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CHROMOSOME NUMBERS OF SOME ARCTIC OR BOREAL FLOWERING PLANTS

BY

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WITH 57 FIGURES IN THE TEXT

KØBENHAVN
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INTRODUCTION

During the Botanical Expedition to West Greenland in 1946 (see Böcher 1949) some fixations of flower buds and a number of collections of living plants and seeds were made in order to provide material for the counting of chromosomes and for cultivation experiments.

The material was later supplemented with some fixations made in Greenland by Kai Larsen, B. A., and Knud Jakobsen, B. A., and a sample of flower buds of *Campanula* fixed in Northeast Greenland by Dr. Th. Sörensen. Furthermore it contains a number of seed samples collected in Greenland in particular by Knud Jakobsen, and finally it was made to include some seeds from Iceland, the Faroes, and Denmark as well as some seeds from the Kola peninsula and northern North America obtained through the Botanical Gardens in Copenhagen.

The seeds were sown and the plants later cultivated in the Botanical Gardens in Copenhagen. Root tips were fixed in Nawashin and stained with gentian violet. For flower buds a short prefixation in Carnoy and staining after Feulgen was employed.

The present paper contains only the chromosome numbers, some few other cytological observations, and some remarks on the plants investigated. Most of the taxonomical problems which may be raised through the chromosome countings will be dealt with in a later paper on the flora of West Greenland. In the same paper the results of the cultivations will appear.

In the following list the species are mentioned in the same sequence as in the work of Löve and Löve (1948). Papers cited in Löve and Löve are not included in the list of references.

We wish to express our thanks to all who have assisted in the collecting of the material and to the Carlsberg Foundation for a grant towards the technical work.

CYTOLOGICAL OBSERVATIONS

Anthoxanthum odoratum L.

Material from six difierent countries was studied. Two samples were diploid and four tetraploid:

1. South Greenland, Narsarssuaq, Tunugdliarfikfjord, subarctic birch wood. Collector: T. W. B. (Böcher), 2 n = 10, cf. fig. 1.
2. The Kola Peninsula. Wild material from Hortus Botanicus Arcto-Alpinus (U.R.S.S.). 2 n = 10, cf. fig. 2.
3. The Faroes, Kirkebø Reyn, montane locality. Collector: F. H. Møller. 2 n = 20.
4. Denmark, Bornholm. Dry grassland on the point Raghammer Odde. Collector: T. W. B. 2 n = 20.
5. Bulgaria, Sofia. Botanical Gardens, 2 n = 20.
6. Rumania, Cluj, Botanical Gardens, 2 n = 20.

The plants cultivated from Cluj were very tall and early and deviated much more from other tetraploid types than did the tetraploids from the diploids. The montane plants from the Faroes were very late in comparison with some subalpine Norwegian plants which were cultivated simultaneously, but which unfortunately died and were not studied cytologically. Compared with Danish plants the Faroese plants were rather low-growing and they flowered simultaneously or a little later. The diploid type, which Löve and Löve regard as a separate species, *A. alpinum*, was previously recorded from the Alps and from alpine stations in Norway and northern Sweden (Östergren 1942). Its range can now be extended to North Russia and Greenland.[1] Cultivated in the experimental field the diploid type from Greenland was rather weak and it died during 1949 after two years' cultivation, whereas all the tetraploids survived.

In the material of diploids a pair of SAT-chromosomes with a large satellite and a fairly long achromatic piece were observed (figs. 1—2). The chromosomes reminded of the SAT-chromosomes in *A. aristatum* described by Östergren (1947). In some of the tetraploids such chromosomes were not observed and may be absent.

[1] Very recently (De Litardiere 1949) a diploid Mediterranean variety (var. *corsicum* (Briq.) Rouy) has been found.

Phleum commutatum Gaud.

