BOTANISKA NOTISER 1966 · VOL. 119 · FASC. 3 · LUND

On Drepanocladus trichophyllus in the Torneträsk Area

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(Received February 10th, 1966)

Introduction

In 1961 the present author found *Drepanocladus trichophyllus* (Warnst.) Podp. with capsules in the Torneträsk area (N. Sweden). Cultivation experiments with spores from this material were performed in Lund (S. Sweden) 1962—1964. The results of this investigation as well as an ecologic survey of the species in the Torneträsk area are given here, while a more detailed description of the ecology of *D. trichophyllus* will appear in a future paper on mire vegetation in the Torneträsk area (SONESSON, in prep.).

The work has been carried out at the Department of Plant Ecology of Lund University (head of the department Laborator NILS MALMER). E. NYHOLM suggested the cultivation experiments. She has also confirmed and revised many determinations of *Drepanocladus*. N. MALMER, Å. PERSSON and H. RUNEMARK have offered valuable criticism concerning the manuscript, and O. MÅRTENSSON has provided much information on *Drepanocladus* in the Torneträsk area. M. VARGA has drawn the diagrams. Lund University and the foundation Seth M. Kempes Minne, Örnsköldsvik, have rendered financial assistance.

To all mentioned I wish to express my sincere gratitude.

The nomenclature of the vascular plants follows HYLANDER (1955). The bryophytes are according to NYHOLM (1954—1965) as to the groups until now treated by her. *Sphagnum* follows MÅRTENSSON (1956 a). The sampling and analysis of water were performed according to MALMER (1960, 1962 a). The terminology of mires and mire vegetation mainly follows SJÖRS (1950, 1952). For a map of the investigation area see MÅRTENSSON (1956 b) and the tourist map "Fjällen kring Abisko, Björkliden, Riksgränsen" (scale 1 : 100,000, the summer edition, Generalstabens litografiska anstalt, Stockholm 1948).

Taxonomic Review

Drepanocladus trichophyllus (Warnst.) Podp. is one of the species in the taxonomically much discussed *Drepanocladus exannulatus* group. This complex is usually referred to the section *Warnstorfia* of the genus *Drepanocladus* together with *D. fluitans* s. lat. The vegetative morphological characters which in modern bryological literature are looked upon as the principal ones in distinguishing taxa in sect. *Warnstorfia* are the structure and arrangement of the angular cells, the length of the nerve and the denticulation of the leaves (as to North-European literature see e.g. H. PERSSON 1943, TUOMIKOSKI 1949, MÅRTENSSON 1956 a, H. PERSSON & SJÖRS 1960, NYHOLM 1965). NYHOLM (op. c.) also mentions anatomic differences of the nerve (cf. the characters of the nerve in *D. exannulatus* s. lat. according to TUOMIKOSKI op. c.). With regard to generative characters the main difference between *D. exannulatus* s. lat. and *D. fluitans* s. lat. is a dioicous gametophyte in the former and a monoicous gametophyte in the latter.

The *Drepanocladus exannulatus* group has been investigated by TUOMIKOSKI (op. c.) using primarily material from northern and northeastern Europe. According to him *D. exannulatus* s. lat. consists of four species viz. *D. tundrae*, *D. procerus*, *D. trichophyllus* and *D. exannulatus* s. str. A fifth taxon in the same group, *D. purpurascens* (Schimp.) Loeske, recognized as a species by e.g. H. PERSSON (op. c.) and SJÖRS (1946, 1948, 1965, see also H. PERSSON & SJÖRS op. c.) is included by TUOMIKOSKI within the variation range of *D. exannulatus* s. str. MÅRTENSSON (1956 a, 1962) has followed TUOMIKOSKI, except in recognizing *D. purpurascens* as a variety of *D. exannulatus* s. str. NYHOLM (op. c.) has treated both *D. purpurascens* and *D. procerus* as varieties of *D. exannulatus* s. str.

All the authors mentioned regard *D. trichophyllus* as a good species. As to the experience of the present author it seems to be well circumscribed and relatively easily recognized in the investigation area.

On British material of *Drepanocladus exannulatus* s. lat. and *D. fluitans* s. lat. LODGE (1960 a) has quantitatively shown the very wide variation concerning e.g. the shape and proportions of the leaves, the length of the lamina cells etc. His experimental investigations (1959, 1960 b) have also shown that much of this variation is merely due to environmental influence and thus the characters concerned are of slight or no taxonomic value. The morphology and arrangement of the angular cells at the base of the leaf are however only slightly influenced by environment. In each of the collective species in question, LODGE thus distinguishes two different types of angular cells each with a narrow range of variation and without any continuous transitions (cf. also the above mentioned authors).

The relative length of the nerve of *D. exannulatus* s. lat. is to some extent correlated with the degree of submersion (LODGE 1959). The nerve however does not reach such a length that it extends to the end of the acumen of the leaf in the material investigated by LODGE.

When regarding also the boreal, subarctic-arctic material of *D. exannulatus* s. lat. it is evident that the variation of the relative length of the nerve is discontinuous too. WYNNE (1945) in her work with special reference to North-American material thus mentions the length of the nerve as a distinguishing character between *D. exannulatus* var. *typicus* (Dixon) Wynne and *D. exannulatus* var. *Rotae* (DeNot.) Grout. Similar results have been obtained on European material in the mentioned investigations by TUOMIKOSKI (1949). Within the *D. exannulatus* group *D. trichophyllus* is thus above all distinguished by the nerve which in typical cases, especially in the branch leaves, completely fills up the usually very long acumen of the leaf. In this character it differs from *D. exannulatus* var. *purpurascens* to which it has the closest resemblance in other respects (cf. H. PERSSON 1943, TUOMIKOSKI op. c., MÅRTENSSON 1956 a, NYHOLM 1965).

Drepanocladus trichophyllus seems to be a boreal circumpolar species (TUOMIKOSKI 1949, H. PERSSON & SCHACKLETTE 1960, NYHOLM op. c., see also WYNNE 1945, the description and figures on pp. 163, 165, 184 of *D. exannulatus* var. *Rotae*). It probably has its highest frequency in the continental areas.

Cultivation Experiments

The locality of the parent material. Luovare in the low alpine belt (see DU RIETZ 1950, MÅRTENSSON 1956 b), c. 950 m above sea-level. — The locality is situated in an area at Mount Luopakte mainly occupied by poor dwarf-shrub heaths, small oligotrophic lakes and poor mires. In the eastern end of a small, shallow lake (c. 75 by 100 m and 50—100 cm in depth) poor mire vegetation occurs on the shore. The parent material was collected from a stand situated between a relatively broad zone of a *Drepanocladus trichophyllus* society close to the open surface of water on one side and a narrow zone of carpet vegetation dominated by *Carex rostrata, Eriophorum angustifolium, Sphag-*

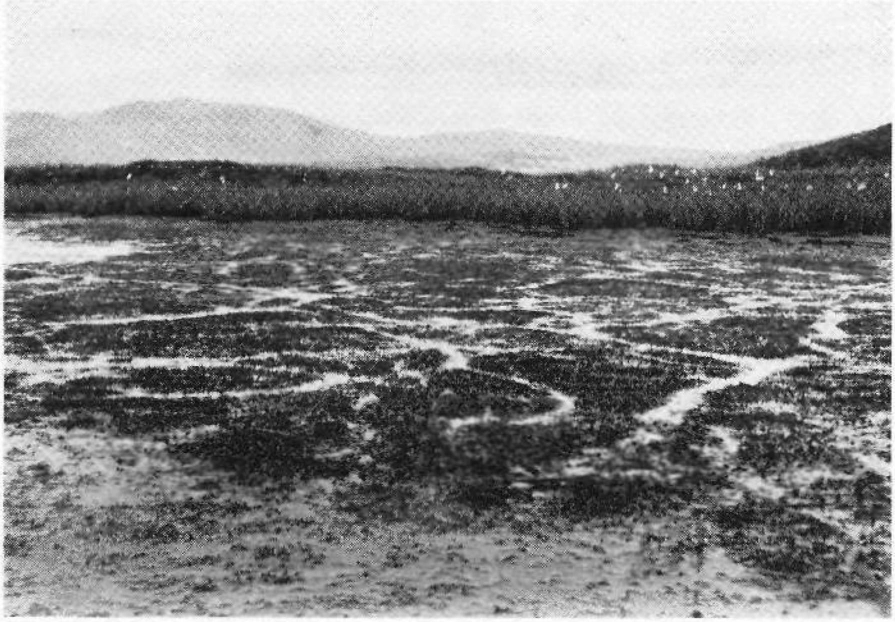


Fig. 1. Locality of parent material, Luovare, low alpine belt c. 950 m, 16.8.1961. In the foreground mats of primarily *Drepanocladus trichophyllus*. Sparse shoots of *Carex rostrata* and *Hippuris vulgaris* also occur. In the background a zone with *Carex rostrata, Eriophorum angustifolium, Sphagnum lindbergii* and *Drepanocladus schulzei*, bordering on an elevated part with hummock vegetation.

num lindbergii, S. riparium and *Drepanocladus schulzei* on the other side. The carpet borders on a rather large, somewhat elevated part with hummock vegetation. This vegetation is dominated by dwarf scrubs, *Sphagnum fuscum, Dicranum elongatum,* lichens etc. (Fig. 1). In the floating mats of *Drepanocladus trichophyllus* there are also other *Drepanocladus* types, mainly *D. exannulatus* var. *procerus* but also e.g. *D. exannulatus* var. *purpurascens* (falcate, weakly denticulate and in appearance much resembling var. *procerus*) and *D. schulzei.* Beneath the floating moss mats there are in some places on the bottom of the lake thick (c. 20—30 cm) layers of amongst others *Drepanocladus trichophyllus.* The bottom mainly consists of coarse mineral matter, probably stony till. Along the shores to the west and to the east the contribution of organic matter is rather large. Analysis of the water (19.8 1962) gave the following values: pH 5.8, $\varkappa_{\mathrm{red}}$ 23; dissolved constituents in µmol per litre: Na 60, K 12, Mg 27, Ca 35, S 137, P 0.6, Fe 25.

Four samples from two different years have been examined. Of in all 26 checked specimens, 7 appeared to be female and the rest sterile. Sporophytes were observed in 1961, 1962, 1963 and in a neighbouring (c. 800 m distant) locality in 1965. In 1964 no observations were made.

The parent individual. A typical specimen of *Drepanocladus trichophyllus* (see Fig. 3, cf. Tuomikoski 1949, Nyholm 1965). — On the occasion of sowing the percentage of morphologically well developed spores was approximately 50. However a greater share of the material germinated, but the percentage of viability was not calculated.

In 1965 a count of spores from the parent material of 1961 and from material in 1962 was made after staining with Cotton-blue. The diameter and degree of staining were determined. In each sample 400 spores were counted:

	Parent material	1962
Percentage of irregular spores	8 %	63 %
Percentage of unstained spores	11 „	37 „
Percentage of weakly stained spores	66 „	
Percentage of strongly stained spores	14 „	

Distribution of diameter classes:

	Parent material (stained, regular spores)	1962 (all spores)
10—< 13 μ	16 %	1 %
13—< 16 „	54 „	27 „
16—< 19 „	29 „	57 „
19—< 22 „	1 „	14 „

The cultivation. In Februari 1962 spores were sown on a sterile agar medium (Beijerinck medium, see Whitehouse 1961, p. 92) in sterilized Petri dishes. The dishes were placed before a window facing east at room temperature. After one week a great share of the spores had germinated and was homogeneously developed into a few mm long filamentous, somewhat branched protonemata. About 40 protonemata, randomly selected, were each placed on a small piece of agar in other Petri dishes. After some days more the first gametophore initials appeared on the vigorously branching protonemata. Morphological differences between these 40 protonemata were not observed. 19 pieces of agar with three week old individuals were placed on peat substrate in a sterilized pot each. The peat substrate was a dried, slightly humified peat from a poor mire in the investigation area (main macrophytic constituents *Sphagnum fuscum* and *S. lindbergii*). The peat was soaked with distilled water and sterilized by boiling in water for at least one hour. Four to five pots were placed together in plastic dishes containing distilled boiled water up to or a little exceeding (c. 0—2 cm) the surface of the peat. The level of water was kept approximately constant during the whole time of

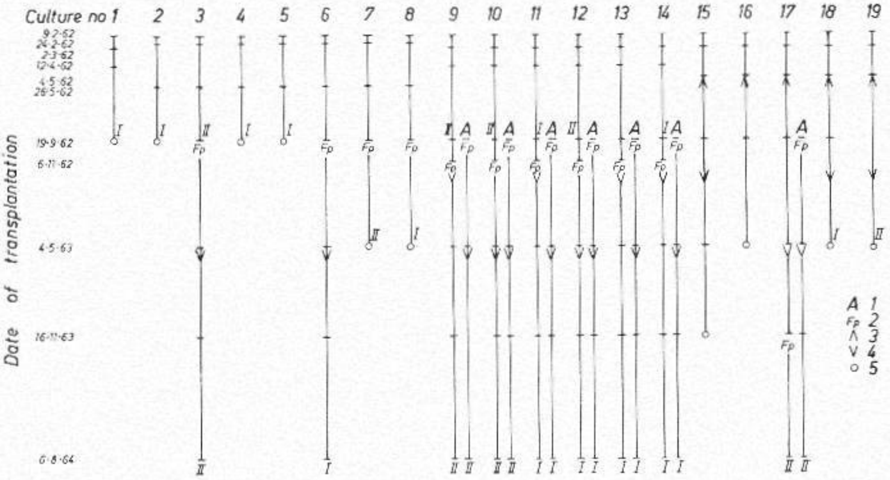


Fig. 2. Plan of cultures. 1 clone individual, 2 fresh peat, 3 tap water, 4 out of doors, 5 dead. The Roman numerals designate different nerve types, see the text.

cultivation. The dishes were kept in two plastic-clad wooden boxes covered with a plate of glass.

At the beginning the cultivation was carried out in a greenhouse with artificial illumination during the day and temperature normally between +10 and +20°C.

From the autumn of 1962 about a third of the moss material and from the summer of 1963 all the material was kept out of doors (see Fig. 2). During the whole time of cultivation the cultures were transplanted several times on new substrate and in new sterilized pots. In doing so all the material of each pot was transplanted except some shoots which were dried and preserved for later examination. To a large extent the condition of the material as to epiphytic growth of mainly blue-green algae decided the time of transplantation.

When transplanting in autumn of the first year seven of the more vigorously growing daughter individuals (strains) were each divided into two clone individuals parallelly cultivated (cf. the "A-individuals" of the strains indicated in Figs 2—4).

During a short period in May 1962 five individuals were irrigated with ordinary (boiled) tap water. In January 1963, on one occasion, the water in all pots was exchanged for water from a moderately rich mire near Lund. In that water were measured a pH of 6.5 and a $\varkappa_{\text{red}}$ of 210. On the same occasion pH and $\varkappa_{\text{red}}$ were determined in the water from the plastic dishes. pH was ranging from 7.1 to 7.3 and $\varkappa_{\text{red}}$ from 90 to 110. All these values much exceed those in water from the parent locality (cf. p. 382).

During the first months of 1962 the growth was very rapid. After about two months (in March—April) the shoots in most of the pots had reached c. 2—4 cm in length. They had also a few short branches irregularly distributed. The shoots in most of the pots were of about the same length. Later on, however, a variation in the growth, appearance and viability of the cultures became more prominent. Four of the individuals showed a slight growth and died (probably so) after about half a year in culture. In May the following year two others died. Also four other individuals apparently died in 1963. They might have been poisoned by tap water (see above). As to nos. 15 and 16 no material was found left in the pots in 1963. A few shoots of some individuals were prostrate but most of the shoots were erectly or suberectly growing at least as to the younger parts of the stems. Some shoots had imbricate leaves, others had spreading distant spaced leaves at a more or less right angle to the stems. The colour was pure green—yellowish green. Rather soon a reddish tinge appeared in many of the shoots especially on the stems.

No generative organs were found in the material studied. In the material remaining in 1964 there were, however, in a few cases short branches with leaves much resembling those in fertile branches of spontaneously growing *Drepanocladus*.

During the summers and autumns the growth seemed to stagnate. It apparently depended on a more or less strong epiphytic growth of mainly *Cyanophyceae* (cf. ZASTROW 1934). Both in the spring of 1963 and of 1964 (in April—May) after thawing, however, a vigorous growth in the whole material was noticed. No algae were visible on those occasions. Also after the transplantations (algae mechanically removed) the growth much improved.

Exchange of dried substrate for fresh peat from the parent locality (cf. Fig. 2) seemed to have slight or no effect on the appearance and growth of the material. Nor had the supply of water rich in electrolytes, but boiled tap water apparently had a negative effect. The only obvious effect of keeping the cultures out of doors seemed to be a reduced growth of *Cyanophyceae*.

In the autumn of 1964 the cultivation was finished. At that time only nine of the primary nineteen daughter individuals remained. Seven of them had been cultivated as two different clone individuals each in separate pots since the autumn of 1962.

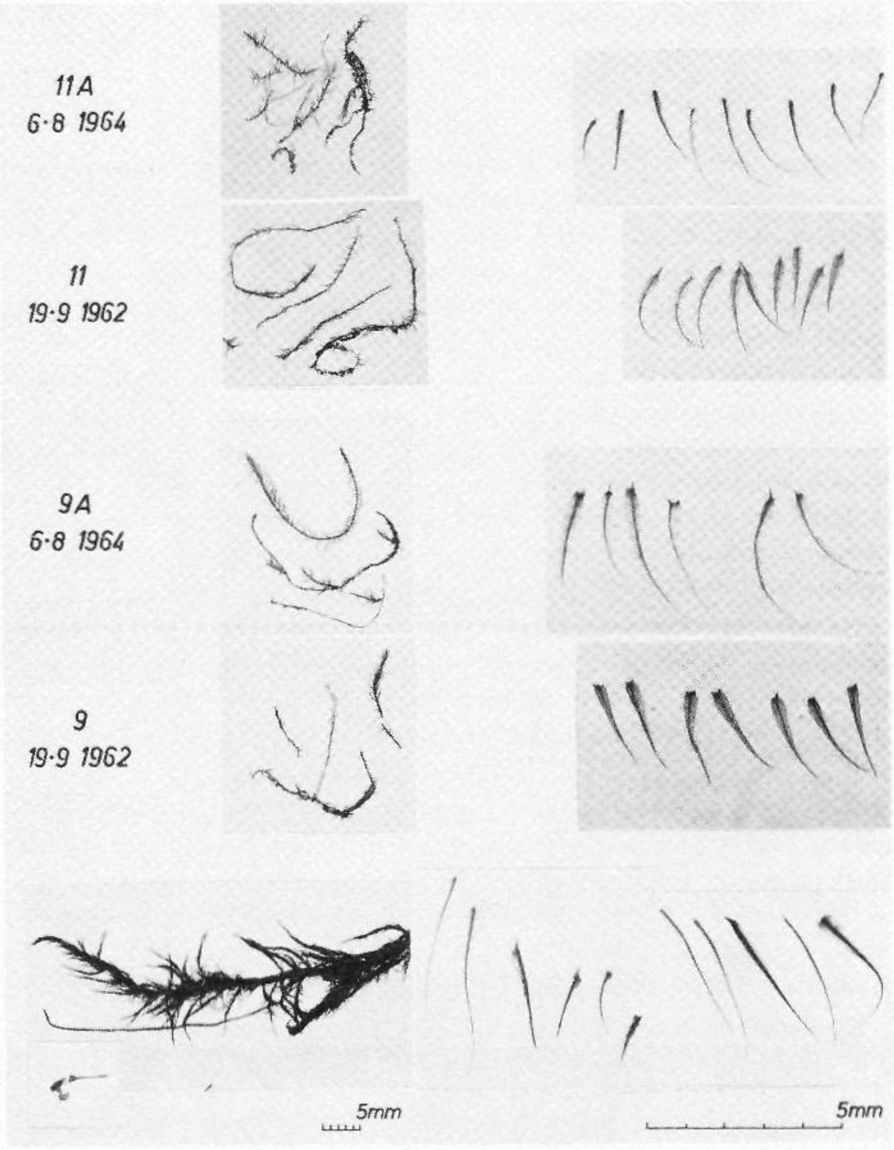


Fig. 3. Parent individual (below) and two daughter individuals, the latter shown at two stages of development.

Results. All the remaining material in 1964 and the preserved material from the autumn of 1962 were examined as to the shape and proportions, the nerve, the denticulation and the angular cells of the leaves.

The dried material was soaked and boiled for a short time in 10 % KOH and then washed in tap water. In that way the leaves were cleaned of algal debris and the cell-walls of the nerve were also rendered a yellowish colour. From each individual the leaves were scraped off the stems and transferred into a Petri dish. The youngest (apical) leaves of the shoots were however disregarded. The leaves were then randomly selected from the dish and studied in the microscope at a magnification of ×125. Fifty leaves proved to be a satisfactorily safe number as to the characters studied (cf. LODGE 1959). The same treatment was given to five different specimens of adult spontaneous *D. trichophyllus* from four localities, but in that case only the youngest parts were used. In the latter material branch leaves and stem leaves could also be distinguished and ten leaves of each kind from each specimen were studied.

The length and width of the leaf and the length of the nerve were measured with a calibrated micrometer eyepiece. Two separate measurements were made on the length of the nerve. The mean measuring error calculated on randomly selected values from the measurement records of the individuals (except herbarium material) amounted to 1.59 %, the standard deviation 1.217 ($n = 160$). The standard deviation (s) was calculated according to the formula

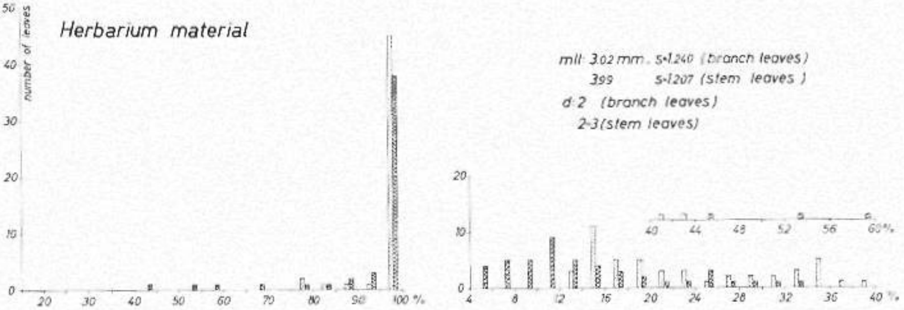
$$s = \pm\sqrt{\frac{\Sigma(x - \bar{x})^2}{n-1}}.$$

The relative values presented in the figures (in per cent) always refer to the length of the leaf.

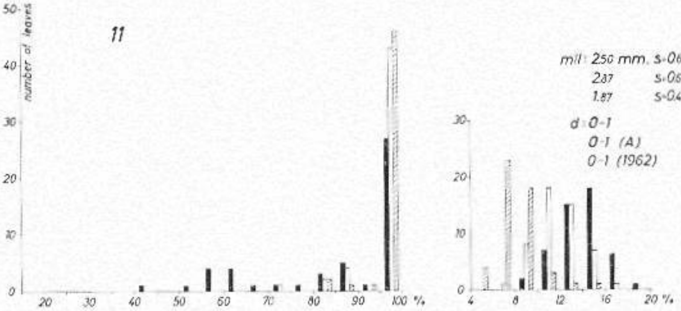
The degree of denticulation was determined according to the following rough scale: 0 = not denticulated, 1 = weakly denticulated, 2 = normally denticulated, 3 = strongly denticulated.

