euglenophyta, Pyrrophyta, Rhodophyta* et *Cyanophyta.*

On évalue à plus de 13,500 espèces, le nombre d'algues d'eau douce répandues dans le monde. Mais ce chiffre est probablement une sous-estimation. Une grande partie d'entre elles sont cosmopolites. Elles forment à peu près, 1,100 genres, mais il est difficile de l'évaluer. Le présent volume est consacré aux algues vertes; un des grands groupes, qui comprend à lui seul à peu près 520 genres, et au moins 8,000 espèces. Plus de la moitié d'entre elles appartiennent aux *Zygnematales.* Mais le nombre de taxa des algues vertes augmente certainement chaque année. Naturellement, il y a plusieurs genres monotypiques, et d'autres qui ne comptent que quelques espèces. Mais d'un autre côté, on trouve chez les algues vertes des genres très considérables tel que *Cosmarium* (2,000 espèces) et *Straurastrum* (1,200 espèces). Heureusement qu'ils sont les exceptions, car les genres comprenant des centaines d'espèces ne sont pas très nombreux.

Il est évident qu'il est difficile de donner une vue d'ensemble acceptable couvrant un sujet aussi vaste; mais le Dr BOURRELLY a réussi cette entreprise et ce, d'une excellente façon. Il a su traiter le sujet en profondeur. La disposition aussi est très claire. On n'y trouve pas de ces descriptions, tirées de volumes anciens et répétés d'ouvrages en ouvrages. La présentation des algues vertes par le Dr BOURRELLY est véritablement à la page.

En débutant avec les *Volvocales* et en terminant avec les *Charales,* il donne un tableau compréhensible et descriptif des genres. On y trouve des clefs d'identifications pour les ordres, les sous-ordres, les familles et les genres. L'auteur étant lui-même un dessinateur habile, et conscient de l'importance des figures dans un travail phycologique, a particulièrement insisté sur les illustrations. Elles sont très nombreuses; plus de mille réparties sur 117 planches. Toutes sont d'une grande qualité, et plusieurs d'entre elles ont été dessinées par l'auteur lui-même. Pour chaque figure, des notes explicatives ont été incluses, indiquant la page où l'espèce illustrée a été décrite. Cette excellente idée facilite le travail de consultation. A la fin du volume, on trouvera un index et une table des matières, faciles à repérer puisqu'ils ont été imprimés sur papier vert.

De plus, cette partie verte comprend aussi une clef d'identification des genres. Ceci sera très utile, j'en suis sûr, non seulement pour les travaux phycologiques, mais aussi pour les écologistes d'eau douce, qui souvent, sont heureux de les utiliser puisqu'ils ont affaire à des groupes terriblement grands, et écologiquement hétérogènes. Nous espérons que les clefs d'identifications plus haut mentionnées, contribueront à une connaissance plus approfondie pour les écologistes d'eau douce, au moins jusqu'au niveau du genre. Naturellement, comme le mentionne FINDENEGG (1965), nous ne pourrons jamais comprendre totalement ce qu'est la production primaire d'un lac, sans savoir quelles espèces s'y trouvent, où et quand elles apparaissent, et comment elles interfèrent avec les communautés planctoniques présentes. Ceci en fait s'applique à tous les milieux aquatiques ainsi qu'à toutes les communautés d'algues.

En résumé, on peut dire que le livre du Dr BOURRELLY est un manuel important et utile pour tous ceux qui s'intéressent et travaillent sur les algues d'eau douce. Nous lui sommes grandement reconnaissants pour son excellent travail.

KUNO THOMASSON

HUTCHINSON, J.: The Genera of Flowering Plants. Based Principally on the Genera Plantarum of G. BENTHAM & J. D. HOOKER. Dicotyledones. Vol. II. — Clarendon Press, Oxford University Press. 1967. XI+659 pp. Price £9.10 s.