7. Southwest Greenland, Ivigtut, herb field on the bank of a river. Collector: T. W. B. 2 n = 28.
8. Southwest Greenland, Grønnedal, Arsukfjord, wet grassland on the bank of a river. Collector: T. W. B. 2 n = 28.

The number corresponds to that found by NORDENSKJÖLD (1945).

Agrostis borealis Hartm.

9. Southwest Greenland, Ivigtut, snow patch vegetation. Collector: T. W. B. 2 n = 56.

The same number was previously stated by SOKOLOVSKAJA (1938).

Calamagrostis neglecta (Ehrh.) G., M. and Sch.

10. West Greenland. Head of Søndre Strømfjord, river bed. Collector: T. W. B. 2 n = 28.
11. West Greenland. Head of Søndre Strømfjord, wet soil between tussocks in a *Rhododendron lapponicum* moor. Collector: T. W. B. 2 n = 28.

The number is in accordance with that stated by FLOVIK (1938), ROZANOVA (1940), NYGREN (1946), and LÖVE and LÖVE (1948).

Calamagrostis lapponica (Wg.) Hartm. var. *groenlandica* Lange.

12. West Greenland. Head of Søndre Strømfjord. *Betula nana*-heath. Collector: T. W. B. 2 n = 42.

My material of "*Calamagrostis hyperborea*" must according to kind oral information by Dr. TH. SØRENSEN be referred to *C. lapponica* var. *groenlandica*. NYGREN (1946, p. 216) mentions two specimens from Lapland of *C. lapponica* with the number 2 n = 42. Most Scandinavian plants, however, belong to a highly polyploid apomictic race group with about 105 or 112 chromosomes in somatic tissues (NYGREN *l. c.*).

Calamagrostis canadensis (Michx.) P. B. ssp. *Langsdorfii* (Link.) Hultén.

13. Southwest Greenland, Ivigtut in Arsuk fjord. Collector: T. W. B. 2 n = 56; see fig. 4.

Calamagrostis purpurascens R. Br.

14. West Greenland. Head of Søndre Strømfjord; subarctic steppe vegetation on dry loess soil. Collector: T. W. B. 2 n = 56; see fig. 5.

According to AVDULOV (1931) and NYGREN (1946) the closely related *C. arundinacea* (L.) Roth. has the chromosome number 2 n = 28. Thus, *C. purpurascens* may be regarded as an arctic tetraploid species within the *C. arundinacea* species group.

Deschampsia brevifolia R. Br. var. *pumila* Ledeb. (*D. pumila* Ledeb.).

15. West Greenland, Nugssuaq peninsula, Eqaluit (70°24′); wet sand flats at the mouth of a river together with *Eriophorum Scheuchzeri*, *Juncus castaneus* and *J. triglumis*. Collector: KNUD JAKOBSEN. 2 n = 39, cf. fig. 3.

GELTING (1934) has studied *D. brevifolia* (*arctica*) and its variety *pumila* in Northeast Greenland. According to him it is very difficult to keep these two grasses separate. Hence, he regards the *pumila*-plants as a variety only. HAGERUP (1939) studied the chromosome numbers of both forms in material from Northeast Greenland and found n = 14 in both cases. The material from West Greenland of the *pumila*-type with 2 n = 39 may go to show that the taxonomical unit called *pumila* covers more than one type. The uneven chromosome number 2 n = 39 is interesting by suggesting apomixis or hybrid origin. A hybrid between a plant with 2 n = 52 and a plant with 2 n = 26 (*brevifolia*?) would give rise to plants with 2 n = 39. According to GELTING (*l. c.*) the seed production of the *pumila*-type is very defective, but it is also rather defective in *D. brevifolia*.

In the West Greenland material the nuclei seem to contain three chromosome sets each containing 13 chromosomes. In the plate fig. 3 only three very long and angular chromosomes are seen. The plate was very easy to count, but otherwise not quite typical as the chromosomes were extraordinarily short and condensed.

Deschampsia alpina (L.) R. and S.