The 1964 material

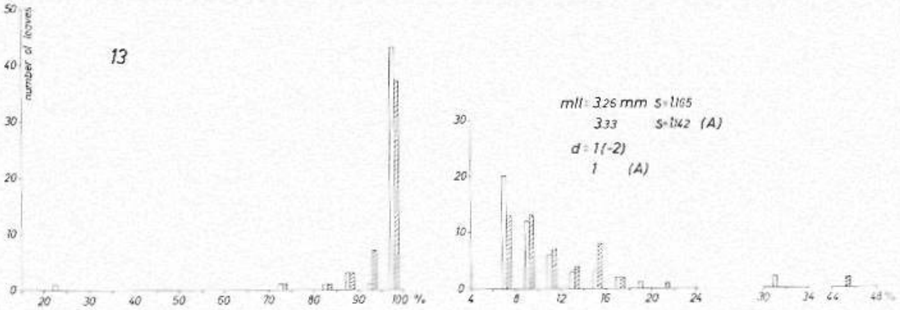
The shape and proportions of the leaves seemed to vary much. In the same clone individual, either on the same shoot or on different shoots, the leaves were long acuminate and more or less straight or slightly acuminate and falcate. Falcate, long acuminate and straight slightly acuminate leaves also occurred. In a few shoots a (basal) part of straight leaves and a (apical) part of almost circinate leaves were also seen. The first developed leaves at the base of the shoot were slightly acuminate and relatively broad. This type of leaves I call juvenile. The development towards a more adult stage appeared primarily in a relatively stronger growth of the acumen in relation to the basal parts of the leaf. The distance between the base of the leaf and the widest part varied slightly in comparison with the length of the leaf. In Fig. 5 the



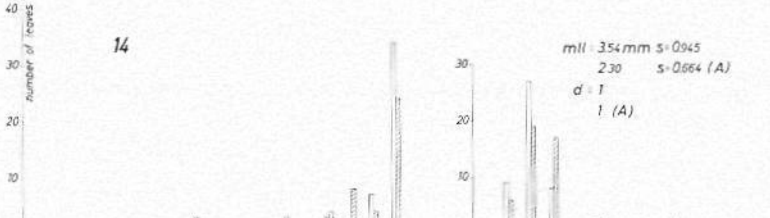
mll: 3.02 mm, s=1.240 (branch leaves)
3.99 s=1.207 (stem leaves)
d: 2 (branch leaves)
2-3 (stem leaves)



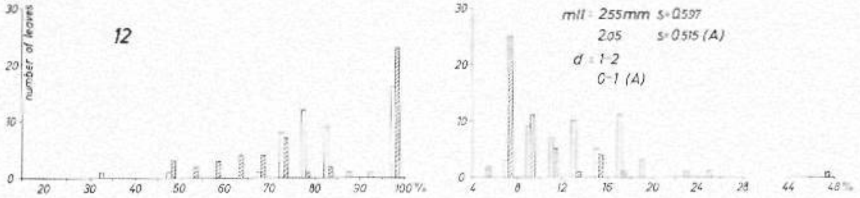
mll: 2.50 mm, s=0.622
2.87 s=0.585 (A)
1.87 s=0.419 (1962)
d: 0-1
0-1 (A)
0-1 (1962)



mll: 3.26 mm s=1.165
3.33 s=1.142 (A)
d: 1(-2)
1 (A)



mll: 3.54 mm s=0.945
2.30 s=0.664 (A)
d: 1
1 (A)



mll: 2.55 mm s=0.597
2.05 s=0.515 (A)
d: 1-2
0-1 (A)

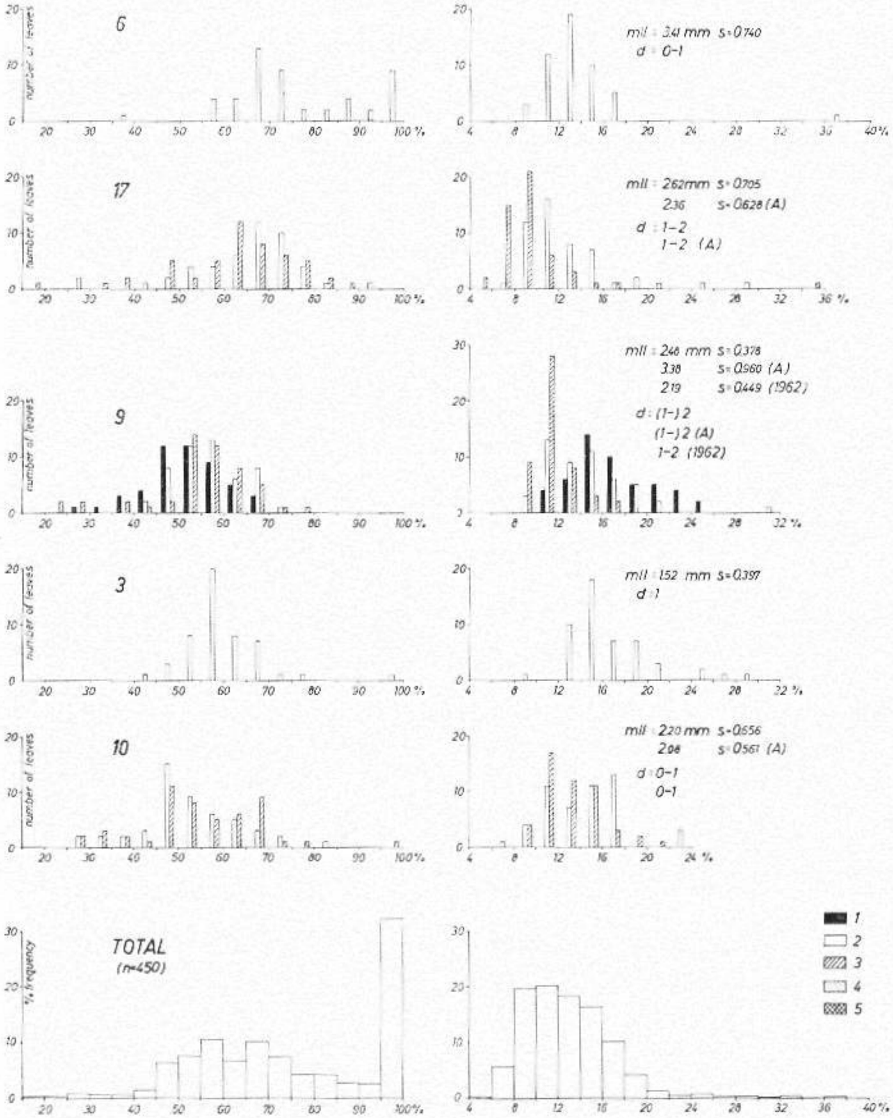


Fig. 4. Distribution of classes of relative nerve length (left column) and relative leaf width (right column). 1 material from 1962, 2 and 3 (=A) clone individuals of the same strain in material from 1964, 4 herbarium material, stem leaves, 5 ditto, branch leaves. mll=mean leaf length, d=degree of denticulation. The total histogram is composed of values from one individual of each daughter strain. All values refer to the length of leaf.

curves of the relative distance of leaf width and that of the relative leaf width accordingly have approximately the same courses. The relative leaf width seems to be a sufficiently good expression of the stage of development of the leaf with respect to the acumination.

In some cases there were rhizoid-initials or rhizoids growing from the lamina of the leaves.

The angular cells were very uniform in the whole material. They were of typical *D. trichophyllus*—*D. exannulatus* var. *purpurascens*-shape (see NYHOLM 1965 and LODGE 1960 a, p. 380, "type B").

The denticulation varied only slightly between the clone individuals except in no. 12 (Fig. 4). Between different strains however there was an obvious variation. In the separate shoots the juvenile leaves (cf. above) seemed to be somewhat less denticulated than the more developed ones. With regard to the whole material of progeny the denticulation was less than in the parent individual and in other material of spontaneous *D. trichophyllus*.

The nerve of the leaves (Fig. 4) completely (or nearly so) filled up the usually long narrow acumens of most of the leaves in three strains, nos. 11, 13 and 14, cultivated as three couples of (cf. Fig. 2) clone individuals (nerve type I).

In nos. 6 and 12, grown as 1+2 clone individuals, the nerve filled up the acumens in about half or less than half the number of leaves. The remainder however had a nerve extending for about 65—85 % of the length of the leaf. Some of these latter leaves were in appearance typical *D. trichophyllus* leaves with a long narrow acumen filled up by the nerve, but in the end the acumen broadened into a "spatula" composed of undifferentiated lamina-cells (included in nerve type I).

During the measurements there were sometimes occasions of uncertainty as to the real extension of the nerve. There were difficulties in delimiting the extension especially in those cases when the nerve seemed to be differentiating also from the end of the acumen. The highest classes of the relative nerve length in Fig. 4 may accordingly be somewhat underrepresentated. As to no. 12 which caused the greatest trouble in this respect, reservations were made during measurements in four cases as to one clone individual (12 A) and in seven cases in the other. Even taking these reservations into consideration, however, the discontinuous distribution of frequency classes in no. 12 will still remain.

In the remaining strains, nos. 3, 9, 10 and 17, the length of the nerve was equivalent to about 50—75 % of the leaf length (nerve type II).

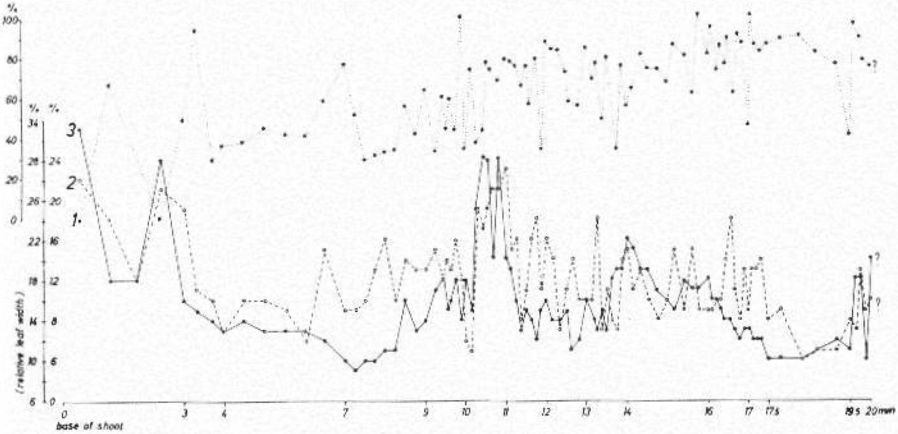


Fig. 5. Consecutive leaves of one unbranched shoot (no. 11, 4.5.1963). 1 relative nerve length, 2 relative leaf width, 3 relative distance to the widest part of the leaf from the base of the leaf. The values refer to the length of leaf.

With regard to all the material from 1964 it is possible to differentiate the strains into four different morphological categories concerning two of the characters studied, viz. the length of the nerve and the denticulation:

I a. Nerve type I, weakly—normally denticulated
I b. Nerve type I, not—weakly denticulated
II a. Nerve type II, weakly—normally denticulated
II b. Nerve type II, not—weakly denticulated

The 1962 material

The material from the autumn of 1962 was also studied in the microscope, though only in two cases, nos. 9 and 11, were measurements made. As to the nerve length and the denticulation the differences between the cultures from the two years in most cases were less than between different strains of each year. An exception, however, was no. 12 (cf. Fig. 2). As to nos. 6, 13 and 17 no material from the autumn of 1962 was preserved.

Nevertheless the material from 1962 was of course on the whole more juvenile as to the length of the nerve and the acumination of the leaves compared with the material from 1964.

Discussion. An apparent variation is shown in the progeny. Though already seen during the cultivation in the general growth, appearance and viability, this variation appears most strikingly in the studied characters of the leaves.

The variation in shape and proportions of the leaves, angular cells, denticulation and nerve must mainly depend on environmental influence and/or the genetic background (as to the measuring errors, see p. 387).

The relative width of the leaves has quite a continuous variation. The difference between two clone individuals may be greater than between two different strains. The proportions of the leaf, mainly determined by the relative length of the acumen, is accordingly much influenced by environment. Principal environmental factors during the cultivation were no doubt the epiphytic algae and the varying treatments of the individuals. The frequencies of straight—falcate leaves, though not accurately measured, seem also to a great extent depend on environment. This is also in accordance with the results of the investigations on British material of *D. exannulatus* s. lat. performed by LODGE (1959, 1960 b).

A discontinuous variation is, however, apparent as to the relative length of the nerve. The difference between the clone individuals is also generally much less than between the different strains. The differences are too great to be explained merely by chance and measuring errors (non-binomially distributed). The total histogram (Fig. 4) indicates a 1 : 1 distribution of leaves with an "excurrent nerve" and those with a nerve extending for about 50—75 % of the length. This seems even more probable when considering a possible underrepresentation of the highest classes (cf. p. 390).

The histograms of two strains, nos. 6 and 12, are of approximately the same type as the total histogram. Also in nos. 3 and 10, otherwise typically belonging to nerve type category II there are a few leaves where the nerve completely fills up the acumen.

The two nerve types mentioned may however correspond to three different genotypes (or rather groups of genotypes):

— one which phenotypically very soon responds to environment in individuals where nearly all the leaves are long-nerved.

— one which phenotypically in a later stage responds to environment in individuals where the late parts of the shoots (or some late shoots) have almost exclusively long-nerved leaves.

— one which never or possibly very late responds to environment in long-nerved individuals.

As to the second genotype there is unfortunately not enough material left to check the separate shoots. There are, however, positive differences as to the relative nerve length of consecutive leaves in separate shoots indicating the possibility of different shoot generations in the material (see Fig. 5). With respect to the morphological differences seen between the shoots even in the same clone individual (cf. p. 387), it seems possible that the differences between the shoots in the same culture (i.e. the same clone individual) and also between various parts of one shoot may be great concerning the length of the nerve.

The different denticulation types presented seem also to be mainly genetically determined. However, this character is more difficult to determine and the accuracy is accordingly less than in the measurements of the nerve. Nevertheless the differences in this respect seen between different strains in the microscope were often striking.

Some of the categories of strains concerning the nerve and denticulation may also be recognized in nature:

As to nerve type I, the denticulate category (I a) closely corresponds to the parent individual, *D. trichophyllus*. However, I have not observed a corresponding type of the non-denticulate—weakly denticulate category (I b) in the field or on herbarium material, nor have I been able to find it being described in bryological literature. With respect to the nerve, strain nos. 6 and 12 may phenotypically come closest to a shore-type of *D. trichophyllus* (not seen by me) mentioned by TUOMIKOSKI (1949, p. 31). In this type the nerve does not fill up the extreme end of acumen.

As to nerve type II both the denticulate and the non-denticulate categories resemble *D. exannulatus* var. *purpurascens*. The distinctly denticulate type of the latter (corresponding to II a) is, however, uncommon in intermediate mire vegetation, but is common in richer and/or more dryly growing vegetation (cf. MÅRTENSSON 1956 a, pp. 256—259, 269, Å. PERSSON 1961, see also next section). It corresponds most closely to *D. exannulatus* s. str. according to TUOMIKOSKI (op. c., pp. 8, 37). He mentions the combination found in mixed moss samples between this species and *D. trichophyllus*, a rare combination. The non-denticulate—weakly denticulated category (II b) is closest to the falcate type of *D. exannulatus* var. *purpurascens* which is often found together with *D. trichophyllus* in intermediate waters and which also occurs in the parent locality (p. 382). It is in appearance very similar to *D. exannulatus* var. *procerus* and can safely be distinguished from the latter only in the microscope according to my experience. However, with regard to vegetative characters, also concerning the angular cells, I am not in all cases convinced of the discontinuities between *D. exannulatus* var. *procerus* and *D. exannulatus* var. *purpurascens* in the Torneträsk area (cf. H. PERSSON 1943, p. 21).

It must be emphasized that the results of the cultivation are not directly applicable to the conditions in nature. The results obtained, however, indicate the possibility that some of the *Drepanocladus exannulatus* types met with in the field are results of occasional sexual processes between different genotypes, normally propagating vegetatively.

Ecologic Conditions

Drepanocladus trichophyllus occurs in mire vegetation both above and beneath timberline. It is, however, most common beneath timberline. All the alpine localities hitherto found are situated in the low alpine belt (see DU RIETZ 1950, MÅRTENSSON 1956 a, p. 257).

I have found the species only in the poor western (westernmost locality at Vassijaure) and eastern parts of the investigation area. These parts are characterized mainly by a poor vegetation on soils derived from hard silicious rocks. In the central part of the area where a rich vegetation occurs and the rocks are generally softer and contain more calcium I have not found it. MÅRTENSSON (1956 a, p. 269), however, mentions it from Abiskojaure in the south-westernmost part of the Abisko valley which belongs to the rich central part in question. In this locality *Drepanocladus trichophyllus* grows together with *Scorpidium scorpioides, Drepanocladus exannulatus* var. *purpurascens* and *D. tundrae*. On the rich northern side of Lake Torneträsk *D. trichophyllus* seems to be very rare or missing (cf. Å. PERSSON 1961).

Plant communities with *Drepanocladus trichophyllus* are typical intermediate mire communities ". . where some of the less exclusive species of rich fens mix with species of poor fens." (SJÖRS 1952, p. 248). Thus common followers of *Drepanocladus trichophyllus* are e.g. *Scorpidium scorpioides,* otherwise with the highest frequency in the rich mires, and some wetly growing *Sphagnum* species, especially *S. lindbergii, S. jensenii* and *S. riparium,* which are most common in the poor mires. Among the mosses *Drepanocladus exannulatus* var. *procerus* s. lat. (incl. *D. exannulatus* var. *purpurascens,* the type with none or weak denticulation, cf. p. 393) is most often found growing together with *D. trichophyllus*. These latter taxa seem to be good indicators of the very wetly growing intermediate mire vegetation in the Torneträsk area. Especially in such communities that border on open surface water, *Drepanocladus trichophyllus* is found in the zone adjacent to the aquatic vegetation or to the surface of water devoid of macrophytic vegetation.

A common zonation (cf. Fig. 1) in the mires of the poor parts of the investigation area is:

1. Zone of transition between terrestrial vegetation and mire vegetation	characterized by mire and terrestrial species, *Salix* spp. (esp. *S. lapponum*)
2. Hummock and lawn zone	characterized by e.g. scrubs, lichens, *Sphagnum fuscum, S. robustum, S. balticum, Drepanocladus schulzei* [1]
3. Carpet zone (often quaking peat)	characterized by e.g. *Carex* spp. (*C. rostrata, C. rotundata*), *Eriophorum angustifolium, Sphagnum lindbergii, Drepanocladus schulzei* [1]
4. Mud-bottom/magnocaricetum zone	characterized by e.g. *Carex rostrata, Eriophorum angustifolium, Utricularia* spp., *Drep. exannulatus* var. *procerus* s. lat.[2], *D. trichophyllus*
5. Mud-bottom/aquatic zone	characterized by e.g. *Drep. exannulatus* var. *procerus* s. lat.[2], *D. trichophyllus, Utricularia* spp., *Sparganium* spp., *Potamogeton alpinus*
6. Open surface of water devoid of macrophytic vegetation	

Some of the zones, especially nos. 2 and 3, may be missing or be poorly developed.

In the transition between zone no. 3 and 4 there are sometimes species otherwise most frequent in the plant communities of the mire margin, e.g. *Potentilla palustris, Carex canescens, C. magellanica, Sphagnum riparium.*

Though usually not growing in proper mud-bottoms the vegetation of zone no. 4 and 5 is phytosociologically often very similar to the vegetation on true mud-bottoms. The vascular plants accordingly grow scattered and the bottom layer is sparse. Often, however, the graminaceous plants are of a more luxuriant appearance than in mud-bottom communities. The transition is usually gradual between this type of

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[1] High frequency, low cover.

[2] Incl. *D. exann.* v. *purpurascens* p.p. (see p. 394).

vegetation and that of typical magnocaricetum vegetation often occurring in the mentioned zones.

Drepanocladus trichophyllus occurs most frequently in the above mentioned types of very wetly growing vegetation, but it is also found in typical carpet vegetation though not frequently.

In the communities with *Drepanocladus trichophyllus* the water level is very constant during the vegetation period. It seldom varies more than ±5 cm. During summer and early autumn the temperature of the surface water generally corresponds to the mean air temperature. In the shallow bodies of water (less than 1 m in depth) the temperatures at the bottom and the surface are approximately the same or differ by only a few degrees. Thus in July 1965 the measured water temperatures were usually between +8 and +10°C (cf. GRANMARK 1965).

Drepanocladus trichophyllus also grows submerged without any individuals on the surface (cf. TUOMIKOSKI 1949, MÅRTENSSON 1956 a. H. PERSSON & SHACKLETTE 1960). According to an investigation of the bottoms of some (c. 15) bodies of water along the shores down to about 3 metres at least some floating individuals of the species occurred in most cases at the places where it was found submerged. Stands with floating individuals and where no submerged ones were found also occurred. At least with regard to the populations in shallow water some of the individuals of the surface often seem to be attached to the bottom or to be connected with the submerged part of the population (or the submerged population).

The individuals of the populations are most often sterile, but sometimes also male or female gametophytes are found intermingled with the sterile ones.

Drepanocladus trichophyllus is found with sporophytes only in one locality in the investigation area (cf. p. 383).

When examining 15 collections from 13 different localities evenly distributed in the Torneträsk area I found besides sterile specimens only male individuals in 5 of the collections, only female ones in 6 and both male and female in one of the collections. The last collection originated from a "pals-mire" at the Torneträsk railway station (see MÅRTENSSON 1956 b, p. 27) in the eastern part of the investigation area. No sporophytes, however, were seen there. Since some of the collections were small and only derived from a small part of a stand the relative share of localities where both male and female gametophytes occur ought to be greater than appears from the examination.

The intermediate mire vegetation has a northern distribution in Sweden (cf. FRANSSON 1965, SJÖRS 1965). It is connected with a kind of water also of an intermediate type. The water is thus characterized by a high pH in relation to the content of dissolved electrolytes (expressed as the specific electrical conductivity). This condition has several times been pointed out in the literature, first by SJÖRS (see SJÖRS 1946, 1948, 1950 and esp. 1952, see also Å. PERSSON 1961, 1962, 1965, MALMER 1962 a, 1963). As to the quantity of electrolytes it corresponds to the water occurring in poor mires (with bogs as the most extremely poor type) both in southern and northern Sweden, but pH is higher. Often the values of pH are about the same as what is measured in moderately rich mires in S. Sweden.

In water where *Drepanocladus trichophyllus* communities are recorded, the reduced specific conductivity[1] varies between c. 5 and 40. Generally the values in the different stands are very constant during the vegetation period. They correspond closest to those measured in poor mires in S. Sweden, even in the mud-bottoms of bogs (see WITTING 1948, MALMER 1962 b, 1965). Thus they are generally much lower than those of oligotrophic lakes in S. Sweden (MALMER 1961), but agree with values from this type of lakes in N. Sweden (LOHAMMAR 1938, 1965, SJÖRS 1946, GRANMARK 1965).

The content of Ca^{2+}, as one of the principal inorganic constituents of the water, is also closest corresponding to the values of poor mire waters. In three samples the quantity of Ca^{2+} has been measured to 41, 47 and 35 μmol per litre respectively. These values are e.g. like those of poor mire waters in S. Sweden (MALMER 1962 a and b). They are lower than the mean values of oligotrophic lakes in S. Sweden and in the lowland of Norrland (MALMER 1960, 1961). GRANMARK (op. c.), however, mentions similar values from high-transparent lakes in Lule Lappmark (south of Torne Lappmark).

pH varies between c. 5.0 and 6.5 which broadly speaking corresponds to the values of oligotrophic lakes (see e.g. SJÖRS 1946, MALMER 1961 and literature quoted there) and of water in moderately rich or moderately poor mires (WITTING 1947, 1948, 1949, SJÖRS op. c., 1948, 1952, MALMER op. c., 1962 a and b, 1965). The range of variation in pH during summer and early autumn in the different stands seems seldom to exceed 0.5 units. In spring, however, the values of pH may be a little higher.

In waters of about the same specific conductivity mentioned but where pH is lower, it is primarily the *Sphagna* which become succes-

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[1] See MALMER 1960.

sively more important and *Drepanocladus trichophyllus* and *D. exannulatus* var. *procerus* s. lat. less important. At pH less than c. 5.0. the latter mosses become rare or are completely missing, but e.g. *Sphagnum lindbergii* and *Drepanocladus schulzei* become frequent. In waters where the specific conductivity is higher, the opposite conditions prevail. *Spaghnum* species are accordingly missing, *Drepanocladus trichophyllus* and *D. exannulatus* var. *procerus* s. lat. are successively replaced by e.g. *Calliergon giganteum, C. trifarium, Drepanocladus revolvens* and *D. tundrae*. *Scorpidium scorpioides* is, however, the most prominent bryophyte of this richer, wetly growing vegetation, but it is also frequent in intermediate waters mentioned above. I have found neither *Drepanocladus trichophyllus* nor *D. exannulatus* var. *procerus* s. lat. in waters of a reduced conductivity exceeding c. 60.

Summary

A cultivation of mosses from spores of one specimen of *Drepanocladus trichophyllus* (Warnst.) Podp. is described. A great variation in the progeny is demonstrated. The length of the nerve, the denticulation and the angular cells of the leaves appeared to be primarily genetically determined, while e.g. the shape and proportions of the leaf were to a great extent influenced by environment. As to the length of the nerve and the denticulation a discontinuous variation appeared. With regard to these characters four different morphological categories are possible to distinguish in the progeny. Two of them resemble *Drepanocladus trichophyllus* and two resemble *Drepanocladus exannulatus* var. *purpurascens* (Schimp.) Herz.

The ecologic conditions of spontaneously growing *Drepanocladus trichophyllus* is also described. It grows in water poor in dissolved electrolytes, but where pH is relatively high. These conditions, including the level of water, vary only slightly during the vegetation period.

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BOTANISKA NOTISER 1966 · VOL. 119 · FASC. 3 · LUND

Vegetation and Microclimate along a Belt Transect from the Esker Knivsås

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Knivsås, an esker with a very sharp profile, is situated on the slopes of Romeleåsen between Dalby and Hällestad, 15 km east of Lund (Fig. 1). The direction of the ridge is WSW to ENE, sloping mostly to the south and to the north. The esker and its vegetation has been popularly discussed in an earlier paper (PÅHLSSON 1964).

During the last glacial age the esker probably was formed in a tunnel or fissure in the ice-sheet which was moving from the northeast over the poor areas of Linderödsåsen. Moraines and glacifluvial deposits were left on a bedrock of gneiss, laid bare in a nearby stone-pit. In the end stage an ice-stream moved up from the southeast through the Vomb-depression with richer moraines. Perhaps such material also was deposited in the area. Finally the ice disappeared, the walls of the gravel bed collapsed and a sharp ridge was left (ÅBERG 1958).

Today most of the esker is covered with beech forest, but the central part is open pasture with scattered juniper shrubs. This vegetation has existed for a very long time. As a borderland between three villages, there have been common pastures or "fäladsmarker" for at least 200 years, perhaps longer (Maps, Hällestad). A marked feature of "fäladsmarker" on poor ground in southern Sweden is the scattered junipers with grass and heather (SELANDER 1957). On Knivsås, however, this vegetation varies in an interesting manner. The southern slope is covered with herbs, often richly flowering, but the northern slope has a grass vegetation rich in mosses. In the present paper this differentiation of the vegetation will be demonstrated by means of a belt transect across the esker. Further, some important microclimatic habitat conditions will be discussed based on a series of measurements on the two slopes in the middle of June 1964.

Fig. 1. Knivsås, the open part of the esker. — Photo L. PÅHLSSON, Sept. 17. 1963.

Similar investigations have been carried out earlier, e.g., by S. DZIUBALTOWSKI (1923), W. LÜDI (1948), J. FABIJANOWSKI (1950), E. RAABE (1955), R. BORNKAMM (1958) and in Sweden by K. O. E. STENSTRÖM (HESSELMAN 1905) and E. STEEN (1957).

Vegetation

The vegetation has been studied by a belt transect straight across the ridge in the eastern part of the open pasture land. There the slopes of the esker are exposed to the south and the north, respectively. In this part the vegetation also is rather free from the influence of the junipers which are common especially on the northern slope.

The belt transect was made up of squares $^1/_2 \times 1$ m with 1 m in the transect direction. The degree of cover was estimated according to the Hult-Sernander-Du Rietz scale with 5 degrees (DU RIETZ 1921). The nomenclature of the vascular plants follows WEIMARCK (1963), that of the bryophytes NYHOLM (1954—65) and as to the lichens MAGNUSSON (1929). There have been some difficulties in determining the species. The grazing of cattle often leaves only fragments of plants and the tramping damages mosses and lichens.

Perhaps these conditions also cause some typical features of this vegetation. Very few species have an unbroken occurrence along the transect. Further, most of the species have a low degree of cover.