The first part of HUTCHINSON's "Genera" was printed in 1964, and it is a great pleasure to see the second volume completed. However, as the series is planned to comprise 10 volumes, it is hoped that the rate of publication will be accelerated. On the other hand, the undertaking of writing a volume of the scope and ambitions as the present one every three years, even with a staff of collaborators, would be inconceivable for anyone but HUTCHINSON. A great help has been the access to the facilities in the form of indices, a comprehensive library and an outstanding herbarium offered at Kew.

With Vol. II HUTCHINSON continues his treatise of the orders in the division of "Lignosae". Whereas in Vol. I (516 pp.) we found only 7 orders (incl. the large *Rosales* and *Leguminales*) we find in the present volume (659 pp.) as many as 27, some with only one family, some with numerous. The orders come in the same sequence and have the same circumscription as in HUTCHINSON's "Families of Flowering Plants" (2nd ed. 1959). The concise English descriptions, largely translated from the Latin ones of BENTHAM & HOOKER's "Genera Plantarum", are brought up to date and improved, and the valuable notes about important literature, distribution, number of species, synonyms, and type species for the genera, deserve great appreciation (see the review of Vol. I in Bot. Notiser 1965 p. 268). Under each family we find a description, a key to the genera, and the most important literature on the taxonomy of the group. Economic properties are given under the families but not under the genera. This contributes to a good survey, as the bulk of text for each genus is not too different.

Short discussions on phylogeny and controversial points in the classification are given under "Phylogeny and morphology" in some families. These remarks could perhaps have been enlarged for the benefit of the non-specialist, especially as HUTCHINSON's system is a very particular one which leaves other alternatives open.

The orders treated in Vol. II are the following:

8. *Cunoniales*
9. *Styracales*
10. *Araliales*
11. *Hamamelidales*
12. *Salicales*
13. *Leitneriales*
14. *Myricales*
15. *Balanopsidales*
16. *Fagales*

17. *Juglandales*
18. *Casuarinales*
19. *Urticales*
20. *Bixales*
21. *Thymelaeales*
22. *Proteales*
23. *Pittosporales*
24. *Capparidales*
25. *Tamaricales*
26. *Violales*
27. *Polygalales*
28. *Loasales*
29. *Passiflorales*
30. *Cucurbitales*
31. *Cactales*
32. *Tiliales*
33. *Malvales*
34. *Malpighiales*

In *Cunoniales, Hydrangeaceae, Grossulariaceae,* and *Oliniaceae* are treated among other families. The former two are distinguished as separate from *Saxifragaceae,* which is treated by Hutchinson in an entirely different sequence of families in the "Herbaceae". *Oliniaceae* is in other works often treated with *Onagraceae, Combretaceae* and other families in or close to *Myrtales* (where also *Penaeaceae* and *Geissolomataceae,* treated by Hutchinson in *Thymelaeales,* would seem to be most properly placed).

Salicales is treated with *Myricales, Fagales,* and other small orders after *Hamamelidales* and is regarded by Hutchinson as more or less closely allied to the families of this order, and not to, e.g., *Tamaricaceae* as often suggested in other works. In the treatment of *Fagales* Hutchinson has been assisted by Forman, a Kew specialist in that group. — *Byblis* and *Roridula,* two vegetatively and florally similar insectivorous genera, are treated by Hutchinson in *Pittosporales* and in the same family, *Byblidaceae.* In other modern literature they usually represent separate families. The treatment of *Cactales,* a large and very special order, which Hutchinson places next to *Cucurbitales,* has been written by Hunt, who refrains from taking up a standpoint on the much-debated relationships of the group.

Some details in the vast mass of facts presented in the volumes are, of course, not correct. For example, in stating that *Brachysiphon* (*Penaeaceae*) has 11 species Hutchinson is influenced by Phillips, who (in his 2nd edition of Genera of South African Flowering Plants, 1951) included *Stylapterus* in this genus. But Hutchinson includes *Stylapterus* in *Penaea* thereby giving this genus 12 species (the *Stylapterus* species being thus included twice in the species number of the family). *Lonchostoma pentandrum* (*Bruniaceae*) also occurs in the Clanwilliam Division (Cape Province) (cf. Pillans' revision of 1947).