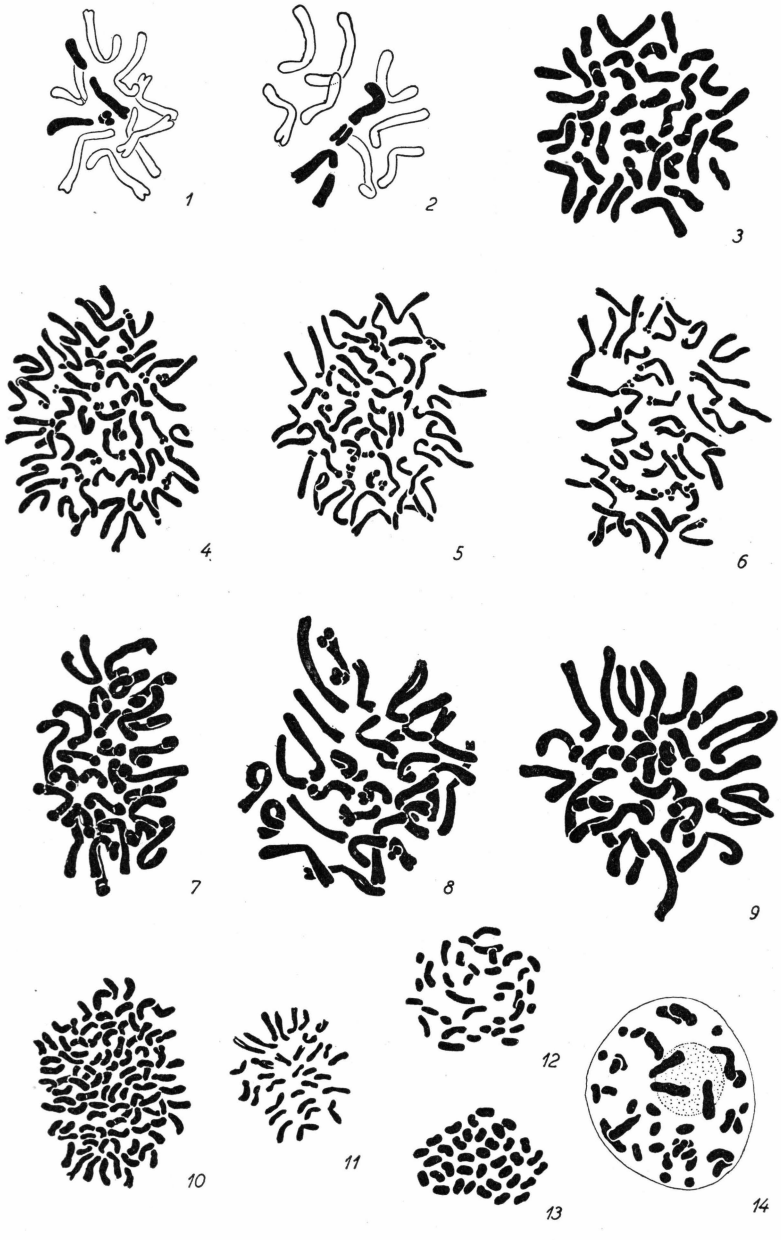
16. Southwest Greenland. Ivigtut, alpine snow bed on Mount Guldfjæld. Collector: T. W. B. 2 n = 52.

The plants were viviparous and the chromosome number agrees with that found by NYGREN (1949) in several viviparous forms from Scandinavia. The number 52 is in good agreement with other numbers in the *D. caespitosa* group where 13 is the basic number (LAWRENCE 1945, NYGREN *l. c.*). HAGERUP (1939) gives the chromosome number 2 n = 56 for *D. alpina* from Norway and n = 14 for *D. brevifolia* and *pumila* from Northeast Greenland. These numbers may now, after the finding of several races or species within the *D. caespitosa* group, with numbers being multiples of 13, be in need of affirmation.