The differences in the vegetation on the slopes appear from the belt transect (Fig. 2). In the field layer there are some species growing only on the southern slope: *Viscaria vulgaris*, *Rumex tenuifolius*, *Hypericum, perforatum* and *Carex caryophyllea*. During the springtime and the early summer, especially on spots between the grasstufts, short-living

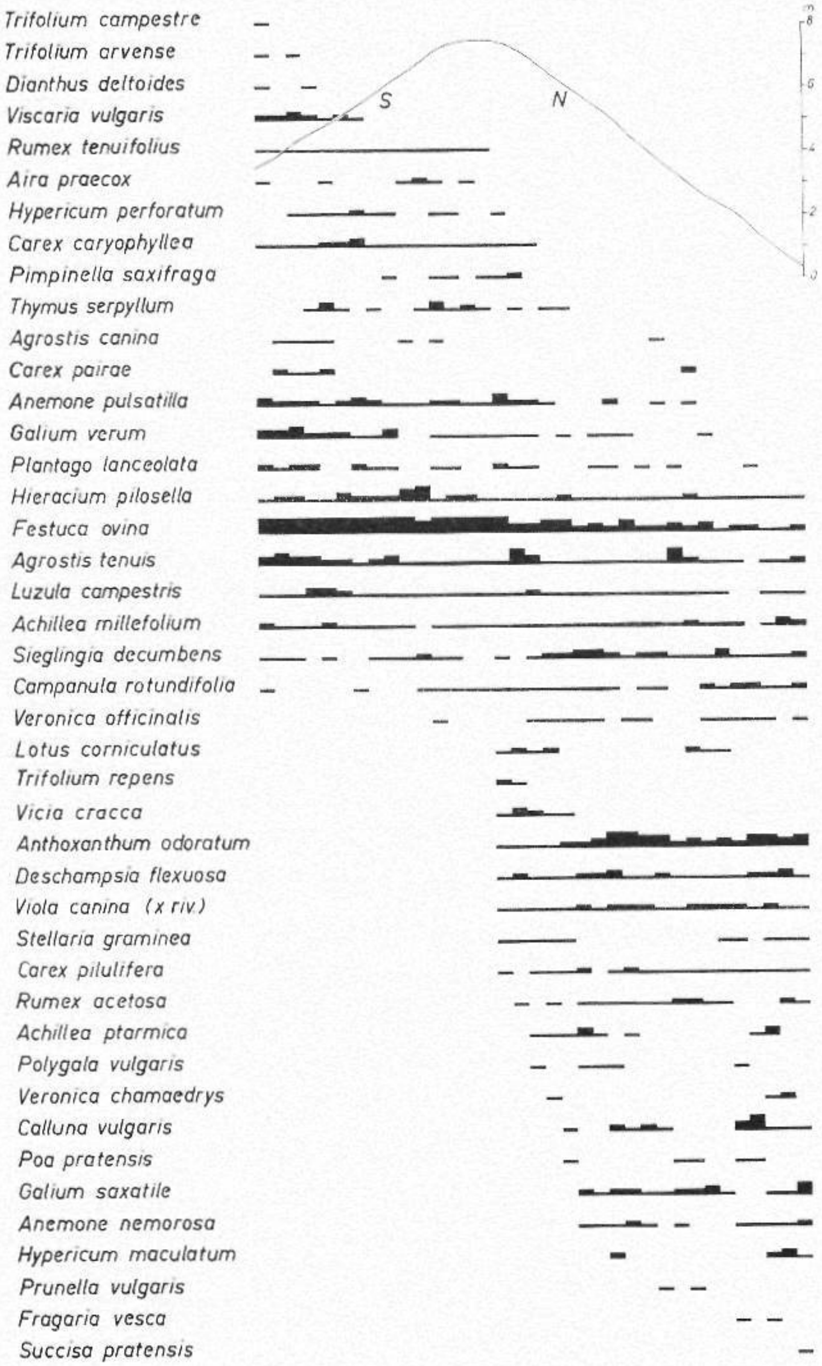
plants are numerous, e.g., *Cerastium semidecandrum, Erophila verna* and *Myosotis hispida.* Other species are present only on the northern slope: *Anthoxanthum odoratum, Deschampsia flexuosa, Carex pilulifera, Rumex acetosa, Galium saxatile, Anemone nemorosa* and *Calluna vulgaris. Anemone nemorosa* is a spring flower with a somewhat decreased degree of cover at the time of the investigation.

Some species are present on both slopes. Among these usually some prefer the southern, others the northern slope. Many dominating plants of the southern slope also can be found to a lesser extent on the opposite side of the esker. Such are *Festuca ovina, Anemone pulsatilla, Hieracium pilosella* and *Galium verum. Campanula rotundifolia* and *Sieglingia decumbens* seem to prefer the northern slope in the same manner.

Near the top *Trifolium repens* and *Vicia cracca* have special positions. In autumn *Gentianella baltica* also can be found in this part of the transect. *Pimpinella saxifraga* grows near the top with a tendency towards the south.

In the bottom layer the species are more specialized on one slope or the other. The mosses of the southern slope are low and scattered: *Brachythecium albicans, Rhodobryum roseum* and *Hypnum cupressiforme.* Lichens are common, e.g., *Cladonia rangiformis* and *Cladonia gracilis.* The latter is present also on the northern slope, but there the ground is covered by a thick carpet of mosses. Dominating are *Hylocomium splendens* and *Pleurozium schreberi* with an intermixture of *Polytrichum formosum* and *Rhytidiadelphus triquetrus. Dicranum scoparium* is as common on the southern as on the northern slope.

The presence and the degree of cover of some mosses vary on the


Trifolium campestre
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Viscaria vulgaris
Rumex tenuifolius
Aira praecox
Hypericum perforatum
Carex caryophyllea
Pimpinella saxifraga
Thymus serpyllum
Agrostis canina
Carex pairae
Anemone pulsatilla
Galium verum
Plantago lanceolata
Hieracium pilosella
Festuca ovina
Agrostis tenuis
Luzula campestris
Achillea millefolium
Sieglingia decumbens
Campanula rotundifolia
Veronica officinalis
Lotus corniculatus
Trifolium repens
Vicia cracca
Anthoxanthum odoratum
Deschampsia flexuosa
Viola canina (x riv.)
Stellaria graminea
Carex pilulifera
Rumex acetosa
Achillea ptarmica
Polygala vulgaris
Veronica chamaedrys
Calluna vulgaris
Poa pratensis
Galium saxatile
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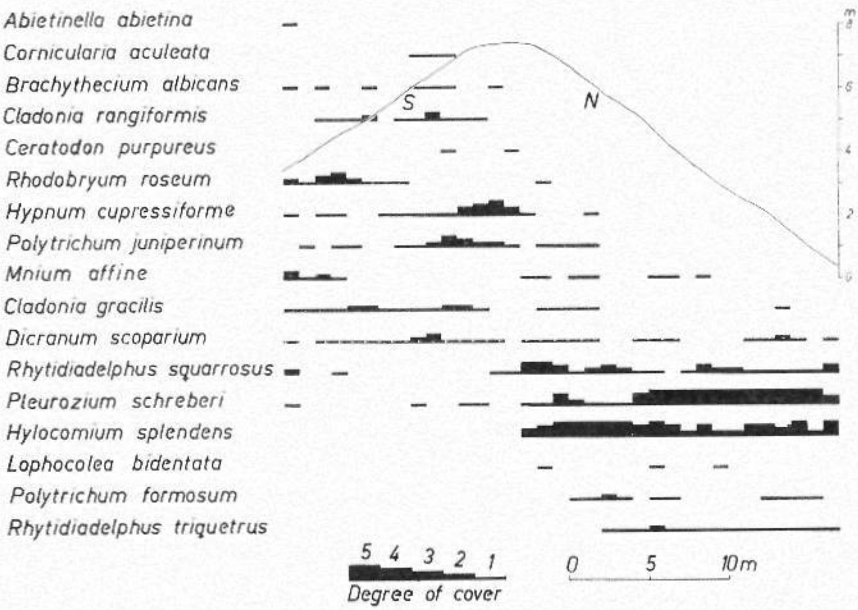

Fig. 2. Belt transect across the eastern part of Knivsås, July 30, 1964. Additional species present only in one or two squares with low degree of cover: The southern slope: *Arenaria serpyllifolia* (1,) *Cerastium holosteoides* (2), *Cerastium semidecandrum* (6), *Prunus spinosa* (3), *Cetraria islandica* (11, 12), *Cladonia rangiferina* (12) and *Peltigera canina* (5). Near the top: *Antennaria dioica* (17, 18), *Cirsium acaule* (16) and *Platanthera bifolia* (18). The northern slope: *Chrysanthemum leucanthemum* (31), *Cerastium holosteoides* (34), *Festuca rubra* (25, 28), *Gnaphalium sylvaticum* (26), *Juniperus communis* (25, 26), *Leontodon hispidus* (34), *Potentilla erecta* (25), *Quercus robur* (32), *Vaccinium myrtillus* (18) and *Atrichum undulatum* (22). (Numbers=squares from S to N.)

slopes. *Rhodobryum roseum* disappears at a high level, where *Hypnum cupressiforme* and *Polytrichum juniperinum* are frequent. On the northern slope *Hylocomium* and *Pleurozium* have a slightly different distribution. These differences are difficult to find in the field layer except for *Pimpinella saxifraga* which grows in the same areas as *Hypnum* and *Polytrichum*. The possible ecological background of these conditions will not be discussed here.

Microclimate

The microclimatic conditions of the slopes were investigated with two sets of instruments, one on each side of the esker. On the southern slope, site K 11, the instruments were mounted about 8 m from the top, and on the northern slope, site K 4, about 14 m, this difference depending on the shape of the esker and the vegetation conditions. The natural horizon of the two sites was as follows. (Numbers of degrees = approximate height of obstacles over the theoretical horizon at one meter above the ground.)

K 11: Direction SSE. Slope angle 23° (appr.).

N→E The esker and bushes of *Prunus* and *Fagus* (15°). (NNE small juniper 2 m from instruments.) E→S→SW Free horizon. SW→W Distant forest (2°). W Small beech (25°). W→N Scattered junipers and the esker (15°).

K 4: Direction NNW—N. Slope angle 29° (appr.).

N→NNE Free horizon. NNE→E Beech forest (8°). E Beech (20°). E→S The esker with junipers (15—20°). SE Higher bushes of beech and juniper (30°). S→W The esker and from SW also junipers (20°). W→N Free horizon.

The investigation was carried out from June 17, 9^{00} a.m. until June 18, 21^{00} p.m. 1964. Records were made every hour at the same time on the two slopes.

Instruments and Methods

Each measuring station (Fig. 3) was equipped with instruments furnishing different microclimatic data.

Light was measured with an "EEL Lightmaster Photometer" luxmeter. The sensitive part of selenium was formed as a plate with a handle connected by a wire to the indicating instrument. This had three measuring ranges 0—10/100/1000×100 lux. Further a neutral filter (about 10×) could be fitted to the selenium plate to extend the sensibility over 100 thousand lux. During the measuring this plate was held parallel to the ground surface. Both incoming and reflected light were recorded. The incoming light was measured just over the grazed vegetation and the reflected light at about 40 cm above the ground.

Wind. The Lambrecht propeller-anemometer no. 1400 was used to measure wind velocity. It gives accurate records between 0.3—20 m/sec and is calibrated by the manufacturer. The wind was measured at 50 cm over the ground for two minutes and then the average velocity has been calculated. However, the anemometer is constructed for measuring only straight against the wind direction. Especially when the wind direction was changing and had a low velocity, there was some difficulty in handling the instrument properly.

Temperatures at different levels over the ground were recorded with the aid of small resistance thermometers. They were manufactured by HAFO, Stockholm with the designation Pearl-thermistor, type N. Their resistance at

Fig. 3. Instruments at K 11 June 18, 1964. From left: EEL luxmeter, Lambrecht hygrometer, Lambrecht propeller-anemometer and thermistors mounted on a wooden stand. — Photo L. PÅHLSSON.

25 °C was about 4000 Ω and their diameter about 1 mm. The thermistors were soldered to double wires (TV aerial wire) with small contacts in the opposite ends. These were fitted into the indicating instrument, Normameter model 185 R 1, a Wheatstone bridge with six measuring ranges from 0.08 to 60 thousand Ω.

The thermistors were calibrated in air of different temperature. Stable conditions were attained in modern constant rooms. Calibration diagrams were constructed and the thermistors were checked according to an accurate mercury thermometer before use.

Temperature measurements are often attended with radiation errors. To eliminate these as much as possible the thermistors were protected with radiation shields, which on the outside were highly reflecting and on the inside black, the shape and size according to MATTSSON 1961, but modified. The small size of the thermistors also diminish radiation errors.

The thermistors with their radiation shields were mounted on a wooden stand at 5, 10, 25, 50 and 150 cm above the ground, two thermistors at each level. On the ground two thermistors were fixed and they were sheltered from direct sun radiation with reflecting aluminium sheets.

Soil temperatures were measured with some larger thermistors (HAFO, Type B 5). Their diameter was about 5 mm and they were protected against moisture with a thin layer of transparent cement ("RX-lim"). A small pit was dug and the thermistors, two at each level were fixed in the walls 3 and 25 cm below the surface. The pit was closed again and the vegetation on the surface was restored.

In testing both types of thermistors in constant temperatures before use errors depending on calibration and readings on the normameter were estimated to some tenths of a degree. Thermocouples with radiation shields of the same type as that of the N-thermistors have been tested (MATTSSON 1961). With intense radiation and some air movement the errors was about 1°C. The difference between two thermistors (both types) at the same level mostly was $< 0.5°C$ and rarely $>1°C$. Temperatures are given as the mean of the two thermistors.

Relative humidity was measured with a Lambrecht hair hygrometer no. 194. The Pernix-type was used giving better values at low humidity and at different temperatures, also low. One hygrometer was laid directly on the ground with the vegetation undisturbed around it. Another was mounted on a wooden pole at 50 cm above the ground. Before measuring they were wrapped in wet towels for about half an hour to be regenerated. Both were shielded with aluminium sheets from radiation.

Weather Conditions

Observations of the weather were made at every recording during the period. In the morning of June 17 the sun was shining, but before the investigation began it became cloudy and very soon it was raining. This rain continued until 15^{00} p.m. with a short cessation about noon. After 15^{00} p.m. the clouds broke up and at 18^{00} p.m. the weather was clear with sun. Then the whole night was clear, but before 3 o'clock in the morning of June 18, mist was formed near the ground and soon enveloped the esker. Three hours later the mist, which sometimes had been rather light, lifted and clouds at a higher level were formed. At 9^{00} o'clock the sky was nearly clear and then followed a clear warm summer day with small scattered clouds in a blue sky until the end of the investigation period at 21^{00} o'clock. However, a slight haze at a high level was observed from 17^{00} p.m. until 19^{00} p.m. Both days the sun rose at 03^{25} a.m. and set at 20^{52} p.m. (K. Vetenskapsakad. 1963).

A more complete picture of the weather can be obtained from the meteorological station at Bulltofta airport, Malmö, about 25 km from Knivsås. In some points there are small differences, but it is of interest to compare the observations from the esker with these from the airport:

Approximate values

Time	Wind direction	Wind velocity m/sec	Cloud covered part of the sky/8	Cloud types	Cloud height 100 m	Weather
17/6						
8—9	WSW	8—5.5	4—7	cumulus	5—9	clouds form
10—15	WSW	6—5.5 (11—12: 3.3)	8	strato-cumulus	9 and 14	rain
16—17	NNW	4	7—5	strato-cumulus	12	clouds dissipate
18—19	NNW	1.5	2	cumulus	9	± clear
20—22	—	0	6—3	cirrus	60	,,
18/6						
23—3	—	0	4—1	strato-cumulus	20	± clear
4—5	—	0	1	cirrus	60	± clear, mist is forming
6—8	—	0	7—4	strato-cumulus	12	(± clear), mist
2—16	mostly W (11: NNW)	3.5—1.5	3—1	cumulus	9—16	± clear
17—18	SW—S	3—2	3—2	cirrus	60	,,
19—22	SE	2	3	alto-cumulus	50	,,

Light Conditions

During the cloudy and rainy weather of June 17, no differences were observed in incoming light intensity between the slopes (Fig. 4). Quite different conditions set in during the clear weather of June 18. In the morning until 8^{00} a.m. light intensities were the same on the two slopes

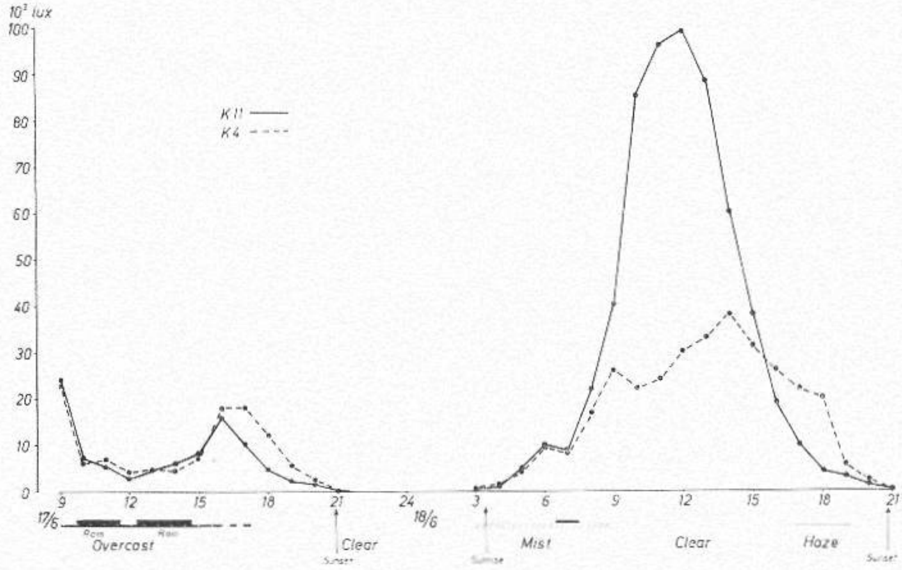

Fig. 4. The course of light intensities.

depending on the mist and the clouds. But then in few hours the light values of the southern slope, K 11, rose to more than 90 thousand lux. During the same period the northern slope, K 4, only showed about 30 thousand lux.

The sun rays strike the ground surface of the two slopes at different angles. On the southern slope they form a more of a right angle with the surface than on the northern where the rays almost sweep along the slope.

After 13^{00} p.m. the values of K 11 dropped rather quickly again and somewhere between 15^{00} and 16^{00} p.m. K 4 attained higher light values than K 11 and this lasted until sunset. The same relations were observed in the evening of the preceding day, when the clouds had disappeared. In the evening the sun rays got to the northern slope and left the southern. However, the light intensity of the evening sun was far below that of the noon and the values were rather small. Certainly the northern slope receives more light than the southern also in the morning. That time was disturbed by mist during the investigation period.

The reflected light gave rather low values compared with the incoming light. Highest value of K 11 was 4600 lux and of K 4 3000 lux.

If the incoming light intensities are interpreted as values of energy, the southern slope receives an excess of energy during clear days

(STRAHLER 1960). On this distribution of energy depend most of the ecological factors of importance for the differentiation of the vegetation on the esker. Most of the energy will be transformed into heat.

Temperature Conditions

Characteristic of the temperature distribution in the layers of air near the ground during a clear summer day are very high temperatures in the lowest layers which decrease with increasing height, the 'incoming radiation type' (GEIGER 1961). This type was most extremely developed during the investigation period at noon on June 18 (Fig. 5 C). When the temperature on the southern slope at 150 cm was 23.6°C, the temperature in low vegetation on the ground was 37.6°C. On the northern slope the air temperatures were some degrees lower. There the maximum occurred 5 cm above the ground depending on the thick moss carpet. The temperature at 0 cm was only 20.5°C. The soil temperatures at 3 cm showed the greatest difference, K 11 31.5°C and K 4 14.9°C. Lower, at 25 cm, the two slopes only differed some degrees.

With regard to the light measuring a temperature difference between the slopes could be expected. However, the temperatures of the air often are about the same at the two sites. The important feature of the temperature distribution is the great differences just at the ground surface and adjacent layers. These differences are enhanced by the vegetation of the northern slope, especially the moss carpet, which impedes the supply of energy to the ground surface.

June 17 the weather was mostly overcast. In rain the incoming radiation type was highly modified (Fig. 5 A). Almost the same temperature prevailed on the two slopes at all levels in the air. But in the soil K 11 had a heat reservoir from clear days (GEIGER 1961) about three degrees higher than K 4. After only a short interruption in the rain also the air temperatures were higher at K 11. The 'incoming radiation type' can be recognized too (Fig. 5 B). In the evening light intensities were higher on the northern slope. Also the air temperatures were more favourable for a short time (Fig. 5 D).

In the clear night only long-wave radiation occurs from the ground which together with the adjacent layers of air loses heat. The resulting temperature distribution is called 'outgoing radiation type'. At 2^{00} a.m. of June 18 this type occurred (Fig. 5 E). It is remarkable that K 11 had lower soil temperatures near the surface than K 4. Again the moss carpet impedes radiation, now with the reverse effect.

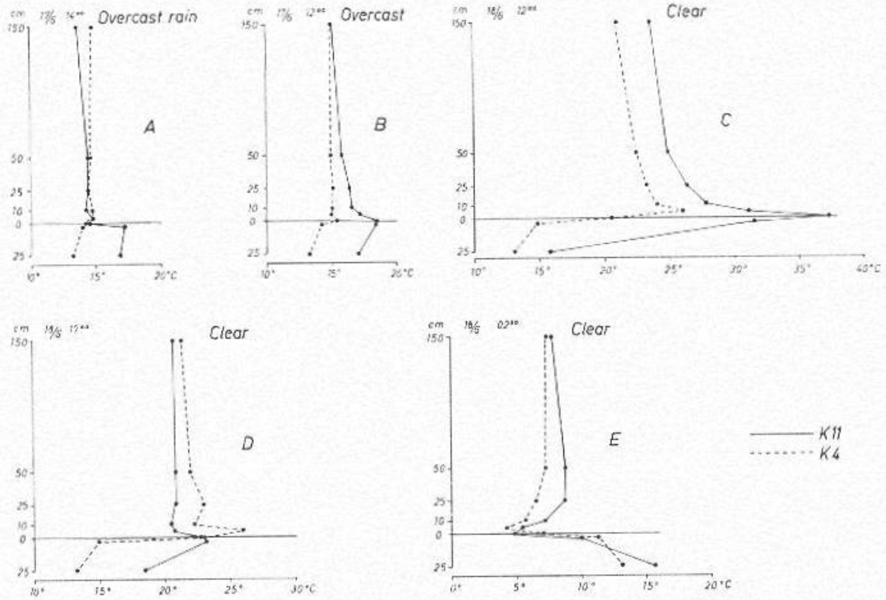

Fig. 5. Temperature distribution of the air and the soil at certain times during the investigation period.

To show the complete picture of the temperatures isoplete diagrams have been constructed with isotherms for every second degree (Fig. 6). During June 17 and the following night air temperatures were almost equal at K 11 and K 4. Yet the cool period in the night was longer at K 4. However, very near the ground and in the soil temperature differences were greater. When the rain stopped at 15^{00} the soil of K 11 rapidly increased its temperature, while almost nothing occurred at K 4. In the night the soil of K 4 was better isolated by the moss carpet than the rather naked soil surface of K 11. Isothermy prevailed in the morning of June 18 and then a clear day with hot temperatures at K 11 and cooler at K 4 followed. The soil temperature near the surface rose very quickly at K 11 to a high level, but it increased very slowly at K 4 to only a few degrees more than during the night. At K 4 at the 5 cm level above the ground two maxima occurred, one at noon and one in the late afternoon depending on the position of the sun mentioned above.

In the soil heat is transported almost entirely through molecular conductivity (GEIGER 1961). A certain amount of heat at the ground

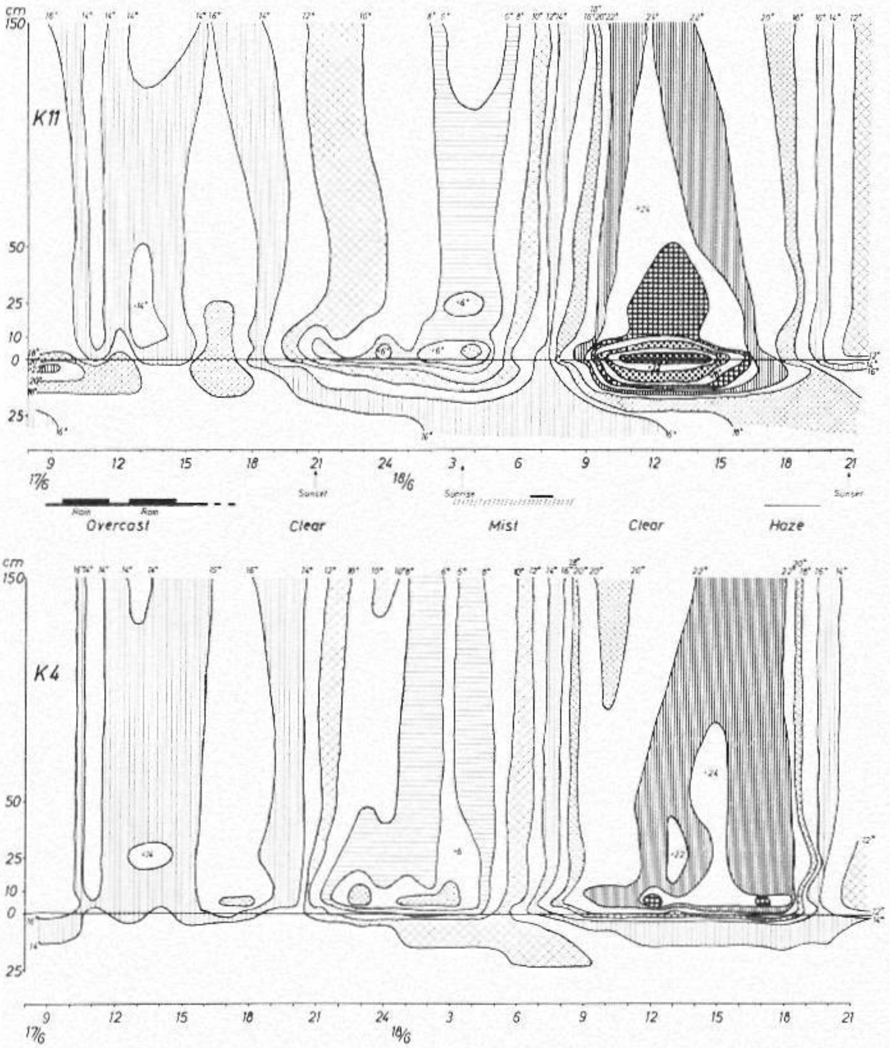

Fig. 6. The course of the temperature of the air and the soil.

surface is slowly transmitted to deeper levels. The isoplete diagram shows this delay, but it is more marked in the temperature course of the soil temperatures (Fig. 7). At the 3 cm level the maximum, obtained at noon of June 18 on the surface, occurred with a delay of one hour on the southern slope and of two hours on the northern. (The absolute maximum at K 4 was later in the evening at 18^{00} p.m.) The same figures

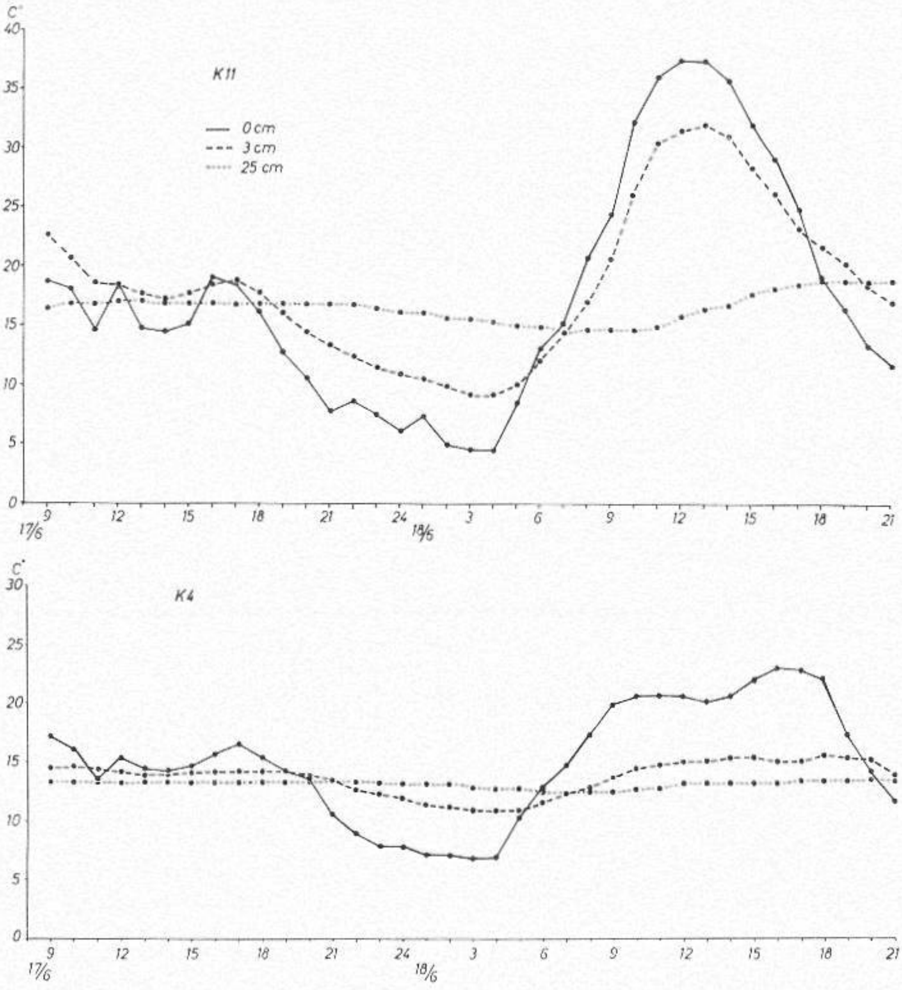

Fig. 7. The course of the temperature at the ground surface and in the soil.

at the 25 cm level were 6 and 8 hours respectively. Thus K 4 reaches its maxima later than K 11.