With regard to the terminology Hutchinson rigidly applies the term "calyx" to the single perianth whorl in many families, thus fixing the interpretation unnecessarily (which is perhaps done deliberately). Concerning the anthers, Hutchinson seems to put a locule on a par with a theca, which makes the meaning somewhat ambiguous. Thus, in fact, his "2-loculate" anthers of, e.g., *Melastomataceae* and *Penaeaceae* have 2 thecae, *each* with 2 microsporangia (=locules).

Many interesting details are revealed in the volume. One is surprised suddenly to see the South African genus *Serruria* (*Proteaceae*) named *Serraria,* which is not a misprint but represents an earlier subhomonym of Adanson and is accordingly the correct name.

At the end of this volume there are one and a half pages with "Additions and Corrections to Vol. I", where some of the nomenclatural (and partly scientific) achievements have been added.

As a final appreciation: the work is welcomed as a very carefully written and extremely important encyclopedia. It is of utmost importance in further research and should be available in all institutes and herbaria. In its details it should not be critized as or confused with new achievements of basic research, but as a valuable presentation of relevant present knowledge in a condensed form. In its interpretation of relationship and phylogeny it should be looked upon as *one,* in some respects rather extreme, choice of a system.

It is evident that in the arrangement of the genera, families, and orders HUTCHINSON has intentionally adhered to that in his "Families of Flowering Plants". Otherwise he would certainly have altered the arrangement and circumscription of several orders and families, as new important data are continuously being revealed by current research in such a dynamic science as systematic botany.

ROLF DAHLGREN

HUTCHINSON, J.: Key to the Families of Flowering Plants of the World. Revised and Enlarged for the Use as a Supplement to The Genera of Flowering Plants. — Clarendon Press, Oxford University Press. 1967. 117 pp. Price bound 30 s.

The key is principally the same as that in HUTCHINSON's work The Families of Flowering Plants, but it is reedited and adapted as a separate tool for determination. For a non-professional botanist such a key has a limited interest because of the special terminology and because of the high rank of the category to which it leads. In order to lessen the former disadvantage a glossary has been added at the end of the book. However, for determination work of exotic plants in herbaria and botanical gardens — possibly also for botanists making a first acquaintance of a foreign flora — this book may be to very great help. It thus makes a good complement to the Genera of Flowering Plants (reviewed above) which continues beyond the rank where the present key ends up.

ROLF DAHLGREN

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C. J. ALEXOPOULUS: Einführung in die Mykologie. Gustav Fisher Verlag, Stuttgart. 1966. XVI+496 Seiten und 194 Abbildungen. DM 62,—.

Das Buch ist eine ziemlich wort- un sinngetreue Übersetzung von MARIE L. FARR nach der 2. amerikanischen Originalauflage „Introductory Mycology" im Verlag John Wiley & Sons Inc., New York, 1962.

Der amerikanische Originaltext von ALEXOPOULOS hat seit der ersten Auflage im Jahre 1952 grossen Beifall gefunden. Es besteht ein grosses Bedürfnis für ein Lehrbuch, das sich an den Anfänger im Studium richtet und ihm eine allgemeine Einführung bietet, ohne ihn mit den komplizierten Einzelheiten zu belasten, die nur für den Spezialisten wichtig sind. Die deutsche Übersetzung ist als so wertvoll zu betrachten wie auch die entsprechende spanische Ausgabe und die planierten Übersetzungen in die arabische und indische Sprache.

Das Buch umfasst reichlich illustrierte Darstellungen der Struktur, Morphologie und Entwicklungsgänge der Pilze, verbunden mit psysiologischen und genetischen Angaben. Die diagramatischen Darstellungen der Entwicklungsgänge und das Glossar der Faschausdrücke sind besonders nutzbringend anzuwenden.

S. O. STRANDHEDE

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