Deschampsia flexuosa (L.) Trin.

17. Southwest Greenland. Ivigtut; *Betula glandulosa* heath. Collector: T. W. B. 2 n = 28.
18. The Faroes. Klaksvik, *Calluna* heath. Collector: T. W. B. 2 n = 28.

The number 2 n = 28 was previously found by STÄLIN, HAGERUP, and LÖVE and LÖVE.



Figs. 1—14. Metaphase plates from mitoses in the root tips. 1—2 *Anthoxanthum odoratum* (diploid), 3 *Deschampsia brevifolia* var. *pumila* (*D. pumila*), 4 *Calamagrostis canadensis* ssp. *Langsdorfii*, 5 *Calamagrostis purpurascens*, 6 *Trisetum spicatum*, race with 2 n = 42, 7 *Poa alpina*, 8 *Roegneria Doniana* var. *virescens*, 9 *Elymus mollis*, 10 *Sisyrinchium angustifolium* (garden form), 11 *Sisyrinchium montanum*, 12 and 14 *Luzula confusa*, 13 *Luzula multiflora* ssp. *frigida*. × 1950.

Trisetum spicatum (L.) Richt.

19. West Greenland. Head of Søndre Strømfjord; fairly dry river bed. Collector: T. W. B. 2 n = 28.
20. Southwest Greenland. Ivigtut. Snowpatch vegetation. Collector: T. W. B. 2 n = 42. Cf. fig. 6.

There are some interesting morphological and physiological differences between these two chromosome races of *Trisetum spicatum* which deserve a closer study. The number 2 n = 28 has been stated previously by FLOVIK and LÖVE and LÖVE.

Poa pratensis L. ssp. *eu-pratensis* Hiit.

21. West Greenland. Head of Søndre Strømfjord. Meadow in a river valley. Collector: T. W. B. 2 n = ab. 95.

A very tall grass which according to determination by Professor I. A. NANNFELDT belongs to the *eu-pratensis* group.

Poa alpina L.

22. West Greenland. Margin of the inland ice at 67° lat. north. Wet sand in a river bed. Collector: T. W. B. 2 n = 28. Cf. fig. 7.

The plants in question deviated morphologically in being loosely tufted. This character, however, was probably due to the peculiar habitat. When transplanted to Copenhagen the plants gradually became more normal in appearance. They were non-viviparous. In another non-viviparous form from Angmagssalik in East Greenland the chromosome number was found to be 2 n = 33 (BÖCHER 1938). A large number of races from other countries than Greenland have been studied in particular by MÜNTZING (1940, 1945).

Poa glauca Vahl.

23. West Greenland, Head of Søndre Strømfjord. Dry grassland. Collector: T. W. B. 2 n = 63.

A robust plant very easy to cultivate in Denmark. The number corresponds to that stated by LÖVE and LÖVE. According to the same writers the number 2 n = 70 was found in Greenland material investigated by SØRENSEN and WESTERGAARD, thus there are at least two, and probably more, chromosome races of this species in Greenland.

Poa nemoralis L.

24. Southwest Greenland, Arsukfjord, Grønnedal. Willow scrub. Collector: T. W. B. 2 n = 42.
25. Bulgaria, Botanical Gardens, Sofia. 2 n = 47—49.

The number 2 n = 42 was also found by ÅKERBERG, KIELANDER, and LÖVE and LÖVE.

Puccinellia deschampsioides Th. Sørensen.[1]

26. West Greenland. Head of Søndre Strømfjord. Store Saltsø at the shore of the lake. Collector: T. W. B. 2 n = 56.
27. West Greenland. Head of Søndre Strømfjord. Mount Hassell. Collector: T. W. B. 2 n = 56.

No. 26 has decumbent and No. 27 erect or ascending shoots, also when cultivated in Denmark.

Festuca vivipara (L.) Sm.