The temperature amplitude also decreases with the depth. But more important in this comparison of K 11 and K 4 is that the temperature amplitude at K 11 was much greater than that of K 4, especially near the surface. At K 11 the minimum temperature at 3 cm was 9.2°C and the maximum temperature 32.0°C. The corresponding figures of K 4 were 10.9°C and 15.2°C. With regard to this the soil climate of the

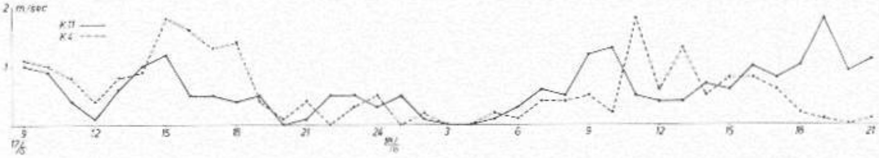

Fig. 8. The course of wind velocities.

southern slope can be characterized as microclimatically continental and that of the northern slope as maritime (STEEN 1957).

Wind Conditions

During the investigation period wind velocities were low, less than 2 m/sec. at 50 cm above the ground. This is of importance because windy weather greatly affects the temperature distribution near the ground. The characteristic features of incoming and outgoing radiation types disappear. Especially the night temperatures are sensible to the wind (MATTSSON 1961). It seems as if the wind had no or very little effect upon the temperatures during the period.

The observations at Bulltofta airport concerning wind directions and also wind velocities are well reproduced at Knivsås (Fig. 8). At noon, on June 17 there was a calm period followed by increasing wind and a change towards NW. Between 15^{00} p.m. and 18^{00} p.m. higher velocities were measured at K 4, while earlier in the day wind velocities had been almost the same on the two slopes with a westerly wind. At Bulltofta no wind was measured from 20^{00} p.m. until the morning of the following day. Yet light winds were measured over the slopes of Knivsås during the first part of the night. The wind direction at this time was from the top of the esker down along the slopes. Probably these winds were a flow of descending cold air (GEIGER 1961).

June 18 the wind was westerly and rather light. A sudden change towards NW at 11^{00} a.m. brought about increased velocity at K 4 and a more southerly wind in the evening gave higher values at K 11.

Humidity Conditions

The humidity conditions near the ground depend on the evaporation from the ground and the vegetation on it (GEIGER 1961). At each of the two sites, K 11 and K 4, one hygrometer measured the relative

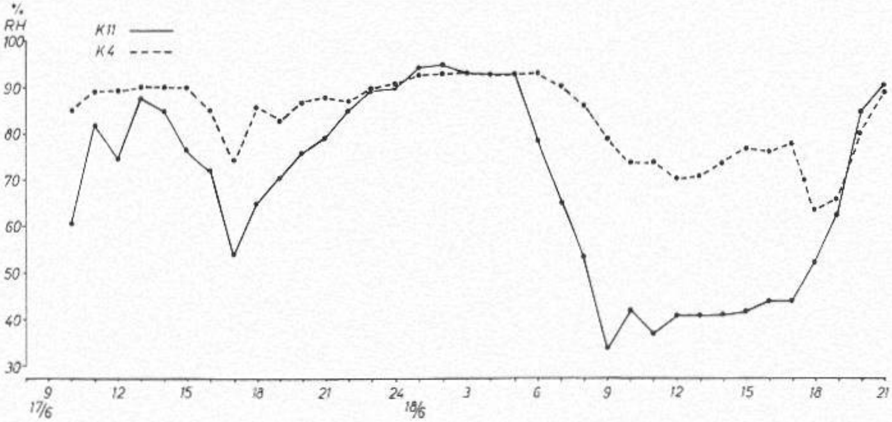

Fig. 9. The course of relative humidity at the ground.

humidity on the ground in the vegetation carpets and another hygrometer gave the values of the air at 50 cm above the vegetation (Figs. 9 and 10).

In rainy weather all the instruments showed high relative humidity. The short period of clear weather in the evening of June 17 was sufficient for drying. At K 4 the air had low humidity for a longer time than K 11, but the humidity in the vegetation remained high.

In the evening dew was formed and all the instruments showed maximum values. (The hair hygrometers had not the possibility of reaching the highest values of their scales. Probably many of the records during the night would have been 100 per cent.)

In the morning of June 18 the relative humidity decreased very rapidly and as early as 10^{00} o'clock all the hygrometers showed about 40 per cent, except the one which was placed on the ground at K 4. The moss carpet and the dense vegetation retarded drying there. Also the humidity of the air at 50 cm was somewhat lower at K 4. In the evening, when the sun had reached the northern slope, humidity decreased at K 4, but never to less than 64 per cent in the vegetation. When the investigation was completed at 21^{00} p.m., again all the hygrometers showed high relative humidity.

Conclusions

This microclimatological investigation for a short period, but one with changing weather conditions, shows that the difference in the vegeta-

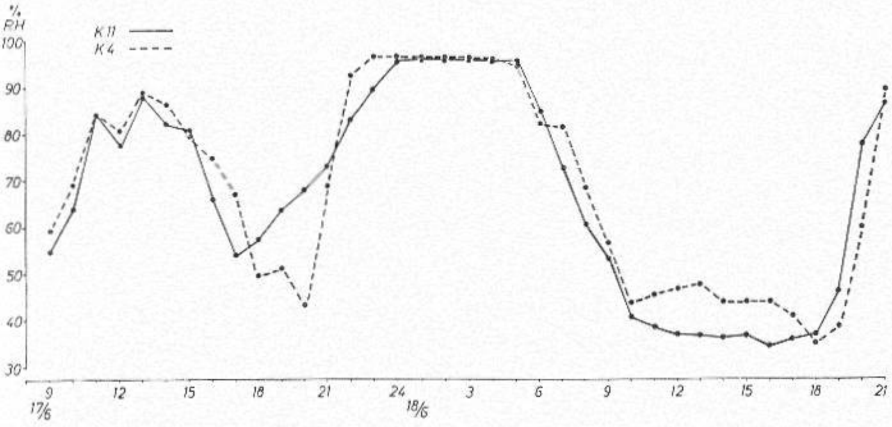

Fig. 10. The course of relative humidity at 50 cm above the ground.

tion of the southern and the northern slopes of Knivsås has an ecological correspondence. Later investigations also have confirmed the results of the measurements made in June 1964.

The different exposition of the slopes to sun rays results in different contributions of energy. This means on the southern slope higher temperatures producing a heat reservoir in the soil. In some respects this seems to be advantageous to the vegetation. Plants adapted to warmer and more continental climatic conditions are able to grow there. The vegetation period also is longer than on the northern slope. On the other hand, the vegetation on the southern slope is exposed to climatic extremes which are highly modified on the northern slope through the shelter of its vegetation. There some of the species also have a more maritime geographical distribution.

As an effect of these differences evaporation from the soil is greater on the southern slope. There the plants must endure drier conditions. This has been shown through investigations of the water content of the soil during two vegetation periods. Perhaps this also means that the leaching of the northern slope is stronger. Yet, until now very few indications of this have been shown on Knivsås. However, the differences in microclimate and, as a consequence thereof, differences in the water content of the soil are obvious. These ecological conditions must be of great importance for the formation of different vegetation types on the two slopes.

Acknowledgements

The present investigation has been carried out at the Department of Plant Ecology (head: Laborator NILS MALMER) of the University of Lund. For advice and help in furnishing me with instruments I am indebted to Fil. lic. JAN O. MATTSSON who also has critically discussed the results of the measurings. Docent ÅKE PERSSON has read the manuscript and given me valuable advice. The drawing of the diagrams has been carried out by Mrs. MIMMI VARGA. The investigation has been supported by grants from the Kungl. Fysiografiska Sällskapet, Lund, Kungl. Vetenskapsakademien, Stockholm and the University of Lund, for which I am sincerely grateful.

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BOTANISKA NOTISER 1966 · VOL. 119 · FASC. 3 · LUND

Måkläppens flora och vegetation

AV HENRIK JOHANSSON

L. Gråbrödersgatan 1 C, Lund

När LINNÉ besökte Falsterbo under sin skånska resa 1749 fanns inte Måkläppen utan bara Falsterbo rev om vilket han skriver: ». . . revet, som löper hela milen under vattnet uti sydost. Revet syntes här och där koxa utur vattnet. Förut har vuxit därpå mycken Zostera, och sjöfåglarne hava i otrolig myckenhet däruppå lagt sina ägg, men är nu mestadels bortskjöld av vattnet och vid blåsväder inunderas». Måkläppen växte upp ur havet igen och den förste som besökte ön i botaniskt syfte var ANDERS LIDBECK år 1794. Han uppger från ön: *Phragmites communis, Agropyron junceum, Elymus arenarius, Rumex maritimus, Atriplex littoralis, Suaeda maritima, Salsola kali, Honckenya peploides* och *Cakile maritima*. Enligt LIDBECK skulle *Elymus arenarius* ha invandrat omkring 1770 till den då vegetationsfria ön.

I PAUL ROSENIUS' fågelskildringar från ön omtalas också ett antal växter. GERTZ (1933) nämner från en av dessa *Phragmites communis, Ammophila arenaria, Elymus arenarius, Honckenya peploides, Cakile maritima, Lathyrus maritimus, Geranium molle, Viola tricolor, Galium verum* och *Artemisia maritima*. Från andra böcker och artiklar av ROSENIUS kan denna lista kompletteras med *Carex arenaria, Rumex acetosa, Sedum acre, Potentilla anserina* och *Vicia cracca*. ROSENIUS uppger vidare, att vid 1800-talets mitt *Rosa* sp. och *Sambucus nigra* funnits på ön med en buske vardera och att *Artemisia maritima* fanns där redan på 1860-talet. Däremot anser han *Phragmites* vara en nykomling från 1920-talet samt *Lathyrus maritimus, Galium verum, Viola tricolor* och *Geranium molle* vara sena invandrare men något tidigare än *Phragmites*. Av intresse är att kring sekelskiftet verkar *Vicia cracca* och *Artemisia maritima*, som nu båda är borta, ej ha varit ovanliga.

Den första fullständiga inventeringen av öns flora gjordes av OTTO

GERTZ 1930—32 under fyra besök på ön i slutet av månaderna maj, juni, september och oktober. NILS SYLVÉN gjorde en ny inventering 21/7 1959. Trots otjänlig väderlek blev artlistan imponerande. Genom vänligt tillmötesgående från professor SYLVÉN har listan ställts till mitt förfogande för denna uppsats.

Under 1965 gjorde undertecknad en ny inventering genom besök på ön 15/5, 10/6 och 10/9. I nedanstående artlista över de av GERTZ, SYLVÉN och mig funna växterna följer nomenklaturen WEIMARCK (1963). I 1965 års inventering förekommer en frekvensangivelse där a=allmän, ta=tämligen allmän, r=sällsynt och mr=mycket sällsynt d.v.s. högst några individ av arten. I övrigt anger + att arten funnits vid tillfället ifråga medan — betyder att den saknats.

Artlistan föranleder några korta kommentarer. År 1965 påträffade jag ej *Calamagrostis epigejos* utan enbart hybriden med *Ammophila arenaria*. 1959 var hybriden vanligare än förstnämnda föräldraart (SYLVÉN muntl. meddel.). *Agropyron junceum*×*repens* var 1965 mycket mera frekvent än *A. junceum*. När LIDBECK 1794 fann *A. junceum* på Makläppen var ön för övrigt den första växtplatsen i Sverige för arten. *Salix cinerea* förekom 1959 som en halvmeterhög buske (SYLVÉN skriftl. meddel.).

Förteckningen upptar för 1930—32 91 arter, medan artantalet 1959 och 1965 var 61 respektive 72. Sammanslås inventeringarna 1959 och 1965 uppnås 84 arter. Således har en obetydlig artminskning skett på ön. 33 arter från GERTZ' inventering har ej påträffats vare sig 1959 eller 1965 medan vid dessa båda senare 26 nya arter upptäckts på ön. Sammanlagda antalet arter angivna från ön sedan 1794 uppgår nu till 121. Dessutom har 2 hybrider antecknats från ön. Felbestämningar kan dock eventuellt föreligga hos GERTZ när det gäller de båda odlade *Hordeum*-arterna liksom i släktena *Schoenoplectus* och *Galeopsis*.

Stora förändringar har som synes skett i floran sedan GERTZ' inventering. Ön har även i övrigt ändrat utseende sedan dess, något som verkar ske kontinuerligt (GERTZ 1933 och BERGMAN 1960). Efter en yttillväxt 1925—56 verkar en minskning nu ske genom att havet tär på västsidan. En insjö fanns på 1930-talet liksom 1959 (GERTZ 1933, SYLVÉN muntl. meddel. och C. A. NILSSON fotografier) men var 1965 helt borta. Den snabba omdaning som ön är utsatt för, kan motivera en kortfattad skildring av vegetationen på ön 1965.

Från den centrala delen av ön utgår en revel i nordlig riktning, här kallad norra reveln, och en revel i sydlig riktning. Den senare böjer av åt öster och delar upp sig i två grenar, som båda i en vid båge böjer av åt norr. Denna revel kallas här östra reveln. Mellan den centrala delen av ön och den senare revelns norra gren instänges en mycket grund bukt i vilken en viss slamavsättning skett.

Den östra revelns södra gren saknar vegetation fransett enstaka exemplar av *Elymus arenarius* och *Salsola kali*. Den norra reveln och den norra grenen av den östra reveln uppvisar en ganska likartad vegetation. Ytterst på revlarna är den ganska gles men tätnar successivt mot ett i det närmaste slutet växttäcke. Längst ut på den norra reveln möter man kraftiga bestånd av *Atriplex*-arterna *calotheca, latifolia* och *littoralis*. Sedan följer en dynvegetation, där *Elymus arenarius* dominerar, medan *Ammophila arenaria* här utgör ett underordnat inslag. Mellan strandrågsruggarna är *Salsola kali* vanlig liksom den mattbildande *Agropyron junceum*×*repens*. Fortsätter man längs den norra reveln söderut tätnar vegetationen efterhand och bl.a. *Lathyrus maritimus* och *Sedum acre* tillkommer, den senare i mattor om ett par m^2.

Dynvegetationen fortsätter på den centrala delens västra sida i form av en dynbrant och enbart kring sjömärket är *Ammophila arenaria* dominerande i denna. Här fanns också 1965 öns enda förekomst av *Galium verum*.

Ytterst på den centrala delens östra strand förekommer ett bälte av *Phragmites communis*. Där innanför finns en zon, där *Agropyron repens* eller *Solanum dulcamara* dominerar. Denna zon kan också saknas, varvid *Atriplex littoralis*-zonen följer direkt på bladvassbältet. Sedan förekommer på ett ganska stort område *Lepidium latifolium*. Där uppträder också bestånd av *Descurainia sophia, Hordeum murinum, Urtica dioica* och *Solanum dulcamara*. Fortsätter vi zoneringen inåt land möter man den forna sjöbottnen, där *Agropyron repens*, fransett *Atriplex littoralis*, är praktiskt taget allenarådande. Kvickroten uppträder här i en upprätt och en nedliggande form.

Utanför bladvassbältet förekommer i buktens norra del en svagt koloniserad strandängsvegetation, där *Puccinellia retroflexa* och *Spergularia marginata* dominerar. I denna ingår också *Scirpus maritimus* och *Aster tripolium*. Utmed buktens södra sida utanför den östra revelns norra gren är strandängsvegetationen nästan sluten. Här dominerar *Puccinellia retroflexa* och *Spergularia marina*. Vanliga växter är här också *Chenopodium glaucum, Tripleurospermum maritimum* och *Aster tripolium*.

Längst in i bukten finns en liten ö där ytterst på östsidan *Glaux maritima* dominerar. Sedan följer en zon av *Scirpus maritimus*. Förhärskande arter i nämnda lilla ös vegetation i övrigt är *Lepidium latifolium*, *Potentilla anserina, Tripleurospermum maritimum* och *Rumex crispus.* Denna ö var 1965 Måkläppens enda växtplats för — förutom *Glaux maritima* — *Juncus ranarius* och *Eleocharis uniglumis.*

På själva Måkläppens revel intill den nyss nämnda lilla ön uppträder i bukten ytterst en zon av *Atriplex littoralis* följd av en *Tripleurospermum maritimum*-zon utanför själva dynerna med *Elymus arenarius.*

Utom floran måste också vegetationen på Måkläppen ha förändrats avsevärt sedan Gertz' inventering. *Lepidium latifolium, Solanum dulcamara* och *Descurainia sophia,* som nu ej är ovanliga i den centrala delens vegetation, saknades då. Ej heller fanns då *Atriplex calotheca,* som 1965 var ganska vanlig i *Atriplex*-bestånden och *Sedum acre* som uppträdde mattbildande (fanns där dock kring sekelskiftet). Likaså saknades då de i strandängsvegetationen vanliga arterna *Aster tripolium, Spergularia marina* och *marginata.* Sannolikt kommer förändringar i vegetationen att ske också i framtiden. Vid fortsatt slamavsättning i bukten kommer strandängsvegetationen att sluta sig. Detta har redan mer eller mindre skett i buktens södra del. Samhället här liknar mest Dahlbecks (1945) *Puccinellia retroflexa*-variant av *Spergularia salina* — Isozionen men kommer enligt samma källa att utvecklas mot *Scripus maritimus*- och *Aster tripolium*-samhällen vid betesfred eller ett *Atriplex*-samhälle vid stark tångavlagring.

Sammanfattningsvis kan konstateras, att Måkläppens flora sedan 1930-talets början förlorat en tredjedel av sitt artbestånd. Denna förlust uppvägs dock av ett nästan lika stort tillskott av arter. Flera av dessa är nu typiska inslag i vegetationen.

Orsakerna till denna förändring är kanske svåra att fastställa. Bidragande orsaker kan dock ha varit att Måkläppen såväl till utseende som fågelfauna ändrats starkt (Bergman 1960). Gråtruten har sålunda efter Gertz' inventering ersatt skrattmåsen och nått ett lika stort parantal. Att anställa jämförelser med förändringarna i floran på Gräsholmen utanför Bornholm (Hansen, Larsen & Pedersen 1965) visar sig svårt, då vegetationen på denna klippö verkar vara annorlunda. Detsamma är fallet med Dynan utanför Klagshamn. Sistnämnda ö, som varit föremål för ny inventering 1965, har i huvudsak strandängsvegetation (J. Ericson muntl. meddel.).

Artlista

	1930—32	1959	1965
Zostera marina	+	+	ta
Iris sp.	+	—	—

	1930—32	1959	1965
Juncus Gerardii	+	—	mr
— *bufonius*	+	+	—
— *ranarius*	—	—	mr
Phragmites communis	+	+	ta
Festuca rubra	+	+	ta
— *arenaria*	+	+	—
— *arundinacea*	+	—	—
Lolium perenne	+	—	ta
Poa annua	+	—	ta
— *trivialis*	+	—	—
— *pratensis*	+	+	ta
Puccinellia retroflexa	+	+	ta
— *maritima*	+	—	—
Dactylis glomerata	+	—	r
Avena sativa	+	—	mr
Holcus lanatus	+	+	—
Ammophila arenaria	+	+	a
— — ×*Calamagrostis epigejos*	+	+	r
Calamagrostis epigejos	+	+	—
Agrostis stolonifera	+	+	ta
— *tenuis*	—	+	—
Bromus hordeaceus	—	—	mr
Triticum aestivum	+	—	—
Agropyron repens	+	+	a
— *junceum*	+	+	r
— — ×*repens*	—	+	ta
Elymus arenarius	+	+	a
Hordeum vulgare	+	—	—
— *distichon*	—	+	mr
— *murinum*	—	—	r
Scirpus maritimus	+	+	ta
Schoenoplectus lacustris	+	—	—
— *Tabernaemontani*	—	+	—
Eleocharis uniglumis	+	—	r
Carex arenaria	+	+	r
Salix cinerea	—	+	—
Urtica dioica	+	—	r
Rumex tenuifolius	—	—	mr
— *acetosella*	+	—	mr
— *crispus*	+	+	a
Polygonum aviculare	+	+	a
— *lapathifolium* ssp. *lapathifolium*	+	+	—
— — ssp. *pallidum*	+	—	—
Chenopodium rubrum	—	+	—
— *glaucum*	+	+	ta
— *album*	+	+	ta
Atriplex latifolia	+	+	ta

	1930—32	1959	1965
Atriplex littoralis	+	+	a
— *calotheca*	—	—	ta
Salsola kali	+	+	a
Stellaria media	+	+	a
— *apetala*	+	+	r
Cerastium holosteoides	+	+	ta
— *glutinosum*	—	—	mr
Sagina procumbens	+	—	—
Honckenya peploides	+	+	a
Arenaria serpyllifolia	+	—	—
Spergula arvensis	+	+	ta
Spergularia marina	—	+	ta
— *marginata*	—	—	ta
Scleranthus annuus	+	—	—
Ranunculus sceleratus	+	—	—
— *repens*	+	—	—
— *flammula*	+	—	—
Papaver dubium	+	+	mr
Sinapis arvensis	+	—	—
Cakile maritima	+	+	a
Lepidium latifolium	—	+	ta
Capsella bursa pastoris	+	+	a
Cochlearia officinalis	+	+	r
Erophila verna	—	—	ta
Arabis thaliana	+	—	—
Descurainia sophia	—	+	ta
Sedum acre	—	+	a
Potentilla reptans	+	—	—
— *anserina*	+	+	ta
Trifolium repens	+	—	ta
Lotus corniculatus	+	—	—
Vicia hirsuta	+	—	—
— *cracca*	+	—	—
Lathyrus maritimus	+	+	ta
Geranium molle	+	+	ta
Viola tricolor	+	—	—
— *arvensis*	+	—	—
Chamaenerion angustifolium	+	+	—
Glaux maritima	—	+	r
Myosotis arvensis	+	—	—
Galeopsis bifida	—	+	mr
— *tetrahit*	+	—	—
Lamium amplexicaule	+	—	—
Stachys arvensis	+	—	—
Solanum dulcamara	—	+	ta
— *lycopersicum*	+	—	—
Linaria vulgaris	—	—	r

	1930—32	1959	1965
Veronica hederifolia	—	—	r
Plantago major	+	+	r
— *maritima*	+	+	mr
— *coronopus*	+	—	—
Galium uliginosum	+	—	—
— *verum*	+	+	r
— *aparine*	+	+	r
Sambucus nigra	+	—	—
Aster tripolium	—	+	ta
Gnaphalium uliginosum	+	—	—
Achillea millefolium	+	+	—
Tripleurospermum maritimum	+	+	a
— *inodorum*	+	—	—
Matricaria matricarioides	+	—	—
Artemisia campestris	+	—	r
— *vulgaris*	—	—	r
Senecio vulgaris	+	—	ta
— *viscosus*	+	—	—
Carduus acanthoides	—	+	r
Cirsium arvense	+	+	mr
Taraxacum sp.	+	+	ta
Sonchus arvensis	+	+	mr
— *asper*	—	—	mr
Hieracium umbellatum	+	+	—

Dessutom har Gertz och Sylvén antecknat följande varieteter och former:

	1930—32	1959
Lolium perenne f. *aristatum*	+	—
Agrostis stolonifera v. *maritima*	—	+
Agropyron repens f. *litoreum*	+	+
Chenopodium album v. *viridescens*	—	+
Atriplex littoralis v. *serratum*	+	+
Galium verum v. *litorale*	+	+
Cirsium arvense f. *ferox*	+	+

Summary

Måkläppen is a small island outside Falsterbo in southernmost Sweden. The flora of vascular plants was investigated by Otto Gertz in 1930—32. New investigations were made by Nils Sylvén in 1959 and the author in 1965. At the end of the paper a list is given from these three investigations. Since 1794 121 spp. have been reported from the island. Most of the island is covered by sand dune vegetation. Where the drift from the sea remains *Atriplex* spp. are common. Along the shore of a cove on the east coast salt marsh is found.

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BOTANISKA NOTISER 1966 · VOL. 119 · FASC. 3 · LUND

Cytotaxonomical Studies in Some Draba Species

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Introduction

The present account deals with the species *Draba nivalis* Liljebl., *D. fladnizensis* Wulf., *D. lactea* Adams, and, to a certain extent, with *D. norvegica* Gunn. It is based on personal observations from the central mountains of S. Norway, on observations communicated by Cand. Mag. TORSTEIN ENGELSKJÖN from a number of localities in Nordland and Troms, N. Norway, and on herbarium material borrowed from the Botanical Museums of the Universities in Bergen, Lund and Oslo, Naturhistoriska Riksmuseet, Stockholm, Tromsö Museum, and Det Kgl. Norske Videnskabers Selskab, Trondheim.