28. Southwest Greenland. Mount Guldfjæld at Ivigtut. Collector: T. W. B. 2 n = 28.
29. Southwest Greenland. The Ivigtut valley. Collector: T. W. B. 2 n = 28.

According to TURESSON this species has 2 n = 21, 28, or 42. Furthermore FLOVIK found a type with the number 2 n = 49.

? *Festuca rubra* L.

30. West Greenland. Head of Søndre Strømfjord. Dry grassland. Collector: T. W. B. 2 n = 42.

The plants had a somewhat deviating shoot structure, being tufted almost in the same degree as *F. trachyphylla*. This structure is maintained in culture. BÖCHER (1947) refers to the same material as a robust race, which reminds of *F. trachyphylla*. It may, however, be incorrect to refer the plants to the *F. ovina*-species group as the basal sheaths are reddish and the structure of the leaves reminds more of *F. rubra* than of *F. ovina*.

Roegneria

Our material of *Agropyrum* sect. *caninum* (= *Roegneria* C. KOCH) has kindly been determined by Dr. A. MELDERIS, Uppsala. According to him the Greenland *Roegneria* may be divided into three different species. (MELDERIS 1950). All three species have the same chromosome number.

Roegneria violacea (Hornem.) Melderis.

31. West Greenland. Head of Søndre Strømfjord. Subarctic steppe. Collector: T. W. B. 2 n = 28.

Roegneria Doniana (White) Melderis var. *virescens* (Lge) Melderis.

32. South Greenland. Narsarssuaq in the Tunugdliarfik fjord. Rock ledges in subarctic birch wood. Collector: T. W. B. 2 n = 28 (fig. 8).

Roegneria borealis (Turcz) Nevski var. *hyperarctica* (Polunin) Melderis.

33. West Greenland. Qapiortoq kitdleq in Aufarssuaq (70°27′ lat. north). Sunny slope at a river bed. Collector: KNUD JAKOBSEN. 2 n = 28.

LÖVE and LÖVE (1944) give the same chromosome number for mate-

[1] A new species which will be described in a paper by Dr. TH. SØRENSEN.

rial of typical *R. borealis* (*R. scandica*) from the Torneträsk region in Torne Lappmark. In my material from Greenland no chromosome-morphological differences between the three species were observed. Thus, from a cytological point of view, the boreal and arctic *Roegneria* complex seems to be very uniform.

Elymus arenarius L.

34. Denmark, Gilleleje. Dunes at the harbour. Collector: T. W. B. 2 n = 56.
35. Denmark. Copenhagen. Botanical Gardens. 2 n = 56.
36. Bulgaria, Sofia. Botanical Gardens. 2 n = 56.

The number agrees with that found earlier (AVDULOV 1941, ÖSTERGREN 1940).

Elymus mollis Trin. (*E. arenarius* ssp. *mollis* (Trin.) Hultén).

37. Southwest Greenland. Ivigtut. Beach at the fjord. Collector: KJELD HOLMEN. 2 n = 28.
38. Canada, Montreal. Botanical Gardens. 2 n = 28 (fig. 9).

E. mollis is found to be diploid, while the closely related *E. arenarius* is tetraploid. The two species can be distinguished morphologically and have different geographical areas and chromosome numbers (cf. LÖVE (1950) who found 2 n = 28 in *E. mollis* from several stations in Iceland).

Luzula parviflora (Ehrh.) Desv.

39. Southwest Greenland, Ivigtut. Collector: T. W. B. 2 n = 24.
40. Canada, Montreal. Botanical Gardens. 2 n = 24.

The seeds from Montreal were sent from the garden under the name of *L. parviflora* var. *melanocarpa* (Michx.) Buch. In material originating from two different stations in North Lapland the same number 2 n = 24 was found by LÖVE and LÖVE (1944) and NORDENSKJÖLD (1949).

Luzula confusa Lindeb.