The aim of the present account has been to contribute to our knowledge of the above-mentioned species by cytological, ecological and morphological studies of Scandinavian material. New localities have been discovered since ELISABETH EKMAN (1926) and HULTÉN (1950) worked out maps showing the distribution of the species in Scandinavia. New distribution maps have, therefore, been worked out, of *D. nivalis* only for S. Scandinavia, partly after LID (in LAGERBERG et al. 1955, fig. 456, and 1959); of *D. fladnizensis* and *D. lactea* also from N. Scandinavia. Records of localities, on which the distribution maps have been based, are on file in the Botanical Museum of the University of Oslo. They include only localities of revised herbarium material. The material of the Institute of Systematic Botany of the University of Uppsala is revised by Mr. JAN BORG.

Chromosome Numbers

Material for cytological examination has been provided partly in the field, partly in garden cultures. There are considerable technical difficulties in determining chromosome numbers accurately, especially in the highly polyploid species. Meiosis is influenced by temperature, making flower buds of no use unless fixed in cool weather or early in the morning. The mitotic chromosomes tend to stick together. La Cour's chromic-osmium tetroxide fixative has given the best results in sectioned material, glacial acetic alcohol in squash preparations.

In all species the chromosomes, although varying somewhat in size, are rather small, isobrachial, and of the type generally found in the *Cruciferae*. The chromosome numbers in *Draba* form a polyploid series with basic number x=8 ranging from the diploid 2n=16 to high polyploid 2n=80—128. As yet, intraspecific polyploidy has not been demonstrated in the species under consideration.

Draba nivalis Liljebl. n=8. S. Norway, Lom, Höyrokampen, at 1440 m a.s.l. This number is previously found in plants from Torne Lappmark, Sweden (HEILBORN 1927), Clavering Island, NE. Greenland (JÖRGENSEN, SÖRENSEN & WESTERGAARD 1958), and from Alberta, Canadian Rocky Mts. (PACKER, in LÖVE & LÖVE 1961). *D. nivalis* seems to be a diploid species, uniform throughout its circumpolar range.

D. fladnizensis Wulf. n=8. S. Norway, Oppdal, Knutshö, at 1000 m a.s.l. — N. Norway, Troms, Överbygd, Bajit Riidagierdo, at 950 m a.s.l. This number is previously recorded from S. Norway, Oppdal, Kongsvoll (HEILBORN 1927), N. Iceland (LÖVE & LÖVE 1956), and NE. Greenland, Clavering Island (JÖRGENSEN, SÖRENSEN & WESTERGAARD 1958). The same number is known also in its Central European area, viz. from the Lechtaler Alps, Feuerspitze (MERXMÜLLER & BUTTLER 1964). Judged from its morphological uniformity it is probably an invariably diploid species.

D. lactea Adams. n=24. S. Norway, Oppdal, Storlidal west of Björnbekken (Skrufluren), at 1200 m a.s.l. — In material from N. Norway, Troms, Överbygd, Bajit Riidagierdo, at 1150 m a.s.l. the number could be estimated to n=ca. 24. Previously, this number has been recorded from NE. Greenland, Clavering Island (JÖRGENSEN, SÖRENSEN & WESTERGAARD 1958). From the few available data *D. lactea* seems to be hexaploid within its circumpolar area.

D. norvegica Gunn. n=24. N. Norway, Finnmark, Habavuoppebakte at Masi. HEILBORN (1927) reports this number in material from Greenland, and also (cf. EKMAN 1941) from S. Norway, Hardangervidda, Kisteskardnut. FLOVIK (1940) found it in material from W. Spitsbergen. This variable species does not seem to vary in chromosome number, being hexaploid within the whole of its range.

Morphological Variation and Distribution

EKMAN (1917, 1926) discusses extensively the morphological variation in *D. nivalis, D. fladnizensis,* and *D. lactea* (syn. *D. wahlenbergii* Hartm. f. *heterotricha* Horn.). Later (1932 b, 1933) she treats these species in Greenland, and finally (1941) the variable *D. norvegica* (syn. *D. rupestris* R. Br.) based on data from a large cultivated collection.

All *Draba* species are separated on quantitative characters showing great modifiability in different environments: size and outline of leaves and silicles, length of stems and pedicels, density of hair covering. Specimens from moist localities especially are often more or less glabrous (see fig. 2 c).

The hair type is a more reliable diagnostic characteristic distinguishing the species. Simple hairs, and the occurrence of a few bifurcate ones, are typical of *D. fladnizensis.* WEINGERL (1923) distinguished between the fine stellulate hairs of *D. nivalis* and the coarser stellate hairs found in *D. lactea* and *D. norvegica.* SCHULZ' (1927) monograph of the genus *Draba,* includes detailed diagnoses of the species, and surveys of their geographical distribution. The many varieties and forms, described and named (cp. EKMAN 1926 and SCHULZ op. cit.) give a clear picture of the great variability of the species. The characteristics on which we have chiefly based our herbarium revisions are summarized in the following.

Draba nivalis Liljebl. Plate I: 14—16, fig. 2 b. — EKMAN 1926, Plate 2. Leaves, stems and pedicels densely stellulate. Rosette leaves oblanceolate—lingulate, obtuse. Stems nude or unifoliate. Racemes usually elongated at fruit ripening, with glabrous, narrowly elliptic silicles, longer than the pedicels. Petals about 2.5 mm long.

D. nivalis is a well defined, arctic circumpolar species. It is weakly bicentric in Scandinavia (cp. HULTÉN 1950 and LAGERBERG et al. 1955 p. 198). In S. Norway (fig. 1) it has a distinct subcentre in Hardangervidda (LID 1959). Farther north, in the Jotunheimen—Vågå Mts. it has a density of localities, with a few isolated stations to the south, north and northwest. According to the collections in Herb. Oslo the northwesternmost stations in coastal direction are: Norddal, Daurmålshaugen at Rendalsvann in Tafjord (O. DAHL 1893) and northwest of Grönvatn, 1450 m above sea level (S. LÖKKEN 1963) and Lesja, Grönhö vis à vis Fallet at Kjölen (R. NORDHAGEN 1952) and Lesjaverk, Svartdal north of Valåvatn (R. NORDHAGEN & R. BERG 1957).

To the northeast, in the Dovre—Folldal Mts. it has scattered occur-

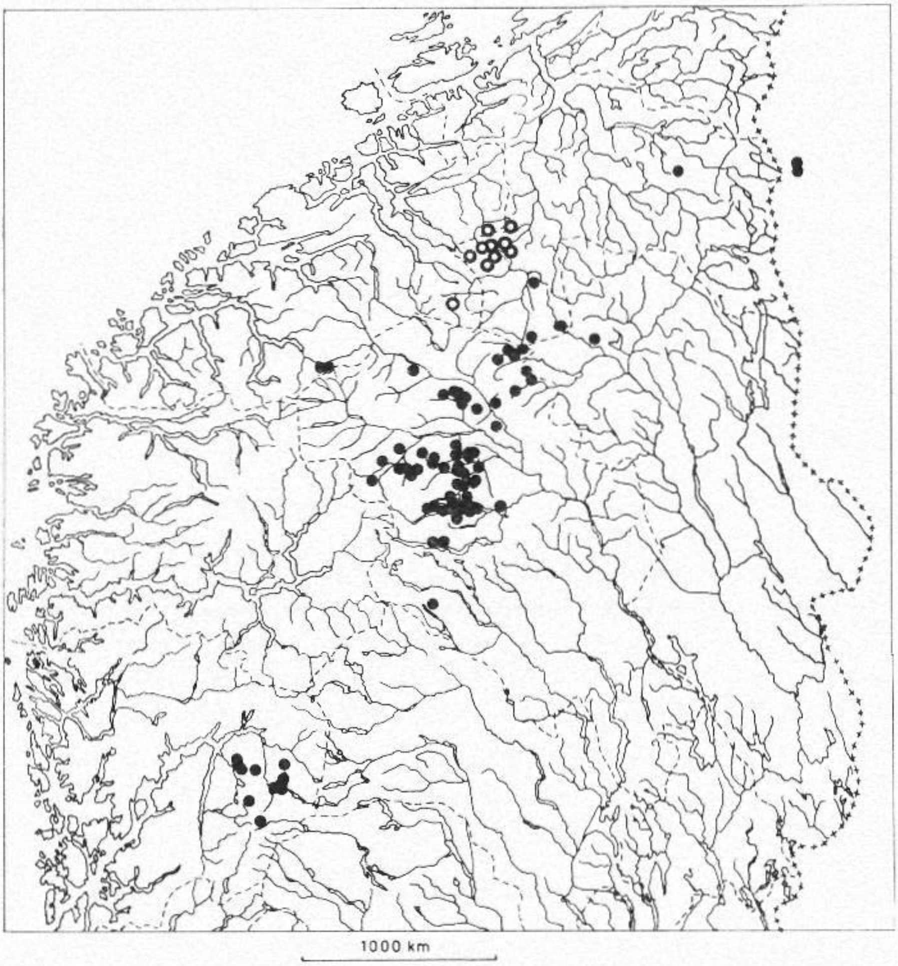

Fig. 1. Distribution in S. Norway and adjacent parts of Sweden of *Draba lactea* (○) and *Draba nivalis* (●).

rences, northwards to Veslkolla, 1320 m above sea level and the 1318 m top of Veslelgsjötangen (G. KNABEN 1964, 1966, Herb. Oslo). The northernmost locality in this area is probably Sisselhö in Oppdal. There are no herbarium specimens available of pure *D. nivalis* from this mountain. There are, however, specimens of *D. fladnizensis* × *nivalis* (J. LID 1946, Herb. Oslo), which indicate that the contingent parent species grow there. The northernmost locality of *D. nivalis* in S. Norway is Haltdalen, south of Bringen, 810 m above sea level (T. OUREN 1965, Herb. Trondheim). — In N. Scandinavia it is distributed from south of the Arctic Circle (Lycksele Lappmark and Helgeland) to E. Finnmark.

Draba fladnizensis Wulf. Plate 1: 8—12. Fig. 4 b. — EKMAN 1926, Plate 2. Rosette leaves narrow oblong-oblanceolate, acute or rather obtuse. Leaves prominently ciliate, laminas glabrous or with scattered simple and a few bifurcate hairs, especially on the ventral side of young leaves. N. Scandinavian plants, particularly, often glabrescent, with a few simple hairs at the leaf apices. Stems gracile, most often uni- or bifoliate, like pedicels and silicles completely glabrous. Silicles 6—10 or more, somewhat variable in shape: elliptic or ovate, longer than the pedicels, at ripening usually brownish violet with a metallic luster. Style not so conspicuous as in *D. lactea,* of the same breadth as the stigma. Petals 2—3 mm long. Raceme elongated at fruit ripening.

D. fladnizensis is an arctic-alpine species. It has been given as circumpolar. However, the distribution in arctic areas is obscure owing to confusion with *D. lactea,* cp. GJÆREVOLL (in GJÆREVOLL & SÖRENSEN 1954).

In Scandinavia *D. fladnizensis* is distinctly bicentric (fig. 3). Since EKMAN (1926, p. 51) worked out its distribution, it has been discovered in several new localities. In S. Norway it has a centre in the Jotunheimen Mts. north and east to Lesja and N. Fron. To the south there are a few isolated stations in Valdres, Inner Sogn on the phyllites in Lærdal and Aurland (R. NORDHAGEN 1929, 1943, 1944, Herb. Bergen), and Finse-Upper Hallingdal. Its southernmost isolated occurrence is in the south slope of Mt. Hårteigen on Hardangervidda (G. KNABEN 1943, Herb. Bergen). North of Jotunheimen it occurs continuously in the schist area of the Folldal—Dovre—Trollheimen and Sunndalen Mts., westwards to Torsvatn in Skjåk (S. LÖKKEN 1963, Herb. Oslo), northwards to the Soknedal—Budal—Kvikne Mts. (see map in GJÆREVOLL & SÖRENSEN 1954).

Its range in N. Scandinavia has been displaced northwards both with regard to the southern and northern boundaries. The southernmost stations of true *D. fladnizensis* in Nordland are: Tysfjord: Noraldagvarre N. of Hellemofjord (S. SIVERTSEN 1964, Herb. Tromsö); Fjelldalen S. of Ridtaborre (O. SKIFTE & S. SIVERTSEN 1955, Herb. Tromsö).[1] Then

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[1] In August 1966 it was found 30 km farther to the south, at Sildhopfjell in Nordfold, by T. ENGELSKJÖN, O. SKIFTE, and H. SÆTRA. This locality is not marked on the map, fig. 3.

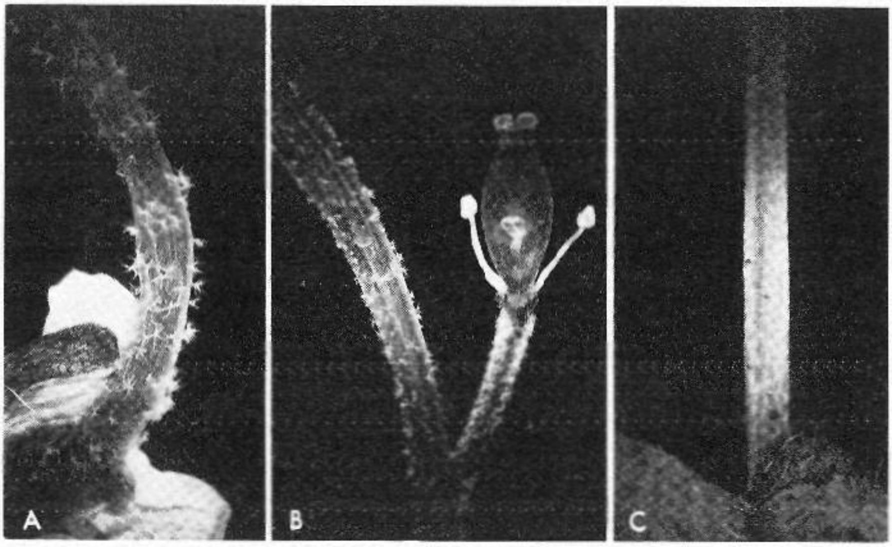


Fig. 2. Pubescence of stems in a) *Draba lactea*, frequent type with coarse stellate hairs. Troms: Bajit Riidagierdo. b) *D. nivalis*, normal type with stellulate hairs. Troms: Bægasangaissa. c) *D. norvegica*, type with entirely glabrous stem and glabrescent rosette leaves. Troms: Flöyfjell. 6×.

it is dispersed throughout Torne Lappmark and Inner Troms northwards to Kåfjord in W. Finnmark, and isolated in E. Finnmark: Lebesby, Erikoaivve, on dolomite gravel (L. R. RYVARDEN 1965, Herb. Tromsö).

D. fladnizensis×*nivalis* (*D. curtisiliqua* Zett.). Plate I: 13. — EKMAN 1926, Plate 2. Leaves oblanceolate, obtuse, stellate on both sides, densest on the ventral side, and with long, irregularly furcate hairs along the margin. Stems erect, gracile, stellate in the lower half. Silicles 2—4 mm long, with prominent style, always aborted.

Occurs frequently as richly flowering, branched clones among the contingent parent species.

As stellate hairs are absent in *D. fladnizensis*, one would expect the hybrid *D. fladnizensis*×*nivalis* to have the same kind of stellulate hairs as found in *D. nivalis*, but they are usually somewhat coarser, and with longer branches. HEILBORN (1927) has found the chromosome number 2n=16, supporting the assumption of its hybrid origin. The genetics of the various types of hairs in the genus must be complex. Unfortunately, it seems impossible to raise F_2 generations of this hybrid, the specimens being seed-sterile. ZETTERSTEDT (see BLYTT 1876) found no seeds developed in 100 investigated specimens. In Greenland it is also sterile (JÖRGENSEN, SÖRENSEN & WESTERGAARD 1958).

D. lactea Adams. Plate I: 1—6. Figs. 2 a, 4 a. — Ekman 1926. Plate 2. Rosette leaves elliptic-linear, acute-attenuate, entire or with a couple of teeth, ciliate along the margins of long simple hairs. Laminas with furcate and coarse stellate hairs concentrated on the ventral side of the apical part, dorsal side usually glabrous. Stems nude, seldom unifoliate, glabrous or with stellate hairs restricted to the basal parts, sometimes extending to below the raceme. Pedicels and silicles glabrous. Petals 3—4.5 mm long. Silicles 4—10, coarse, narrow ovate, in a short corymboid raceme. Generally it is shorter than in *D. fladnizensis* and *D. norvegica,* though in some specimens it can reach a length of 6 cm. Style short (0.5 mm), conspicuous.

D. lactea has a characteristic habit of growth. Especially those specimens growing in deep moss carpets develop a number of rosettes clustered together in flattened tufts, caused by the repeated dichotomous branching of the subterraneous stems (fig. 4 a). These branches are covered by leaf remains consisting mainly of the sharply pointed and lignified mid-nerves. In this respect *D. lactea* differs from *D. fladnizensis* and *D. norvegica,* which are more irregularly branched, the rosettes more fortuitously clustered.

ADAMS' original description does not mention the occurrence of stellate hairs either on the rosette leaves or on the stems. From ADAMS' Latin diagnosis the following is cited: "Folia erecta laxa lineari-lanceolata acuta utrinque attenuata, integerrima, supra fere glabra, subtus et ad marginem pilis simplicibus hispida . .", and "Scapi numerosi ex eodem caespite, digitales erecte glaberrime, terminati corymbo racemosa abbreviato 5—10-floro glabro".

ADAMS' type locality is the shore of the Arctic Sea at the mouth of the river Lena. According to EKMAN (1932 b) there are authentic specimens of *D. lactea* from the Arctic coast of Siberia in the Herbarium De Candolle in Geneva, with stellate hairs on the laminas. Of more interest are the two specimens in Herbarium Moscow collected by ADAMS at the river Lena and labelled "*Draba lactea* mihi. Vid. Mém. Mosq. Tom V. num 12". According to NASAROV (1923—24, p. 342) these two specimens belong to ADAM' original collections from 1806. NASAROV discusses them as follows: "Sie (i.e. *D. lactea*) ist durch zwei Individuen vertreten, von denen das eine glatte Blütenschaften hat,

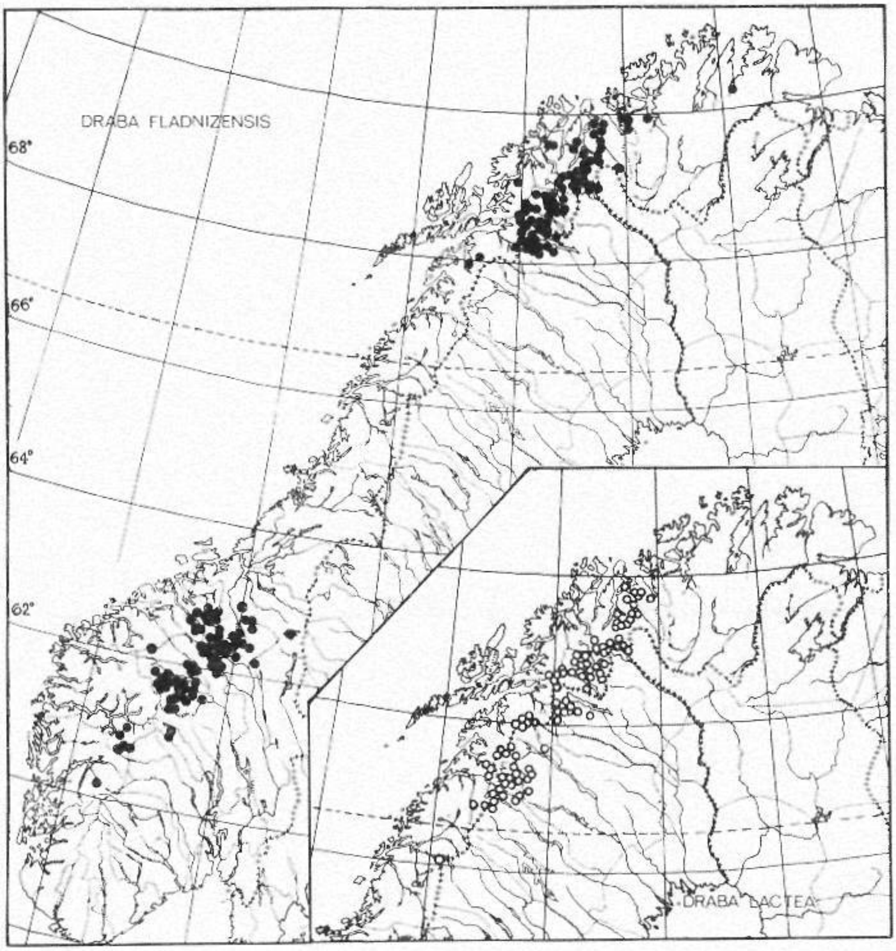


Fig. 3. Distribution in Scandinavia of *D. fladnizensis* (●) and in N. Scandinavia of D. *lactea* (○).

das andere hat an der unteren Blütenschaft gabel-ästige Härchen. Bei beiden fehlen die Blätter an der Blütenschaft, die Kelchblätter sind nicht mit dichten ungeteilten Härchen bedeckt, die Schötchen sind kahl, der Griffel ist bemerkbar — 0.5 mm. Hierher gehören zwei dürftige Exemplare: 1) aus dem Herb. Hoffmann, No 4856 sub. n. "*Draba lactea* Ad.; ad mare glac." und 2) aus dem Herb. Trinius, No 384, mit demselben Namen und mit Bezeichnung der Fundstelle. Die Blätter der beiden Individuen haben ausser den ungeteilten Härchen auch ästige. Alles übrige ist wie beim Typus."

Fig. 4. a) *Draba lactea*. S. Norway, Trollheimen, Skrufluren. b) *Draba fladnizensis*. S. Norway, Dovre Mts., Knutshö. Approximately natural size.

With respect to all the morphological characters except occurrence of the stellate hairs, ADAMS' and NASAROV's descriptions fit the species with $2n=48$ chromosomes which today is recognized as *D. lactea*, not with *D. fladnizensis*. Hairiness of the lower parts of the scapes is mentioned by NASAROV. The occurrence of stellate hairs on the stems is evident in many herbarium specimens from N. Scandinavia (fig. 2 a), according to EKMAN also from Greenland. SELANDER (1950 II, p. 88) states that this character can vary in one single individual, and is of no taxonomical significance. It is probable that different segregation patterns in the various gene complements in the polyploid species *D. lactea* could be the cause of this variation.

D. lactea is distinctly bicentric in Scandinavia (fig. 1 and 3). In S. Norway it has scattered localities in the Trollheimen—Sunndalen Mts. In N. Scandinavia it is scattered from Mieskattjåkko in Lycksele Lappmark and Solvågtind in Nordland northwards to Kvænangen in E. Troms. It avoids the lower coast mountains, and is especially frequent in the continental districts of Torne Lappmark and Inner Troms.

D. norvegica Gunn. Plate I: 7. Fig. 2 c. Characters distinguishing this species from the three others are: rosette leaves entire or serrate, variable in outline. Stems with 1—3 leaves, in small specimens usually nude. Leaves varying as to hairiness, with simple, bifurcate and coarse stellate hairs, usually only with a few simple hairs along the margins, not ciliate as in *D. lactea*. Stems usually with irregularly branched stellate hairs, sometimes quite glabrous or with a few, scattered hairs not especially on the lower parts. Silicles elliptic-ovate, 5—10 or more, in an elongated raceme much longer than in *D. lactea*. Silicles normally glabrous, in certain types densely stellate.

D. norvegica does not develop the characteristic dichotomous branching seen in *D. lactea*. The rosettes are few or solitary, larger specimens are irregularly branched.

D. norvegica coll. is the most common alpine *Draba* in Scandinavia. It is found at different altitudes, and occurs in a number of regional and local forms.

Discussions

The earlier botanists were inclined to regard some of the variation in the *Draba* species as being caused by introgression, believing the species to outcross freely. ELISABETH EKMAN was much occupied by this problem and holds (1932 a, p. 200) that in some arctic areas *D. fladnizensis*×*lactea* seems to be more common than its parent species, *D. fladnizensis,* which she holds, is seldom quite pure in these areas. As to fertility, she states, that *D. fladnizensis*×*lactea* within the arctic areas is mostly fertile.

However, in recent times it has also been held that the range of *D. fladnizensis* is difficult to ascertain in arctic areas due to transitional forms interlocking it with *D. lactea* (see HULTÉN 1958).

In our time, with better knowledge of the nature of polyploid species and their origins, one would rather hesitatingly take it for granted that the diploid *D. fladnizensis* and the hexaploid *D. lactea* are interfertile. An F_1 hybrid being formed will surely be highly sterile and not a source for backcrosses and introgression. A probable relationship should be discussed in connection with the problem of origin and presumable progenitors.

The one common prominent feature connecting *D. fladnizensis* and *D. lactea,* the long cilies and occurrence of simple and bifurcate hairs on the blades, might be taken as a sign of relationship, with *D. fladnizensis* considered as one of the diploid ancestors of *D. lactea.*

From a revision of the available herbarium material I have come to the conclusion that the difficulties in the separation of *D. fladnizensis* and *D. lactea* are not caused by the obscuring of specific boundaries by transitional forms of hybrid origin, but by previous confusion due to the fact that the circumscription of them on morphological grounds has not been clear. Apparently, the variability in hairiness of leaves and stems, especially in *D. lactea,* has been a chief cause of the confusion.

EKMAN (1933, p. 446) lists the localities from W. and E. Greenland of the supposed hybrid *D. fladnizensis*×*lactea,* among them five collections of J. VAAGE from E. Greenland in Herbarium Oslo. A re-evaluation of these five collections reveals that they are pure *D. lactea,* with characters within the range of variation of this species, being fertile with well developed silicles. Another collection, from Torne Lappmark (H. SMITH 1925, Herb. Stockh.) mentioned by EKMAN (1926 p. 55) may also be *D. lactea.* The numerous collections of *D. fladnizensis* and *D. lactea* in the herbariums from Scandinavian and extra-Scandinavian areas indicate that the hybrid between them, if occurring, is rarer than previously believed.

When two species cross freely one would expect to find prospective hybrid specimens in adjacent localities where one of the species occurs abundantly and the other is scarce, such as in Trollheimen, provided the parent species are more or less self sterile. EKMAN (1917, pp. 9—10) shows that the flower biology of the *Draba* species favours self pollination. The frequent occurrence of some hybrid combinations, e.g., that of *D. fladnizensis* × *nivalis*, shows that cross pollination takes place. In sunny weather, even in low temperatures, there are always some flies about in the localities with these *Drabas,* even at high elevations. In my garden cultures, which included the species occurring in the Dovre Mts., some species outcross, others do not. This question is in need of further analysis.

D. fladnizensis and *D. lactea* were once joined under the name *D. Wahlenbergii* Hornem., including f. *homotricha* Lindbl. and f. *heterotricha* Lindbl., the former corresponding to *D. fladnizensis,* the latter to *D. lactea.* EKMAN (1933 b) settles the nomenclatural question, giving priority to the name *D. lactea* Adams. In her previous paper (1926) she used this name for a subalpine form of *D. fladnizensis,* or one having simple hairs both on leaf margin and blades.

The different forms of *D. fladnizensis* mentioned by EKMAN (1926), are not given with a geographical area. They vary as to hairiness and are either modifications induced by the environment or Mendelian segregates: f. *genuina* Busch is glabrous with ciliate leaves, f. *homotricha* (Lindbl.) Weingerl has simple and bifurcate hairs on the leaves, f. *glabrata* Busch is glabrous, and f. *nidificans* (Norman) Ekman is a stunted form showing nanism with hairiness as in f. *genuina.* The f. *suspecta* Ekman is the only one deviating from the specific diagnosis of *D. fladnizensis*: "Folia interior rosulae sterilis uno alterove pilo stellato praedita; caeterum ut in f. homotricha" (EKMAN 1926, p. 14. 1932 b, p. 432). The following can be cited in elucidation of this form (EKMAN 1926, p. 11): "Die Frage, ob einige vereinzelte Sternhaare einer echten *D. fladnizensis* angehören können, müssen wir leider als noch ungelöst betrachten. Vorläufig muss ich deshalb eine solche Form mit einigen Sternhaaren an der inneren Blättern der sterilen Rosette *D. fladnizensis* f. *suspecta* benennen." Later the author stresses that suspect individuals with stellate hairs can be confused with several other taxa such as *D. lactea, D. norvegica* or *D. siliquosa* hybrids. The conclusion is that either the diagnosis of f. *suspecta* does not agree with the type, or this form belongs to another species, not to *D. fladnizensis.* SCHULZ (1927 p. 373) mentions *D. fladnizensis* f. *suspecta* as a synonym of *D. lactea.*

ARWIDSSON (1943, pp. 210—211) discussing the relationship of *D. fladnizensis* and *D. lactea,* holds that specimens seen by him, with stellate hairs which have been identified as f. *suspecta,* belong to *D. lactea.* This author verifies the identification to *D. lactea* of a collection of O. DAHL's from Trollheimen which EKMAN (1926) at first hesitatingly referred to this species, the first known record from S. Norway. The present chromosome count of 2n=48 in specimens from Storlidalen in Trollheimen, identical with those in O. DAHL's collection (Herb. Oslo), also, lends support to the determination of it to *D. lactea.*

The difference in ecology is one of the most important features separating populations of *D. fladnizensis* and *D. lactea.* In Trollheimen both species occur on the same mountains, but in quite different environments and plant communities. Both are basophilous, growing in open vegetation. While *D. fladnizensis* grows abundantly in fissures and on barren rocks, where the snow cover in winter is thin, *D. lactea* is confined to wet moss carpets on gravel with more snow protection, and is rather scarce. This was the case on Tyrikvamfjell (1100 m a.s.l.), likewise on Skrufluren in Storlidal, where the two species were growing under different moisture conditions only a few meters from each other, according to my observations in 1961.

Mosses are often intermingled among the rosettes of the herbarium specimens of *D. lactea.* Head curator Mr. PER STØRMER has kindly identified some of these, all belonging to the alliance *Tomenthypno-Dryadetum* (see HEDBERG et al. 1952): *Campylium stellatum, Dicranum fuscescens, Dicranum glaciale, Ditrichium flexicaule, Drepanocladus uncinatus, Hylocomium splendens, Timmia austriaca,* and *Tomenthypnum nitens.*

D. lactea has a wider distribution area than *D. fladnizensis* in N. Scandinavia. In the outer districts it is scarce, specimens therefrom showing signs of introgression with *D. norvegica* (e.g. in the coastal mountains in Tysfjord, Nordland). These two species, both hexaploid, could be expected to produce a more or less fertile hybrid promoting gene exchange in back-crosses. As to type of hairs, size of leaves and silicles, etc. they are closely related.

SELANDER (1950) gives *D. lactea* from the central "rich area" of SW. Lule Lappmark, ascending to 1460 m a.s.l., at lower levels mostly on moist screes and north exposed cliffs, in upper alpine levels on solifluction soil and high-alpine lithosol, also in south exposition. BENUM (1958) records it as basocole in Troms, from wet or moist, gravelly soil on ravines, talus slopes, rock ledges, gravelly patches on grassy hills and on solifluction terraces. TORSTEIN ENGELSKJØN (1963, Herb. Tromsø) has found it at 1500 m a.s.l. on Mt. Kirkestind in Troms, that is at its N. Scandinavian altitudinal limit, and considers it as most abundant in the middle alpine region.

On Pältsa in Torne Lappmark HEDBERG et al. (1952) gives it from the low-alpine and middle-alpine belts (900—1300 m above sea level) as calcicole. In 1965 ENGELSKJÖN found it characteristic of the extensive solifluction slopes on the northern part of the mountain, especially frequent in *Luzula arctica* alliances.

The southernmost, isolated locality in S. Norway of *D. fladnizensis,* the southern declivity of Hårteigen in Hardangervidda, is situated in the area from where LID (1958) reports *D. nivalis* in several localities, and which harbours many bicentric species at their southern boundary of distribution in Scandinavia.

In N. Scandinavia its southern and northern limits are displaced northwards. ARWIDSSON (1943, pp. 210—211) states that the herbarium collections seen by him from Lule and Pite Lappmark and from Solvågtind in Nordland, recorded as *D. fladnizensis,* are *D. lactea.* In our revision of the herbarium material ENGELSKJØN and I found that several sheets with plants from Solvågtind were erroneously labelled *D. fladnizensis,* although showing no resemblance to this species in its stricter sense. They were re-identified as *D. lactea,* some of them as possibly *D. lactea* ×*norvegica.* On account of this labelling Salten has erroneously been recorded as the southern limit of *D. fladnizensis* in N. Norway (cp. LID 1963). The southernmost locality now known is Sildhopfjell in Nordfold (see above). In Nordland county the species is rare, being confined to a few stations in the inner, northern districts in Tysfjord and Skjomen. In Troms BENUM (1958) records it as calcicolous, chiefly from dry lithosol on barren ridges, in chionophobous plant communities. It is, moreover, frequent also in the lower alpine region.

D. nivalis is as restricted in distribution as the two species discussed above. It is continentally accentuated, occurring in inland areas especially. In S. Norway this is very prominent, cf. map fig. 1. The northernmost localities in the Dovre Range, Veslkolla and Veslelgsjötangen are of particular interest. They are situated close to Knutshø, from where *D. nivalis* has not been recorded. It is, however, known from several mountains surrounding Knutshø to the NE, SE and SW. In the herbarium of Riksmuseet, Stockholm, is a sheet with a mixed collection of *D. fladnizensis* and *D. nivalis* (G. KNABEN determ. 1966), from: "Norvegia, Dovre, Kongsvold ad saxa. Juli 1870 legg. J. E. ZETTERSTEDT et J. A. O. WICKBOM." This should encourage botanists to search eagerly for *D. nivalis* on Knutshø, which harbours most of the southern unior bicentric species in Scandinavia. Kongsvoll is situated at the foot of Knutshø, to the west.

Another important feature is the total absence of *D. nivalis* in the Trollheimen Mts. It is also seen that *D. lactea* replaces *D. nivalis* in this region, a feature discussed by GJÆREVOLL & SØRENSEN (1954). In the discussion of vicariism of different taxa in various subcentres, the peculiar differentiation of *Papaver radicatum* must be mentioned. In S. Norway this collective species comprises a number of geographical races, distinct as to morphological characters and chromosome structure, as shown in experiments (KNABEN 1959):

Papaver radicatum ssp. *ovatilobum* s.str. in the Dovre Range, ssp. *gjaerevollii* in Trollheimen, ssp. *oeksendalense* and ssp. *groevudalense* in the Sunndalen Mts., and, farther south, ssp. *intermedium* in Jotunheimen Mts. and ssp. *relictum* in Valdres-Sogn. These races should be considered as markers of the different sub-centres within the S. Norwegian range of the bicentric species. *P. radicatum* is absent only in the southernmost sub-centre, i.e. Hardangervidda.

It is evident that the Trollheimen-Sunndalen Mts. must have been a centre of migration in late glacial times, provided the rich Dovre flora was being recruited from the west. During their eastward migration, some species, such as *Draba lactea,* apparently did not reach farther than to the Trollheimen area.

On the basis of distributional studies of the flora in Sogn, Western Norway, in areas with the highest precipitation in Scandinavia (KNABEN 1950), I concluded that it must be more difficult for a species to conquer new areas penetrating into a region with an old vegetation cover and a high degree of humification, than it is to maintain its existence in edaphically favourable localities, where it has an adaptive advantage, even if the climate changes unfavourably. If *D. lactea* migrated as far as the Dovre-Folldal Mts. it would certainly have been able to persist there even during post-glacial hot periods. There are moist irrigated slopes of the mountains e.g. of the Drivdal valley, which could have offered favourable conditions throughout the latest 10,000 years.

The dry Folldal Mts. where *D. nivalis* occurs, are situated in the rain shadow of the high mountains in the west. The ground is generally exceedingly dry, covered with *Cetraria nivalis—Alectoria ochroleuca* carpets with a vascular flora rather poor in species (RESVOLL-HOLMSEN 1914). *Draba nivalis* is restricted to the very summits of the mountains in fissures, barren ridges and lithosol, or in lichen-rich *Dryas-Kobresia* heaths. On the top of Veslkolla the somewhat chionophilous *Sagina caespitosa* grows copiously on patches of frost upheaval alternating with rocky flats harbouring *D. nivalis*. On Råtåsjøhø at 1500 m *D. nivalis* grows abundantly also in the scattered green mats of *Silene acaulis*, intermingled between the leaves of this species. On Pigghetta it occurs in rock fissures and dense lichen mats together with *D. fladnizensis*, *Campanula uniflora*, *Taraxacum dovrense*, among others.

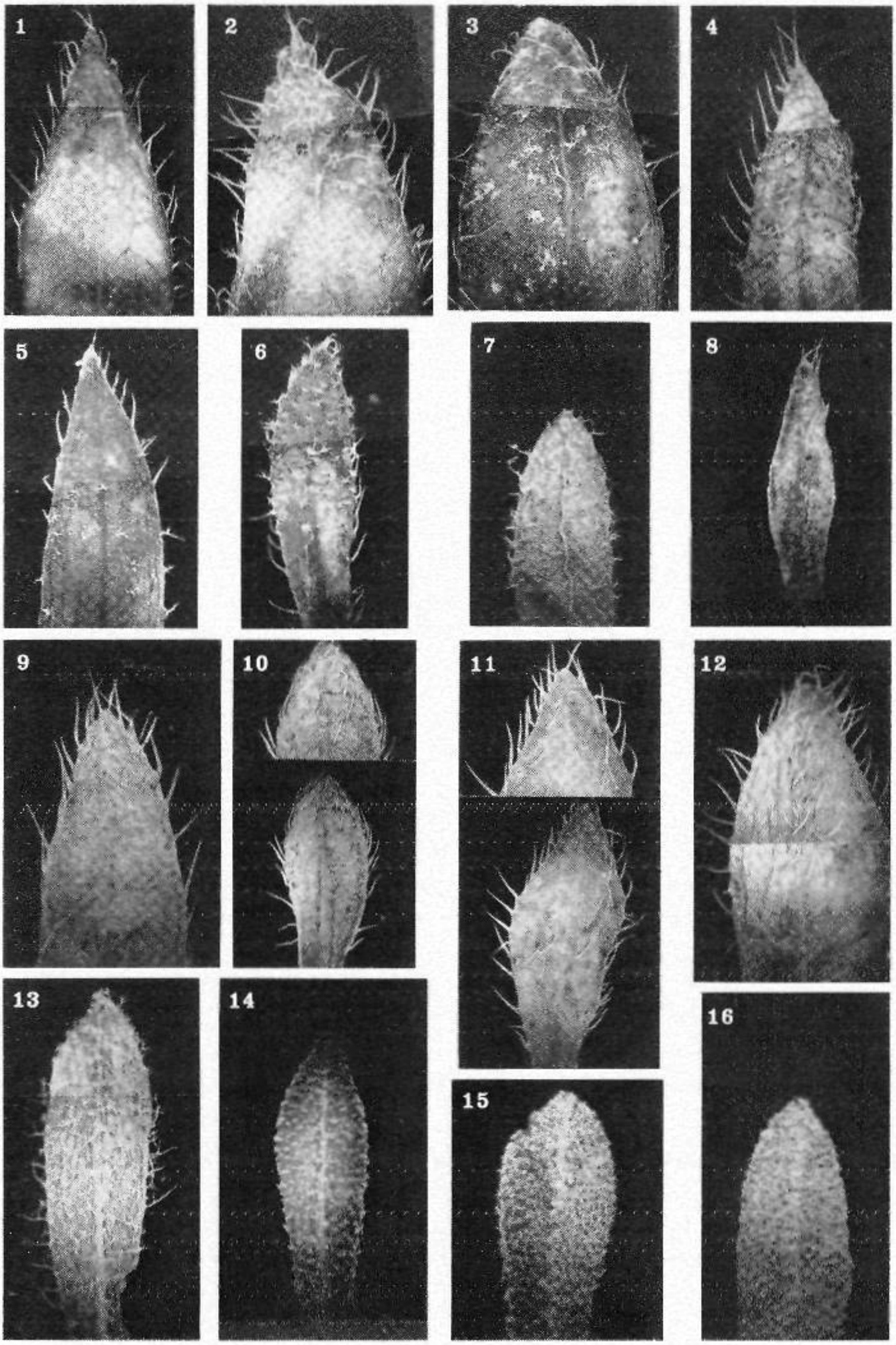
It seems probable that *D. nivalis* has reached the Dovre Mts. from the south or south-west, from a centre in the Jotunheimen—Vågå Mts. It seems that the species has not reached beyond the watershed in the Dovre Range, i.e. the ridges between the upper Drivdal Mts. and the Snøhetta massif. The occurrences are of relic nature, and the species has been crowded out in parts of its present range subsequent to the ripening of the vegetation cover.

The distribution centre in Jotunheimen of *D. nivalis* coincides with that of *Rhododendron lapponicum*, in S. Norway one of the most restricted of the bicentric species. Discussing its late glacial history, NORDHAGEN (1965) conjectures that it must have migrated from the west, and that present populations in Romsdal and Lesja, situated nearer the coast than the main Jotunheimen centre, may provide an indication of its migration route.

Similarly, *D. nivalis* has a few stations in a coastal direction from Jotunheimen (cf. map fig. 1, and listed stations above). These localities may also be taken as an indication of an eastward migration route from the coast in late glacial times.

GJÆREVOLL & SØRENSEN (1954) and GJÆREVOLL (1963) discussing phytogeographical problems in the central mountains of S. Norway find it difficult to relate the distribution of to-day of *D. nivalis* to a migration from the coastal zone, either to the southern subcentre, Hardangervidda, or to the more northerly Jotunheimen—Dovre Mts. They are inclined to agree with ELISABETH EKMAN (1926), who explains the curious distribution of this species, mostly on windswept, exceedingly dry localities on the mountain tops, by glacial age survival within the Jotunheimen—Dovre Mts. They believe that this species, and several other of the numerous problematic species, in S. Norway confined to mountains in some distance from the sea, persisted on nunataks rising above the inland ice, and that they did not manage to spread to a larger area after the retreat of the ice.

D. nivalis is a typical chionophobous species occurring in small populations often in south exposed localities with extreme temperatures.



Pl. I. Photos of rosette leaves. Magnification appr. 6×.

1—6. *Draba lactea*. 1. Dorsal side. Troms, Bajit Riidagierdo. 2. Ventral side. Troms, Bajit Riidagierdo. 3. Ventral side. Torne Lappmark, Pältsa. 4. Ventral side. W. Spitsbergen, Advent Fjord. 5, 6. Ventral sides. S. Norway, Trollheimen, Skrufluren. 7. *Draba norvegica*. Ventral side. Troms, Flöyfjell. 8—12. *Draba fladnizensis*. 8. Ventral side. Troms, Paras. Glabrescent type. 9. Dorsal side. S. Norway, Trollheimen, Tyrikvamfjell. 10. Ventral side. S. Norway, Trollheimen, Tyrikvamfjell. 11, 12. Ventral sides. E. Greenland, Myggbukta. 13. *Draba fladnizensis×nivalis*. Ventral side. S. Norway, Oppdal, Sisselhö. 14—16. *Draba nivalis*. Troms: Bægasangaissa. 14. Ventral side. 15. Dorsal side, young leaf. 16. Ventral side.

The ecological potentialities of such a species for glacial age survival are apparently great, on localities favourable as to snow conditions. GJÆREVOLL & SØRENSEN (loc. cit.) treat especially the possibilities for plant life during the last glaciation in Trollheimen where *D. nivalis* does not grow, but where several other species with uni- or bicentric distribution in Scandinavia have a common restricted area. In S. Norway, taxa such as *D. lactea* and the endemic *Papaver radicatum* ssp. *gjaerevollii* do not occur outside this area.

It seems easier to explain the isolated occurrences to-day of the rare species in the Trollheimen—Dovre—Jotunheimen Mts. and Hardangervidda by nunatak survival, than only by survival on icefree strips of land along the coast. Much more research on different fronts is, however, needed before all the phytogeographical problems in these areas are explained satisfactorily.

Summary

The species *Draba nivalis, D. fladnizensis, D. lactea,* and *D. norvegica* have been treated as to chromosome numbers, ecological and morphological variation, and geographical distribution especially in Scandinavia. The conclusion is that the diploid *D. fladnizensis* and the hexaploid *D. lactea* are well-defined species, not connected by hybridogenous forms and, further, that the arctic range of *D. fladnizensis* has not yet been determined satisfactorily due to confusion of this species with *D. lactea,* which has a wide range of variation, possibly due to its polyploid constitution.

Acknowledgements

The present work has been performed through grants from the Norwegian Research Council for Science and the Humanities. Cand. Mag. TORSTEIN ENGELSKJØN has taken part in the cytological examination of the species, the herbarium revisions and the working out of the distribution maps. Cand. Mag. SVERRE LØKKEN, Dr. TORE OUREN, Cand. Real. LEIF RYVARDEN, and Cand. Real. SIGMUND SIVERTSEN have communicated recent discoveries of new localities of the species. I wish to express my sincere thanks to all these persons for their kind cooperation, and to the officials at the different Botanical Institutes for lending herbarium material of the *Draba* species.

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BOTANISKA NOTISER 1966 · VOL. 119 · FASC. 3 · LUND

A List of Series and Species in the Genus Cotoneaster

By K. E. FLINCK[1] and B. HYLMÖ[2]

Our knowledge of the genus *Cotoneaster* has recently been increased considerably. On the one hand a number of new species have been described, and on the other, studies of heredity pattern and cytology within the genus have shown apomixis. The difficulty in treating the taxonomy of the genus is increased by the absence of a systematical division of the genus into sections and series. As a modern species list for the genus is missing we list below all the known species, systematically arranged in series.

SAX (1954) showed that a large number of *Cotoneasters* bred true if propagated from seed and that the offspring showed no deviations from the maternal parent, this being interpreted as apomixis. It was further found that a number of species were triploid with a chromosome number $2n=51$. SAX determined the chromosome numbers for 57 taxa of *Cotoneaster* and found 8 diploids, 43 triploids and 6 tetraploids. SAX also found that a number of species developed fruits and viable seed after having the flowers destyled. Studying the embryosac development, HJELMQVIST (1962) recently confirmed cytologically the occurrence of apomixis within the genus. The seven taxa investigated by HJELMQVIST were by far predominantly apomictic; only one of them, *C. roseus* Edgw., was occasionally amphimictic, while this may possibly be true also of two others, *C. nitens* Rehd. et Wils. and *C. soongoricus* (Regel) Popov.

BROERTJES (1956) could not confirm SAX' investigation. He found investigated *Cotoneaster* species to be diploid or tetraploid. Quite recently ZEILINGA (1964) in an important work has also questioned SAX'

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chromosome determinations. ZEILINGA proved that *Cotoneaster* species are normally either diploid or tetraploid. Triploidy was only found in two cultivars and these showed a reduced fertility. ZEILINGA tested 38 taxa, of which 7 were diploid, 2 triploid and 29 tetraploid. It was further demonstrated that 10 cultivars within the *C. salicifolius* - *C. frigidus* groups were diploid.

Our own cultivation trials as well as our studies in commercial nurseries, prove that of the *Cotoneaster*s possible to cultivate in Southern Scandinavia and in Central Europe the dominating majority of species breeds true. The only species we have noticed not to breed true after seed propagation are the following: *C. frigidus* Wall. ex Lindl., *C. salicifolius* Franch., *C. dammeri* Schneid. and *C. conspicuus* Marq., — all these belong to Sect. *Chaenopetalum*. It should, however, be pointed out that a significant number of *Cotoneaster* species are not hardy in Scandinavia and have, therefore, not been studied in culture after propagation from seed. We also suspect that *C. nitidifolius* Marq. does not breed true but we do not yet have positive proof.

KLOTZ (1963 a) has only noticed heterogeneous offspring for crosses between *C. frigidus* cultivars and for species closely related to *C. salicifolius*. On the other hand KLOTZ did not observe the normal sexual behaviour of *C. dammeri* or *C. conspicuus*, which, unfortunately, has resulted in the description of a number of obviously unnecessary species.

Our out-breeding species *C. frigidus*, *C. dammeri* and *C. conspicuus* are included in SAX', BROERTJES' and ZEILINGA's diploids. SAX could not, on the other hand, determine with accuracy the chromosome number for *C. salicifolius*, but the closely related species *C. glabratus* Rehd. et Wils. and *C. henryanus* Rehd. et Wils. are, according to SAX, diploids. We have not had the last two species in cultivation. ZEILINGA showed *C. salicifolius* to be diploid as well as a number of cultivars of this species.

C. rugosus Pritzel (*C. salicifolius* var. *rugosus* Rehd. et Wils.) on the other hand, was shown by SAX to be triploid and by ZEILINGA tetraploid. *C. rugosus* also breeds true in our sowings and is obviously apomictic. Interesting is an early notice by STAPF (1924) that *C. floccosus* (Rehd. et Wils.) Flinck et Hylmö sown in French nurseries did not give any variation. We have also found herbarium collections of this taxon uniform and the species is probably apomictic. Plants in general cultivation in Scandinavia and Central Europe under the name of *C. salicifolius* var. *floccosus* are, however, nearly always *C. salicifolius*. BROERTJES and ZEILINGA report *C. salicifolius* var. *floccosus* to be diploid. After studies of living and dried material, which was kindly placed at our disposal, we consider the material of *C. salicifolius* var. *floccosus* that ZEILINGA has investigated, to be *C. salicifolius*.

Of SAX' other diploids we have never seen *C. acutifolius* Turcz. in cultivation while of *C. acuminatus* Lind. and *C. microphyllus* Wall. ex Lind. we have, unfortunately, observed so few plants in cultivation that no accurate conclusion could be reached. What is cultivated under the name of *C. acutifolius* is not the Mongolian species but taxa from Central and Southern China (FLINCK & HYLMÖ 1962). What we have seen under the name of *C. acuminatus* in culture has not been uniform but requires a closer study; ZEILINGA found his *C. acuminatus* tetraploid. In our opinion, a number of microspecies are joined under *C. microphyllus* (cp. KLOTZ 1963 b). We have determined ZEILINGA's (1964) tetraploid *C. microphyllus* to be *C. thymifolius* Baker (syn. *C. integrifolius* (Roxburgh) Klotz).

It is interesting that our splitting species are also amongst those that ZEILINGA has shown to be diploid. BROERTJES and ZEILINGA found, however, contrary to SAX, that *C. adpressus* was diploid. We do not have sowings of true *C. adpressus* and do not know if this species is constant when sown.

ZEILINGA's diploid cultivars of *C. watereri* is closely related to the diploid *C. frigidus*. Our observation that the majority of the *Cotoneaster* species in cultivation is uniform when sown, is in contrast to a common opinion amongst nurserymen in countries with a milder climate. These nurserymen generally believe that there is a frequent hybridization within the genus. In these countries, and not least in the British Isles, *C. frigidus* and *C. salicifolius* and crosses between these two species are very common in the nurseries, together with *C. dammeri* and *C. conspicuus*.

TURRILL (1950) discusses, when describing a taxon of the genus, "the notorious difficulty in the genus Cotoneaster to determine satisfactorily the limits of species". At that time, before the apomixis in the genus had been shown, there was not sufficient information to give full reasons for the limits of species: "since we do not know how far hybridization happens in the wild, how plastic individual plants are, or how much intraspecific genetic variation occurs, there results a frequent difference of opinion between "lumpers" and "splitters". Splitting in North America has been carried to much more extreme lengths in the allied genus Crataegus than in Cotoneaster".

We have a feeling that a detailed study of the genus *Cotoneaster* and

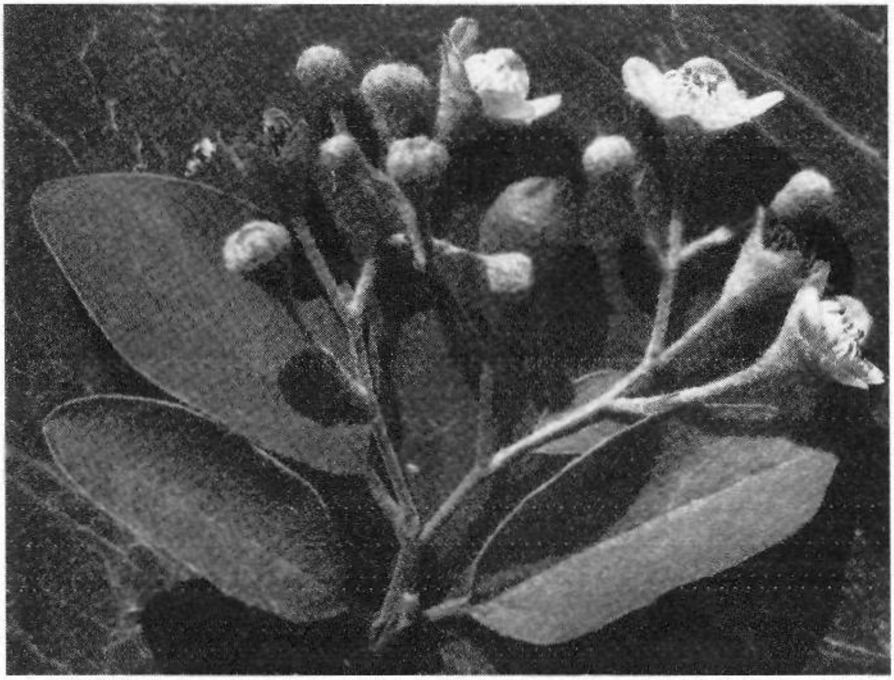

Fig. 1. Sect. *Cotoneaster* (*C.* sp.n., Ser. *Zabelioides*).

a splitting into relatively easily separated microspecies ought to be valuable, both for the theoretical plant geography and for the horticulture. Many taxa within *Cotoneaster* have a very high horticultural value and are propagated and sold by nurseries in different parts of the world, not infrequently on a very large scale. Under the same species taxa are sometimes distributed, which horticulturally are very different. Such an example is *C.* "*horizontalis*" hort. with 3 or 4 microspecies under the same name, even if the practical horticulturist has tried to split them into varieties or cultivars.

From the point of view of plant geography it must be valuable that a genus like *Cotoneaster* can be split up. With a distribution centre for the genus in China and a concentrically diminishing number of species towards Europe and north Africa (BROWICZ 1959) it ought to be possible, with a more thorough knowledge of the variations, to contribute to the evaluation of the recent development and distribution speed of our present plant societies.

We have considered it necessary to work as much as possible with

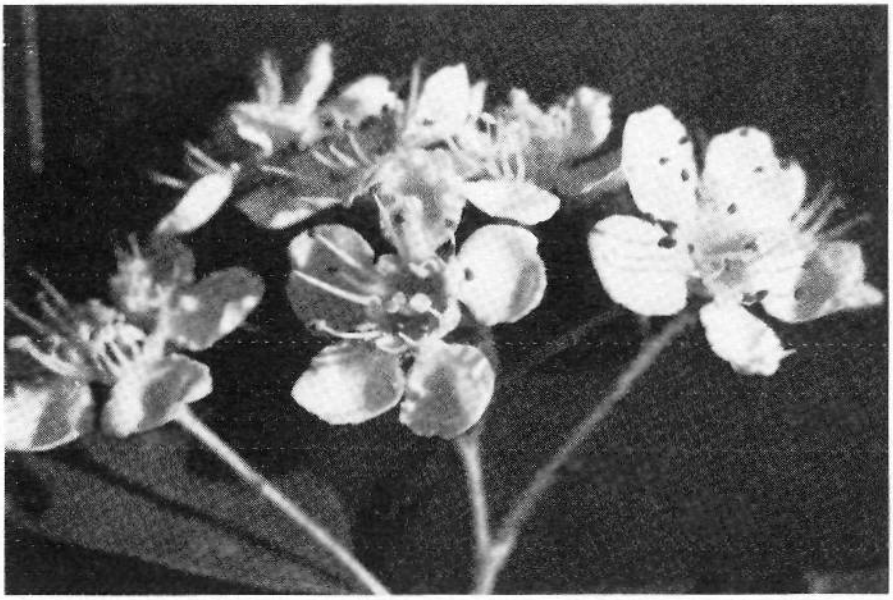

Fig. 2. Sect. *Chaenopetalum* (*C. calocarpus* (Rehd. et Wils.) Flinck et Hylmö).

living material, as differences between apomictic species within a genus like *Cotoneaster* often partly disappear in dried material. In cultivation such differences between microspecies can frequently be interpreted as significant macrocharacters. Furthermore, with seed propagation we obtain a control of heredity and can judge if a species breeds true or not.

Sections, subsections, series and species

Realizing the difficulty which at present exists in obtaining a clear picture of the systematics of the genus we will, in spite of this, give a list of species where we try to group 174 species into 24 series. This list must, however, be considered preliminary, and we hope later to be in a position to make a revision. The difficulty for us originates in the fact that of several species we have not yet seen a representative specimen and we particularly lack material from the many species described by Russian taxonomists. As far as we know, no complete systematical list has been published at the present time, with the exception of REHDER's (1949) list of cultivated species. KLOTZ' (1957) careful revision unfortunately lacks systematical grouping. Later KLOTZ (1963 a, b and c) thoroughly revised three groups of species.

KOEHNE's (1893) division of the *Cotoneaster* genus into two sections: *Orthopetalum* (=*Cotoneaster*) and *Chaenopetalum*, has been strongly criticized by some authors. KLOTZ (1963 a) considers that KOEHNE's division, based on the positions of the petals, is corresponding neither to natural relationship within the genus nor to international rules of botanical nomenclature.

YÜ (1963) proposed a division into the sections, *Densiflos, Cotoneaster* and *Uniflos*. We consider YÜ's division to be artificial in the highest degree and to have no foundation whatsoever with the natural relationship. A grouping of the species within the genus based on the number of flowers in the inflorescences leads to ridiculous consequences. So in Sect. *Uniflos* YÜ tries to bring together all species with solitary or sometimes 2—5 flowers in the cluster. The section is divided into two series, *Microphylli* and *Distichi,* which to us appear to be totally unrelated. Ser. *Distichi* seems very heterogeneous and contains, for instance, *C. uniflorus* Bunge placed by us in Ser. *Cotoneaster, C. horizontalis* Dcne. belonging to Ser. *Adpressi* and *C. rubens* W. W. Smith more related to Ser. *Distichi* in the original sense. Although YÜ places *C. uniflorus* in Sect. *Uniflos* he includes *C. integerrimus* in Sect. *Cotoneaster* because of the number of flowers in the inflorescences being 3 or more. Most authors agree on the very close relationship between these two species. Often *C. uniflorus* is treated as a variety of *C. integerrimus*. Several other examples could be mentioned to illustrate the artificial way in which YÜ's system divides the genus.

Therefore, in contrast to KLOTZ and YÜ we consider that KOEHNE's sections are natural and fully justified. They divide the genus *Cotoneaster* into two so well defined groups that we could very well accept the genus split into two genera based on this principle. The position of the petals is only one of the marks that differentiate the sections. A number of other characters could be mentioned and not least the flowering of the corymb extended or simultaneous (Figs. 1 and 2). Hybrids between the two sections have been reported on several occasions. However, we do not know of any positive case and consider reported hybrids between the sections not to be proved. All of our investigated cases have obviously been wrong.

One cause for the opinion that the borderline between KOEHNE's two sections should be undefined is probably the species with ascending petals like *C. armenus* Pojark., *C. zeravschanicus* Pojark., and *C. oli-*

Table 1. List of Series of Cotoneaster

Subsection	Series	Numbers of stamina	Numbers of pyrenae	Colour of fruit
Sect. I. Cotoneaster				
A. *Adpressi*		10(—13)		
	1. *Distichi*		2—3	red
	2. *Adpressi*		2—3	red
	3. *Nitentes*		2—3	black
B. *Cotoneaster*		20		
	4. *Lucidi*		2—3	red or black
	5. *Melanocarpi*		2—3	bluish black
	6. *Cotoneaster*		2—5	red
	7. *Acuminati*		2—5	red
	8. *Glomerulati*		4—5	red
	9. *Bullati*		4—5	red or purple
	10. *Franchetioides*		2—3	red
	11. *Zabelioides*		2	red
Sect. II. Chaenopetalum				
C. *Chaenopetalum*		20		
	12. *Multiflori*		1—2	red
	13. *Tomentelli*		1—2	purple
	14. *Racemiflori*		1—2	red or purple
	15. *Orbiculares*		2	red
	16. *Saxatiles*		2	purple or black
	17. *Insignes*		1—2	bluish black
	18. *Hebephylli*		1—2	purple
	19. *Chaenopetalum*		2	red or black
	20. *Salicifolii*		(3—)5	red
	21. *Pannosi*		2	red
D. *Microphylli*		20		
	22. *Buxifolii*		2—3	red
	23. *Microphylli*		2—3	red
	24. *Marginati*		2—3	red

ganthus Pojark. Pojarkova (1955) places the two first mentioned species in Sect. *Chaenopetalum*. After many years of observing cultivated specimens we have no hesitation to place these species in Ser. *Melanocarpi* within Sect. *Cotoneaster*.

Of Sect. *Cotoneaster* we have had the opportunity to study in culture and in herbaria the majority of the species. We do not, however, know the species within Sect. *Chaenopetalum* so well. Many of these species are not hardy in Scandinavia and type specimens hide frequently in herbaria. which have not been available to us. Species of which we have not seen material have been marked with an asterisk (*) in the list of species. For Sect. *Chaenopetalum* we have followed Klotz (1963 a, b).

Cotoneaster B. Ehrhart 1761

Sect. I. *Cotoneaster*

Syn.: Sect. *Orthopetalum* Koehne 1893

Subsect. A. *Adpressi* Hurusawa 1943

The subsection *Adpressi* is characterized by flowers with only 10 (—13) stamina. All other subsections within the genus *Cotoneaster* comprise species having (15—)20 stamina.

Series 1. ***Distichi*** Yü 1954

C. nitidus Jacques 1857
Syn.: *C. distichus* Lange 1882

*C. *forrestii* Klotz 1963
*C. *marquandii* Klotz 1963
*C. *nagaensis* Klotz 1963
C. cordifolius Klotz 1963
Syn.: *C. distichus* var. *parvifolius* Yü 1954
C. verruculosus Diels 1912
C. cavei Klotz 1963
*C. *sandakphuensis* Klotz 1963
C. rubens W. W. Smith 1917
C. chengkangensis Yü 1963
C. sanguineus Yü 1954

Series 2. ***Adpressi***

Frutices decidui; folia herbacea vel subcoriacea; inflorescentia 1—3-flora; stamina 10—13; fructus rubri; pyrenae 2—3(—4).

Series *Distichi* Yü foliis coriaceis sempervirentibus ab ea serie differt.

Species typica: *C. adpressus* Bois in Bull. Soc. Bot. France 51: CXLIX. 1904.

C. adpressus Bois 1904
C. subadpressus Yü 1963
C. duthieanus Klotz 1963
Syn.: *C. distichus* var. *duthieanus* C. K. Schneider 1906
C. apiculatus Rehder et Wilson 1912
C. nanshan Mottet 1925
Syn.: *C. adpressus* Bois var. *praecox* Bois et Berthault 1918
C. horizontalis Decaisne 1877

C. perpusillus **(C. K. Schneider) Flinck et Hylmö stat. nov.** (*C. horizontalis* Decaisne var. *perpusillus* C. K. Schneider in Ill. Handb. Laubh. 1: 745, Fig. 419 e. 1906)

C. divaricatus Rehder et Wilson 1912

C. ascendens **Flinck et Hylmö nom. et stat. nov.** (*C. horizontalis* Decaisne var. *Wilsonii* Havemeyer ex Wilson in Bull. Arnold Arb. Ser. 3, 1: 68. 1927)

The close affinity of *C. apiculatus* to Ser. *Adpressi* does not seem to have been observed earlier. *C. apiculatus* is very closely related to *C. nanshan* and we have difficulties in separating the two species. For the present, however, we prefer to keep *C. nanshan* as a species of its own, awaiting results from the cultivation experiments in progress.

In the valuable review of *Cotoneasters* from the Eastern Himalaya, Yü (1954) regards *C. adpressus* as a variety of *C. horizontalis*. Later, however Yü (1963) changed his view on the interpretation of the concept of species range within the genus *Cotoneaster*, describing the new species *C. subadpressus*. This new species is closely related to *C. adpressus*, being a microspecies from Yünnan. *C. adpressus* was described from the province of Szechuan. We prefer to include the Himalayan collections mentioned by Yü (1954) in *C. duthieanus*. The sexual behaviour of *C. adpressus* and its relatives has to be checked as ZEILINGA (1964) showed *C. adpressus* to be diploid.

Series 3. ***Nitentes*** Flinck et Hylmö, ser. nov.

Frutices decidui; folia herbacea; inflorescentia 3(—5)-flora; stamina 10 (—12); fructus atri ad atrorubri; pyrenae 2—3.

Series *Adpressi* colore rubro fructuum ab ea serie differt.

Species typica: *C. nitens* Rehder et Wilson in Sargent, Plant. Wilson. 1: 156. 1912.

C. nitens Rehder et Wilson 1912
C. harrysmithii Flinck et Hylmö 1962
C. taylorii Yü 1954
C. tenuipes Rehder et Wilson 1912

With some hesitation we include *C. taylorii* and *C. tenuipes* in Ser. *Nitentes*. The species have, however, inflorescences of only a few flowers, mostly 3, and 10 or 10—12 stamina, as well as 2 pyrenae and black berries.

Subsect. B. *Cotoneaster*

Syn.: Subsect. *Integerrimi* Hurusawa 1943

Series. 4. ***Lucidi*** Pojarkova 1939

- *C. acutifolius* Turczaninov 1832
- *C. konishii* Hayata 1913
- *C. pekinensis* (Koehne 1893) Zabel 1898
- *C. lucidus* Schlechtendal 1854
- *C. villosulus* (Rehder et Wilson 1912) Flinck et Hylmö 1962
- *C. ambiguus* Rehder et Wilson 1912
- *C. foveolatus* Rehder et Wilson 1912

HURUSAWA (1943) divided this groups into two series, *Lucidi* and *Acutifolii*. We consider the seven mentioned species to form a rather homogeneous group of species and prefer to keep them in the first described Ser. *Lucidi*. However, with some hesitation we include *C. foveolatus*, as this species shows several characters indicating relationship with species within Ser. *Glomerulati*.

Series 5. ***Melanocarpi*** Pojarkova 1939

- *C. melanocarpus* Loddiges 1830
- *C. niger* (Wahlenberg 1820) Fries 1845
- *C. laxiflorus* Lindley 1829

C. commixtus **(C. K. Schneider) Flinck et Hylmö stat. nov.** (*C. melanocarpus* Lodd. var. *commixtus* C. K. Schneider in Ill. Hand. Laubh. 1: 752. 1906)

C. chailaricus **(Klotz) Flinck et Hylmö stat. nov.** (*C. melanocarpus*
C. antoninae Juzepczuk 1950

Lodd. var. *chailaricus* Klotz in Wiss. Z. Univ. Halle, Math.-Nat. 6: 963. 1957)

- *C. talgaricus* Popov 1935
- *C. armenus* Pojarkova 1955
- *C. zeravschanicus* Pojarkova 1955
- *C. ignavus* E. Wolf 1907
- *C. oliganthus* Pojarkova 1938

Series 6. ***Cotoneaster***

Syn.: Ser. *Integerrimi* Pojarkova 1939

C. integerrimus Medicus 1793

C. cinnabarinus Juzepczuk 1950
C. uniflorus Bunge 1830
**C. pojarkovae* Zakirov 1955
C. humilis Dunn 1924
C. obtusisepalus Gandoger 1875
C. intermedius Coste 1893
C. tomentosus Lindley 1821
C. soczavianus Pojarkova 1955
C. obovatus Wallich ex Dunn 1921
**C. camilli-schneideri* Pojarkova 1955

Series 7. ***Acuminati*** Yü

C. simonsii Baker 1869
**C. khasiensis* Klotz 1963
C. acuminatus Lindley 1821
C. mucronatus Franchet 1890

Series 8. ***Glomerulati*** Flinck et Hylmö, ser. nov.

Frutices erecti, decidui vel semi-sempervirentes; folia herbacea vel subcoriacea; cymae parvae; flores minuti; receptaculum parvum, tomentosum; petala erecta; stamina 16—20; fructus parvi, globosi, rubri; pyrenae plerumque 4—5, raro 3.

Species typica: *C. glomerulatus* W. W. Smith in Not. Bot. Gard. Edinburgh 10: 21. 1917.

C. cinerascens (Rehder 1923) Flinck et Hylmö 1962
C. glomerulatus W. W. Smith 1917
C. nitidifolius Marquand 1930
C. newryensis Lemoine 1911

Ser. *Glomerulati* include species from the province of Yünnan in Southern China. In the description (MARQUAND 1930) *C. nitidifolius* is said to have only 2 pyrenae. We have found, however, that the berries of this species have 4 pyrenae — even the holotype (K).

Series 9. ***Bullati*** Flinck et Hylmö 1962

C. bullatus Bois 1904
C. rehderi Pojarkova 1955 (*C. bullatus* var. *macrophyllus* Rehder et Wilson 1912)
C. moupinensis Franchet 1886
C. cornifolius (Rehder et Wilson 1912) Flinck et Hylmö 1962
C. obscurus Rehder et Wilson 1912
C. reticulatus Rehder et Wilson 1912
C. sikangensis Flinck et Hylmö 1962

Series 10. ***Franchetioides*** Flinck et Hylmö 1962

C. franchetii Bois 1902
C. wardii W. W. Smith 1917
C. sternianus (Turrill 1950) Boom 1957
C. amoenus Wilson 1912
C. dielsianus Pritzel 1900
C. elegans (Rehder et Wilson 1912) Flinck et Hylmö 1962
C. splendens Flinck et Hylmö 1964
**C. fangianus* Yü 1963

We include *C. fangianus* in this series with some hesitation as we have seen no specimens of this newly described species.

Series 11. ***Zabelioides*** Flinck et Hylmö, ser. nov.

Frutices decidui, ramis graciliter arcuatis; folia herbacea; petala erecta vel subpatentia; pedicelli crassi; inflorescentiae multiflorae; stamina 20; fructus rubri; pyrenae magnae; numerus pyrenarum 2, raro 3.

Ab ea series Ser. *Cotoneaster* ramis crassioribus, petalis incurvatis, racemis paucifloris differt.

Species typica: *C. zabelii* Schneider in Ill. Handb. Laubh. 1: 749. 1906.

C. zabelii Schneider 1906
C. wilsonii Nakai 1918
C. genetianus Hurusawa 1943
C. gracilis Rehder et Wilson 1912

***C. miniatus* (Rehder et Wilson) Flinck et Hylmö stat. nov.** (*C. zabelii* Schneider var. *miniata* Rehder et Wilson in Sargent, Plant. Wilson. 3: 430. 1917)

C. wilsonii was described by NAKAI as being closely related to *C. racemiflorus* of Sect. *Chaenopetalum*. Even HURUSAWA (1943) included it in Ser. *Racemiflori*, dividing the species into two forms. Still KLOTZ (1963 a) relates *C. wilsonii* to *Racemiflori* and includes it in Ser. *Tomentelli*. We have seen the holotype (A) and paratypes (A and K) and without any hesitation relate *C. wilsonii* with *C. zabelii*. Ser. *Zabelioides* thus includes closely related species all native of the wintry North-eastern part of China and Korea, including the type locality of *C. wilsonii*, viz. Dagelet Islands east of the Korean peninsula. These small islands seem to be the easternmost outpost of the genus, the westernmost being Wales or Spain for *C. integerrimus*, Granada, Spain, for *C. granatensis*, or probably the Atlas mountains of Morocco, being the habitat of *C. atlanticus*.

Sect. II. *Chaenopetalum* Koehne 1893

Subsect. C. *Chaenopetalum*

Syn.: Sect. *Racemiflori* Klotz in Wiss. Zeitschr. Univ. Halle. Math. Nat. 12: 756. 1963.

Species typica: *C. frigidus* Wallich ex Lindley in Bot. Reg. 15, tab. 1229. 1829.

Series 12. ***Multiflori*** Pojarkova 1939

- *C. roseus* Edgeworth 1861
- *C. multiflorus* Bunge 1830
- **C. submultiflorus* Popov 1935
- **C. pseudomultiflorus* Popov 1935
- **C. megalocarpus* Popov 1935
- **C. mongolius* Pojarkova 1955
- **C. meyeri* Pojarkova 1955
- ***C. calocarpus* (Rehder et Wilson) Flinck et Hylmö comb. nov.** (*C. multiflora* Bunge var. *calocarpus* Rehder et Wilson in Sargent, Plant. Wilson, 1: 170. 1912)
- **C. roborowskii* Pojarkova 1961
- **C. kaschkarovii* Pojarkova 1961
- *C. przewalskii* Pojarkova 1961
- *C. reflexus* Carrière 1871
- *C. silvestri* Pampanini 1910 (Syn.: *C. hupehensis* Rehder et Wilson 1912)
- *C. granatensis* Boissier 1838

C. silvestri was described as related to *C. integerrimus* and *C. zabelii* and has since been treated so. We have the holotype specimen at our disposal (SILVESTER no. 900 a: Hupeh, Monte Niany-niany, alt. 1950 m, VII. 1907 (FI)) and find it synonymous with *C. hupehensis*.

C. przewalskii was described by POJARKOVA (1961) as synonymous to *C. multiflorus* Bunge var. *calocarpus*. As holotype, however, POJARKOVA did not choose the holotype of *C. multiflorus* var. *calocarpus*, which is WILSON no. 4015 from Szechuan (A) but a specimen collected by G. POTANIN in SE Kansu (LE). We have a specimen from Kansu collected by D. HUMMEL (no. 5154, Sept. 9, 1930 in Da-chu-Kuo ad Tan-chang, in prato silvatico ad pedem montis, ca 600 m.s.m. Frutex 1.5 m altus (S) which we want to identify as *C. przewalskii*. We feel that *C. przewalskii* and *C. calocarpus* are two distinct microspecies; we have both in culture.

Series 13. ***Tomentelli*** Klotz 1963

C. tomentellus Pojarkova 1961
**C. tumeticus* Pojarkova 1961
C. soongoricus (Regel 1873) Popov 1935
**C. allochrous* Pojarkova 1961
C. veitchii (Rehder et Wilson 1917) Klotz 1957

With some hesitation we accept KLOTZ' (1963 a) Ser. *Tomentelli*. The number of species, however, has been strongly reduced. Thus, we prefer to include *C. potaminii* in Ser. *Hebephylli*, *C. silvestri* (*C. hupehensis*) in Ser. *Multiflori* and *C. wilsonii* in Ser. *Zabelioides* (Sect. *Cotoneaster*).

Series 14. ***Racemiflori*** Pojarkova 1939

C. atlanticus Klotz 1963
C. racemiflorus (Desfontaines 1829) K. Koch 1869
**C. transcaucasicus* Pojarkova 1961 (*C. obovatus* Pojarkova 1954 non *C. obovatus* Wallich ex Dunn 1921)
**C. karatavicus* Pojarkova 1961
**C. krasnovii* Pojarkova 1961
C. discolor Pojarkova 1954
**C. schubertii* Klotz 1963
C. tauricus Pojarkova 1938
C. persicus Pojarkova 1954
C. ovatus Pojarkova 1950
C. parnassicus Boissier 1856

Series 15. ***Orbiculares*** Klotz 1963

C. nummularius Fischer et Meyer 1835
C. kotschyi (Schneider 1909) Klotz 1963
C. orbicularis Schlechtendal 1854
C. minutus Klotz 1963

Series 16. ***Saxatiles*** Pojarkova 1939

**C. saxatilis* Pojarkova 1938
C. nummularioides Pojarkova 1954
**C. turcomanicus* Pojarkova 1961
**C. subarcutus* Pojarkova 1961
**C. morulus* Pojarkova 1961
**C. tytthocarpus* Pojarkova 1961

Series 17. ***Insignes*** Pojarkova 1939

C. insignis Pojarkova 1939
Syn.: *C. lindleyi* auct.

**C. hissaricus* Pojarkova 1954
C. suavis Pojarkova 1954
C. aitchisonii Schneider 1906

C. suavis from Tadzhikistan (Hissar) seems to us very closely related to *C. aitchisonii* from Afghanistan. Having no comprehensive material available of *C. suavis* we prefer, for the present, to keep both species.

Series 18. ***Hebephylli*** Klotz 1963

C. hebephyllus Diels 1912

C. monopyrenus **(W. W. Smith) Flinck et Hylmö nov. stat.** (*C. hebephyllus* Diels var. *monopyrenus* W. W. Smith in Not. Bot. Gard. Edinb. 10: 27. 1917)

C. majusculus (W. W. Smith 1917) Klotz 1963
C. incanus (W. W. Smith 1917) Klotz 1963
C. ludlowii Klotz 1963

C. microcarpus **(Rehder et Wilson) Flinck et Hylmö nov. stat.** (*C. racemiflorus* (Desfontaines) K. Koch var. *microcarpus* Rehder et Wilson in Sargent, Plant. Wilson. 1: 169. 1912)

**C. potaninii* Pojarkova 1961

C. ludlowii was described by KLOTZ (1963 b) as belonging to Ser. *Marginati* (Subsect. *Microphylli*). The species, however, diverges strongly from Ser. *Marginati*, for instance, by having only one pyrena. We have at our disposal an abundance of collections from Himalaya (BM) belonging to KLOTZ' species and we do not hesitate to include *C. ludlowii* in Ser. *Hebephylli*.

Series 19. ***Chaenopetalum***

Syn.: Ser. *Frigidi* Yü 1954
C. affinis Lindley 1821
C. obtusus Wallich ex Lindley 1829
C. bacillaris Wallich ex Lindley 1829
C. frigidus Wallich ex Lindley 1829
C. cooperi Marquand 1927

Series 20. ***Salicifolii*** Yü 1963

C. henryanus (Schneider) Rehder et Wilson 1912
C. salicifolius Franchet 1886

C. floccosus (Rehder et Wilson) Flinck et Hylmö stat. nov. (*C. salicifolius* Franchet var. *floccosus* Rehder et Wilson in Sargent, Plant. Wilson. 1: 173. 1912)
C. rugosus Pritzel 1900
C. rhytidophyllus Rehder et Wilson 1912
C. dammeri Schneider 1904
C. morrisonensis Hayata 1915

For the creeping species *C. dammeri* and *C. morrisonensis* KLOTZ (1963 b) formed a new Ser. *Radicantes* which was included in Subsect. *Microphylli* (KLOTZ' Sect. *Alpigeni*). Many marks like 5 pyrenae, type of leaves, flowers and habitus allow us, however, to consider them closely related to Ser. *Salicifolii*.

C. dammeri is one of the very few species shown by SAX (1954) and ZEILINGA (1964) to be diploid. In our experiment *C. dammeri* is not breeding true and we believe this species to have normal sexual behaviour. Awaiting cytological investigations and cultivation experiments, we prefer to consider the new species of KLOTZ (1963) *C. kweitschoviensis* and *C. radicans* as clones within *C. dammeri*; probably even *C. procumbens* Klotz (1957) will have to be included in *C. dammeri*.

Series 21. ***Pannosi*** Flinck et Hylmö, ser. nov.

Frutices erecti, sempervirentes; folia coriacea; stamina 20, fructus rubri; pyrenae 2.

Species typica: *C. pannosus* Franchet in Plantae Delavayanae 3: 221. 1890.

C. glabratus Rehder et Wilson 1912
C. coriaceus Franchet 1890
C. lacteus W. W. Smith 1917
C. glaucophyllus Franchet 1890
C. harrovianus Wilson 1912

C. vestitus (W. W. Smith) Flinck et Hylmö stat. nov. (*C. glaucophyllus* Franchet var. *vestitus* W. W. Smith in Not. Bot. Gard. Edinburgh 10: 21. 1917)
**C. insculptus* Diels 1912
C. serotinus Hutchinson 1920
C. turbinatus Craib 1914

C. robustior (W. W. Smith) Flinck et Hylmö stat. nov. (*C. pannosus* Franchet var. *robustior* W. W. Smith in Not. Bot. Gard. Edinburgh 10: 21. 1917)
C. pannosus Franchet 1890
C. crispii Exell 1928

C. crispii was described as being a hybrid between *C. frigidus* and *C. pannosus*. However, in our experiments it breeds true (FLINCK & HYLMÖ 1964).

Subsect. D. *Microphylli* (Yü) Flinck et Hylmö, stat. nov.

Ser. *Microphylli* Yü in Bull. Brit. Mus. I, 5: 134. 1954.

Syn.: *Stirps* ("*Strips*") *C. microphylli* Baker in Saunders Refug. Bot. 1: Febr. 1869.

Gruppe *Alpigeni* Koch in Dendrol. 1: 175. 1869.

Sect. *Alpigeni* Hurusawa in Acta Phytotax. et Geobot. 13: 231. 1943. — KLOTZ (1963 b).

Series 22. ***Buxifolii*** Klotz 1963

C. buxifolius Wallich ex Lindley 1829
C. lichiangensis Klotz 1963
C. hodjingensis Klotz 1963
**C. delavayanus* Klotz 1963
C. brevirameus Rehder et Wilson 1912
C. rockii Klotz

Series 23. ***Microphylli***

C. conspicuus Marquand 1937
Syn.: *C. pluriflorus* Klotz 1963
  C. permutatus Klotz 1963
  C. nanus Klotz 1963
  C. argenteus Klotz 1963
C. rotundifolius Wallich ex Lindley 1829
**C. cashmiriensis* Klotz 1963
C. prostratus Baker 1869 (*C. microphyllus* Wall. cv. 'Ruby' Boom 1959)
C. congestus Baker 1864
C. thymifolius Baker 1869 (*C. integrifolius* (Roxburgh 1932) Klotz 1963)
C. microphyllus Wallich ex Lindley 1827
**C. cochleatus* (Franchet 1890) Klotz 1957
C. elatus Klotz 1963

C. conspicuus was shown by SAX (1954), as well as by ZEILINGA (1964), to be diploid. In our cultivation trials it does not breed true and we consider this species to have normal sexual behaviour. Awaiting the results from cytological investigations and breeding experiments we prefer to reject several of KLOTZ' (1963 b) new species, which according to our opinion represent a normal variation within the species *C. conspicuus.*

We should also like to forward a note on a herbarium specimen (K) made by MARQUAND by which the black hairs on the under side of the leaves of *C. buxifolius* forma *melanotricha* Franchet in Plantae Delavayanae 3: 224. 1890, are caused by a fungus. The mentioned forma has thus to be rejected. In culture we have seen a large number of plants grown under the name of *C. microphyllus* f. *melanotricha* (Franchet) Handel-Mazzetti (syn. *C. cochleatus* f. *melanotricha* (Franchet) Klotz) which we consider as typical *C. microphyllus.*

Series 24. ***Marginati*** Klotz 1963

**C. sherriffii* Klotz 1963
C. schlechtendalii Klotz 1963
C. marginatus Lindley ex Schlechtendal 1854 (*C. lanata* Jacques 1859)
**C. meuselii* Klotz 1963

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Studies in Montia L. and Claytonia L. and Allied Genera

II. Some Chromosome Numbers

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In this paper I will give a preliminary report of chromosome numbers of some species within the genera *Montia* L., *Claytonia* L., *Naiocrene* (Torrey & Gray) Rydb., and *Montiastrum* (Gray) Rydb. The chromosome numbers (varying basic numbers) have proved to be of importance in these genera, particularly for their delimitation but also for the taxonomy within them. For this purpose the external morphology of the chromosomes is also significant.

Living plants or seeds for this investigation was received from colleagues in N. America and Europe. Particularly I am grateful to Miss PATRICIA KERN, Seattle, Dr. ALICIA LOURTEIG, Paris, Dr. J. A. CALDERS, Ottawa, and Dr. K. L. CHAMBERS, Corvallis. Much material I have also got from seeds in herbarium specimens. Some seeds and plants I have collected in Scandinavia and SE. Europe. The material has been cultivated in greenhouse in the Botanical Garden of Lund.

The determination of the chromosome numbers have been made in mitoses from root tips. Usually two preparations of five plants from every collection have been examined. The Svalöv modification of NAVASHIN-KARPECHENKO's fixative followed by a standard crystal violet staining with an addition of aniline have been used, without any pretreatments. The external morphology of the chromosomes was studied in squash preparations. The technique for this was described by ÖSTERGREN & HENEEN 1962 (Hereditas 48 pp. 332—341), it has been used with a few modifications; Carnoy (3 parts acetic acid + 2 parts absolute alcohole) was used instead of the special fixative recommended, and after staining the roots were placed in a 5 % pectinase solution for about one hour, the roots were pretreated for 3 hours with a 1.7 mM solution of 8-hydroxy-quinoline at 10°C.

Dried plant material and seeds are preserved at the Botanical Museum of Lund.

Table 1. Chromosome numbers in *Montia, Naiocrene, Montiastrum,* and *Claytonia*

Species	2n	Collections investigated
Montia fontana L. coll.	20	Sweden: Lapland, Tärna, Ö. Nilsson; Västerbotten, Umeå, Ö. Nilsson; Östergötland, Krokek, Ö. Nilsson; Västergötland, Dalum, Ö. Nilsson; Halland, Ölmevalla, Hästholmen, Ö. Nilsson; Skåne, Dalby, J. Ericson; Skåne, Gladsax, Ö. Nilsson; Norway: Opland, Dovre, Dombås, Ö. Nilsson; Ostfold, Idd Bakke, Ö. Nilsson; Faroe Isl.: Sandoy, E. Kjellquist; Iceland: Reykavik, Geysir, E. Kjellquist; Greenland: Ûnartoq Fjord, K. Hansen et al.; Alaska: Kodiak Isl., SE. of Karluk, E. Hultén; Seward, Kenai Penins., J. A. Calder.
M. fontana L. coll.	40	Sweden: Skåne, Baskemölla, Ö. Nilsson.
M. minor C. C. Gmel.	20	Sweden: Skåne, Dalby, Ö. Nilsson; Skåne, S. Mellby, Stenshuvud, Ö. Nilsson; Skåne, Ullstorp, Ö. Nilsson; Skåne, Gladsax, Bäckhalladalen, Ö. Nilsson; Denmark: Zealand, Amager, Ö. Nilsson; Bornholm, Rönne, Ö. Nilsson; Jutland, Skive, Ö. Nilsson; France: Haut Rhin, Bollweiler, C. Simon; Italy: Calabria, Lago di Arvo, A. Chiarugi et al.; Hungary: c. Vas, SE. of Örség, T. Pócs; Jugoslavia: Serbia, Kriva Feja, H. Runemark & Ö. Nilsson; Greece: Naxos, S. of Komiaki, H. Runemark no. R-699; Australia: Victoria, Mt. Buffalo, near Chalet, F. N. Hobson; New South Wales, Adelong, H. S. Mac Kee no. 7239.
M. limosa Decker	20	Sweden: Skåne, Limhamn, Ö. Nilsson.
M. rivularis C. C. Gmel. coll.	20	Belgium: Antwerp, from Botanical Gard.; Portugal: Coimbra, from Bot. Gard.; Greece: Ikaria, H. Runemark; Mt. Olympos, Ö. Nilsson; Morocco: 10 km E. of Ifrane, N. Engleson.
M. hallii (Gray) Greene	20	Canada: B. C., Vancouver Isl., J. A. Calder; B. C. Saltspring Isl., Calder & Mac Kay; U. S. A.: Oregon, Benton Co., Steward; Washington, Seattle, P. Kern.
M. linearifolia Urv.	40	Kerguelen Isl., A. Lourteig; South Georgia: King Edward Cove, Bonner; Hestesletten, Smith; Esmark Glacier, S. W. Green.

Species	2n	Collections investigated
Naiocrene parvifolia (Moç.) Rydb.	22	U. S. A.: Oregon, Corvallis, K. Chambers, Oregon, Linn Co., E. of Foster, K. Chambers; California, Fremo Co., Quibell; Canada: B. C., SW of Hope, Calder & Savil nr. 8371.
N. flagellaris (Bong.) Heller	44	U. S. A.: Alaska, Kuiu Isl., W. J. Eyerdam no. 7582; Washington, Seattle, P. Kern.
Montiastrum dichotomum (Nutt.) Rydb.	14	Canada: B. C., Vancouver Isl., Mt. Newton, John Dear Park, M. C. Melbourn.
M. lineare (Dougl.) Rydb.	28	U. S. A.: Washington Kittitas Co., between Easton and Cle Elum, P. Kern; Oregon, Grand Co., SE. of Dayville, A. Cronquist no. 7341; California, Shasta Co., W. of Platina, E. K. Balls no. 11234; Washington, N. of Kettle Falls, Beamish & Vrugtman no. 60355.
Claytonia cordifolia S. Wats.	20	U. S. A.: Oregon, Harney Co., Steen's Mt., K. Chambers.
C. sibirica L. coll.	24	U. S. A.: Alaska, Kuiu Isl., W. J. Eyerdam; California, Mendocino Co., N. of Rock Port, E. K. Balls no. 10579; Canada: B. C., Englishmans River Park, W. of Parksville, M. C. Melbourn; B. C., Pike Lake, T. Todd.
C. sibirica L. coll.	48	U. S. A.: Oregon, Jefferson Co., Black Butte, J. Morris Johnson no. 490; Holland: Utrecht, cult. in Cantons Park no. 610.
C. spathulata Dougl. in Hook.	48	Canada: B. C., Vancouver Isl., Mt. Newton M. C. Melbourn.
C. perfoliata Donn coll.	12	U. S. A.: Oregon, Jefferson Co., Black Butte, J. Morris Johnson; California, Monterey Co., Meebold; Canada: B. C., Cedar Hill, Vancouver, M. C. Melbourn.
C. perfoliata Donn coll.	24	U. S. A.: California, Marine Co., Howell 1947.
C. perfoliata Donn coll.	36	U. S. A.: Washington, Chelan Co., S. of Wenatchee River, P. Kern; Oregon, Linn Co., E. of Foster, K. Chambers; England, cult. in Chelsea Phys. Gard.; Germany: Oberhessen, Kr. Alsfeld, H. Hupke; Bonn, cult. in Bot. Garden.
C. gypsophiloides Fisch & Mey.	16	U. S. A.: California, Sonoma Co., Benson.

In the genus *Montia* the chromosomes are short and rod-shaped. The absolute length of the chromosomes varies in the diploid species ($2n=20$) from 0.9 to 1.8 μ (in the tetraploid taxa they are somewhat smaller), in preparations made after the technique mentioned above.

In some species the longest chromosome in one set may be twice the length of the shortest. The chromosomes are usually ± metacentric with a rather distinct centromere. The diploid species have all one pair of satellited chromosomes. This satellite is almost as broad as the chromosome body and is distinctly connected to the chromosome arm by means of a long coarse "stalk". The tetraploid *M. fontana* has two pairs of satellited chromosomes of the same size, while *M. linearifolia* has two pairs of different size. In *M. fontana*, 2n=40, the four genomes are all very similar, but in *M. linearifolia* two are different from the others. The karyotypes of different species are often taxonomically valuable. The length and shape of the satellited chromosome compared to the rest of the chromosome set is easily observed and a useful character. In e.g. *M. fontana*, 2n=20, the satellited chromosome is somewhat shorter than the longest of the other chromosomes, but in *M. minor* it is distinctly longer. In some species one pair of chromosomes is distinctly longer than the other. This long chromosome usually has another secondary, ± terminal constriction. The karyotypes of different taxa in this genus will be described in a later paper. The chromosomes of *Montia* are similar to those of *Neopaxia* (cf. Ö. NILSSON 1966, p. 277) but somewhat longer. For *M. fontana* and *M. minor* 2n=18 has been reported previously, but this must be caused by some misinterpretation (cf. also MOORE 1963, p. 26). The basic number is 10.

The chromosomes of *Naiocrene* are very similar to those of *Montia* considering size and shape. In *N. parvifolia* one satellited chromosome pair has been noticed. Only chromosomes with a ± median, distinct centromere have been observed, one pair has a secondary constriction. Compared to *Montia* the chromosomes are somewhat more uniform in length. The basic number is 11.

In *Montiastrum* the karyotype differs in many respects from those of preceding genera. The chromosomes are longer, about five times longer than those of *Montia*. In metaphase II they are often winding or bent in various directions. The centromere is in many pairs ± subterminal. At least three of the longest chromosomes have a secondary constriction. In the diploid *M. dichotomum* one satellited pair has been observed. The satellite is distinctly thinner than the rest of the chromosome. The chromosomes within one set vary somewhat in length, the shortest is about $^2/_3$ of the longest. The chromosomes of this genus resemble in their shape more those of *Claytonia* than those of *Montia*. The basic number is 7.

In *Claytonia* the chromosomes vary somewhat in size between different taxa examined. In comparison to those of *Montia* they are longer. In *C. perfoliata* (2n=12) the chromosomes are in relative length about 7—9 times longer than those of *Montia*, and those of *C. cordifolia* are 12—15 times longer. The chromosomes are rod-shaped and much winding in metaphase II. The centromeres may be median but are usually placed in a ± terminal position. In the diploid taxa only one satellited pair of chromosomes has been observed. The satellite is distinctly thinner than the rest of the chromosome. Most of the other chromosomes have a secondary constriction. The length of the chromosomes within one set varies much in some taxa, whereas they are ± uniform in length in other taxa. In *C. perfoliata* (2n=12) the longest chromosome is about twice the shortest, in *C. cordifolia* they are ± uniform. In the length and shape the chromosomes of *C. cordifolia* resemble those of *C. sibirica*. On the other hand the chromosomes of the other species are similar, e.g. between *C. perfoliata* (2n=36) and *C. spathulata* there is much resemblance. The chromosome numbers are known for rather many species within this genus. LEWIS (1962, pp. 918—928) and ROTHWELL (1959, pp. 353—360) reported aneuploid series for *C. virginica*, the chromosome numbers vary widely, 2n=12 to 2n=72 in some populations. DAVIS & BOWMER (1966, pp. 37—38) have obtained differing counts for e.g. *C. sarmentosa* C. A. Mey. (n=7, 8, 14 and 16) from one single collection, and varying numbers in some collections of *C. lanceolata* Pursh and *C. virginica*. In their counts 2n=24 and 16 are the most usual diploid numbers. My counts n=10 (*C. cordifolia*) and n=6 (*C. perfoliata*) give haploid numbers not previously reported from this genus.

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Botaniska Notiser 1966 · Vol. 119 · Fasc. 3 · Lund

Smärre uppsatser och meddelanden

Studies in Montia L. and Claytonia L. and Allied Genera, I.

Correction and Additions

In the second fascicle of this journal 1966 (Bot. Notiser 119, pp. 266—285) I described the two new genera *Mona* Ö. Nilss. and *Paxia* Ö. Nilss. Dr. Walter H. Lewis, Missouri Botanical Garden, St. Louis, U.S.A., has drawn my attention to the fact that the latter is a later homonym of *Paxia* Gilg 1891, in Engler, Bot. Jahrb. 14, p. 320 and in Engler & Prantl, Nat. Pflanzenfam. II: 3, p. 70 (*Connaraceae*) and also to *Paxia* Herter 1931 in Estud. Bot. Reg. Urug. 4, p. 8, nom. nud. (*Euphorbiaceae*).

I now propose a new name:

***Neopaxia* Ö. Nilss. nom. nov.** (syn. *Paxia* Ö. Nilss., l.c. p. 274).

Type species *Neopaxia australasica* (Hook. f.) Ö. Nilss. comb. nov. (basionym *Claytonia a.* Hooker f. 1840 in Icon Plant.).

Recently I received some new collections of *Mona meridensis* (Friedrich) Ö. Nilss. from Caracas in Venezuela (VEN). I want to thank the direction of this herbarium and also Dr. Volkmar Vareschi for making this material available to me.

The new collections are:

Venezuela, Est. Merida: Between Chachopa and Los Apartaderos, 13,000 feet, no. 55889, 1944; Laguna Mucubaji, 3750 m., L. Aristequcita no. 921, 1952; Mucubaji, 3750 m., Vareschi no. 2096, 1952 (isotype); Cerca Laguna Mucubaji, 3600 m., Vareschi no. 7002 and no. 7119, 1958; Pico del Aquila, E. L. Little Jr. no. 16288, 1954; Mucubaji, Vareschi no. 8032, 1964; Laguna Anteogos, Massif del Pico Bolivar, Sierra Nevada de Merida, 4200 m., Vareschi no. 7835, 1965.

The distribution of the species within the state of Merida in Venezuela is now known in more detail through these new collections.

On the labels of some of the specimens there is given some further information on the ecology and the mode of growth of this species. *Mona meridensis* grows in moist places around small pools, lakes or near springs, in a type of vegetation described by Vareschi as *Epilobietum meridensis*. It reaches an altitude of 4200 m. The plants often form dense mats by their prostrate stems and branches. The flowers are noted to be cream coloured or whitish yellow and the leaves are membranaceous and often ± reddish on ascending stems.

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Litteratur

J. D. HOOKER: *The botany of the antarctic voyage of H. M. Discovery Ships Erebus and Terror in the years 1839—1843.* Under the command of Captain Sir James Clark Ross. — London 1844—1860. 3 volumes text (2224 pp.) + 1 volume atlas (528 plates). Facsimile edition (J. Cramer, Weinheim, Germany) 1963. Price DM. 960: —.

The 19th century saw many scientific voyages to unknown and at that time remote parts of the world. The British Erebus and Terror expedition to Antarctica and adjacent continents is known as one of the most important enterprises of this epoch. Its botanical results were published by JOSEPH DALTON HOOKER in a classical work, which, like many floras and monographs of the past century, has now become extremely rare. In 1960 a British bookseller offered a complete copy (including the coloured plates) at a price of £ 900. Among the many reprints of botanical works from the 18th and 19th centuries which have appeared during the last few years, the reissue of the "Erebus and Terror" should be mentioned as outstanding. This work is indispensable to all botanists working on the taxonomy and phytogeography of the southern hemisphere.

The reissue appears in a somewhat different form from the original edition. The text-volumes I. Flora antarctica (preceded by a "Summary of the voyage") (1847), II. Flora Novae-Zelandiae (1853—1855), and III. Flora Tasmaniae (1860) have been reduced to royal octavo size. The 528 plates, which in the first issue were contained among the three text-volumes, have been reproduced in the original quarto size and combined in one volume. The plates now appear in black-and-white. It is evident that this method has reduced the beauty of the coloured plates of the original work, but in general the reproductions can be considered good.

The bibliography of this work is somewhat involved. The years of publication quoted above, which appear on the title-pages, are partly misleading. Part I was issued in instalments between 1844 and 1847, part II in the same way between 1852 and 1855, and part III between 1855 and 1860. The differences can sometimes become important from a nomenclatural point of view. The exact dates of publication are quoted (compiled from various sources) in Flora Malesiana I, vol. 4^5 (1954) and in Taxon 14 (1965). An introduction containing some bibliographic and biographic information would have been a useful complement to the reissue of this magnificent work.

OVE ALMBORN

MASON E. HALE, Jr.: *A Monograph of Parmelia Subgenus Amphigymnia.* — Contributions from the U.S. National Herbarium 36: 5. Washington 1965. 168 pp., 16 plates, 29 figures (mainly distributional maps) in the text.

Parmelia has been considered as a fairly well known lichen genus in Europe (c. 75 species recorded, sec. POELT 1963) and in North America (c. 120 species, sec. HALE & CULBERSON 1960). Its main centres of distribution, however, are situated in tropical and subtropical areas. The total number of species, including *Hypogymnia* and *Menegazzia,* (which have often been treated as proper genera) has been estimated at c. 800. Many of them have been poorly known and often from the type locality only. A critical world monograph of this large genus has been eagerly desired by all lichenologists. The present volume by Dr. M. E. HALE (Smithsonian Institution, Washington, D.C., U.S.A.) deals with the subgenus *Amphigymnia.* It is proposed to be followed by revisions of the subgenera *Parmelia, Xanthoparmelia* (yellow species), and *Melanoparmelia* (brown species). HALE has completed a careful and well-written volume. No doubt, it is one of the most important contributions to lichen taxonomy in many years.

HALE has given a narrower delimitation to *Amphigymnia* than the one accepted by VAINIO and ZAHLBRUCKNER. So a considerable number of species have been transferred to the subgenera *Parmelia* or *Xanthoparmelia.* The *P. cetrarioides* group has not been included, as its position has not yet been determined. The total number of *Amphigymnia* species accepted amounts to 106 including 22 n.spp. described by HALE in the present volume. No subspecific taxa have been accepted. A considerable number of taxa have been reduced to synonymy. This is the result of a careful investigation of type specimens and other material from all important herbaria. The list of *nomina inquirenda,* where the type material has been too fragmentary for study or is presumably lost, is fairly short. On the whole, it seems probable that the nomenclature accepted by HALE will prove to remain stable.

Introductory chapters are devoted to morphology, chemistry and geographical distribution. HALE points out that the structure of the lower side of the thallus (especially the rhizines) and the "maculae" (=white spots in the upper cortex similar to pseudocyphellae) afford good specific characters. Much attention has been given to chemistry. A total of 23 lichen substances have been demonstrated in the 106 species. The structure of 8 of them is still unknown. "Chemical strains" have been found in several species, and their rôle as taxonomic critera is discussed.

The descriptions of the species are fairly brief, but they seem to contain all essential data for the taxonomic delimitation. Each description is followed by a discussion of the systematic position of the species, and the decisive characters are appraised. The species concept seems to be well founded, mainly on characters from external morphology. Microscopical data from apothecia and spores are given, whereas few facts are quoted about the microscopical anatomy of the thallus, which is evidently of little use in the taxonomy of *Parmelia.*

To the merits of this book should be added that it is not encumbered with many "chemical species". In some cases, however, (*P. margaritata - P. arnoldii,* *P. perforata* - *P. rigida*, and *P. xanthina* - *P. aberrans*) the specific delimitation has been founded on correlation in chemistry and geographical distribution within each pair of species. E.g., *P. margaritata* contains salacinic acid and is restricted to eastern North America, whereas the morphologically identical *P. arnoldii* has alectoronic acid and is widely distributed in Europe and America (including eastern N. America). The reviewer would recommend that *P. arnoldii, P. rigida,* and *P. aberrans* be treated as "chemical strains" of *P. margaritata, P. perforata,* and *P. xanthina* respectively, as the distribution patterns are partly overlapping within each pair of species.

Artificial keys to the 106 species are given, often using distinctions as "medulla C+ red" vs. "med. C—" or "corticolous" vs. "saxicolous". There keys do certainly not claim to reflect any "natural system", but they are extremely useful as guides to the species. Several checks made by the reviewer showed that this approach is successful.

All of the material revised has been recorded in detailed lists of localities for each species. Further, the distribution of each species has been given in dot maps. Some areas, such as N. America, Africa and Japan, are well represented, whereas considerable gaps are found in S. America, Indonesia, China, and Australia. Several species have interesting patterns of distribution, often correlated with temperature and precipitation. Areas of other species, probably due to historical or propagative factors, are more difficult to explain.

Ove Almborn

D. D. Awasthi: *Catalogue of the lichens from India, Nepal, Pakistan and Ceylon.* — Beihefte zur Nova Hedwigia 17. Weinheim (J. Cramer) 1965. 137 pp. Price DM. 40: —.

Although the first lichen from India was recorded more than two hundred years ago (Linnaeus 1753), our knowledge of the lichen flora of this subcontinent is still fairly incomplete. Collections of Indian lichens, as a rule made by non-lichenologists, have been worked up by specialists in Europe. Several lists of localities have been published, and a considerable number of new species have been described, many of them known from the type collection only. Some scattered material is found in the monographic literature (e.g. *Acarospora, Cladonia,* and *Usnea*), but no effort at a Lichen Flora of India has ever been made.

Dr. D. D. Awasthi (Dept. of Botany of the University, Lucknow, India), who has been working on Indian lichens for the last two decades, has issued a catalogue of all lichen species known from India including Nepal, Pakistan and Ceylon. This catalogue lists, alphabetically arranged, 158 genera and 1310 species. Several of the species are obviously synonyms, so that the real number of species recorded from India will amount to a lower figure. About half of the species listed were first described from India. In these cases, the location of the type material (usually in European herbaria), is indicated.

The work also includes a list of literature concerning lichens recorded from India. There is no taxonomic treatment of the material, except for some new combinations, which the author has considered as necessary in order to fit all species into the genera of Zahlbruckner's system. Whether or not such preliminary combinations will gain acceptance will only become apparent on the appearance of a taxonomic revision.

The present volume is comparable to similar catalogues compiled for other areas, whose lichen flora is imperfectly known, e.g., Southern Africa (DOIDGE), Central America, Mexico and the West Indies (IMSHAUG), Argentina (GRASSI), and Chile (FOLLMANN). These afford valuable starting material for thorough taxonomic revisions, which must precede the issue of lichen floras of less known areas. To quote the words of J. D. HOOKER (Flora Indica, 1855): "The botanist should endeavour to determine how few, not how many, species are comprised in the flora of his district."

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Disputationer. Vid Lunds universitet försvarade fil. lic. SUNE PETTERSSON den 7 maj 1966 avhandlingen: »Active and Passive Processes of the Sulfate Transport through Roots», fil. lic. SVEN-OLOV STRANDHEDE den 16 maj 1966 avhandlingen: »Studies in European Eleocharis, Subser. Palustres», fil. lic. BJÖRN E. BERGLUND den 17 maj 1966 avhandlingen: »Late-Quaternary Vegetation in Eastern Blekinge, South-Eastern Sweden. A Pollen-Analytical Study», fil. lic. STIG OLOF FALK den 21 maj 1966 avhandlingen: »Effect on Transpiration by Rapidly Changed Water Transport», och fil. lic. GERHARD HOLM den 15 sept. 1966 avhandlingen: »Studies in chlorophyll mutations in barley».

Vid Uppsala universitet disputerade den 21 maj 1966 fil. lic. GUNNAR WASSÉN på avhandlingen: »Gardiken. Vegetation und Flora eines lappländischen Seeufers».

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is edited by the Botanical Society of Lund, Sweden, as a supplement to Botaniska Notiser. The series consists of larger treatises, issued at indefinite times. About 400 pages form a volume. Price per volume for members: vol. 1—4 15 Sw. kr., vol. 5—10 20 Sw. kr. (vol. 5, bound, 28 kr.), vol. 11 30 Sw. kr., vol. 12 42 Sw. kr. Address Opera Botanica, Botanical Museum, Lund, Sweden.

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