41. West Greenland. The Nugssuaq peninsula. Collector: KNUD JAKOBSEN 2 n = 36, see fig. 14.
42. East Greenland. Angmagssalik. Collector: K. L. (KAI LARSEN) 2 n = 36, see fig. 12.

According to NORDENSKJÖLD (1949) material from Härjedalen has also 2 n = 36, while SØRENSEN and WESTERGAARD have counted 2 n = 48 in *Luzula confusa* from Northeast Greenland.

Of special interest is the great difference in size between the chromosomes. NORDENSKJÖLD found three chromosome sizes, about 1.9 μ, 1.1 μ, and 0.7 μ in length. There were 12 large and about 12 in the two other size classes. In the material studied by us from Greenland similar differences in size occur, but the size classes do not seem to correspond entirely with those found in Scandinavian material. We

may distinguish four classes: 6 very long chromosomes (about 2 μ), 6 rather long (about 1.7 μ), 18 short chromosomes (about 1.1 μ), and 6 very short chromosomes (about 0.7 μ). These classes were particularly easy to demonstrate in late prophases, where the condensation of the chromosomes was less pronounced (compare figs. 12 and 14). It will undoubtedly be valuable to make further cytological observations on this species. *Luzula confusa* together with *L. arcuata* forms a very polymorphous complex, and, hence, a safe demonstration of the occurrence of races with different size classes would be of great interest. The above-mentioned differences in chromosome number make a closer study still more attractive.

Luzula pallescens Sw.

43. Canada, Montreal. Botanical Gardens. 2 n = 12.

The plants were raised from seeds sent to us under the name of *L. L. multiflora*, from which it is clearly distinct. All characters agree with *L. pallescens*, which according to NORDENSKJÖLD has 2 n = 12 (material from Sweden).

Luzula multiflora (Retz.) Lej.

44. Iceland, Reykjavik. Grassland on rocks. Collector: T. W. B. 2 n = 36.
45. Denmark, Lyngby Mose. Bog. Collector: T. W. B. 2 n = 36.

The number agrees with that stated earlier by BÖCHER, LÖVE and LÖVE, and HAGERUP.

Luzula multiflora ssp. *frigida* (Buch.) V. Krecz.

46. Southwest Greenland. Kajartalik west of Arsuk. (61°10′). Collector: K. L. 2 n = 36.
47. Southwest Greenland. Ivigtut. Dwarf shrub heath. Collector: T. W. B. 2 n = 36 (see fig. 13).
48. Southwest Greenland. Tigsaluk (61°20′). Head of the fjord in luxuriant vegetation. Collector: K. L. 2 n = 36.
49. West Greenland. The Nugssuaq peninsula. Collector: KNUD JAKOBSEN. 2 n = 36.

Nos. 46—48 are typical ssp. *frigida* while no. 49 belongs to var. *contracta* Samuelsson (cf. BÖCHER 1950). All samples have the same size of seeds, viz. 1.1—1.4 mm and can be distinguished from *L. multiflora*, which has 1.4—1.6 mm long seeds, and from the following species, which have small seeds, about 0.9—1.1 mm long, and small flowers. The chromosome number seems to be constant within the *Luzula multiflora* complex. 2 n = 36 for ssp. *frigida* has previously been found by HAGERUP, LÖVE and LÖVE, and SØRENSEN and WESTERGAARD.

Luzula groenlandica Böcher (see BÖCHER 1950).

50. West Greenland. Kugssuaqdalen near Sarqaq (70°4′—70°6′). Collector: KNUD JAKOBSEN. 2 n = 24.

51. West Greenland. Head of Søndre Strømfjord. River valley. Collector: T. W. B. 2 n = 24.
52. West Greenland. Head of Søndre Strømfjord. Roadside in the main camp. Collector: T. W. B. 2 n = 24.
53. Canada, Ungava, natural vegetation (seeds from the Botanical Gardens in Montreal). 2 n = 24.

The seeds from Ungava were sent to us under the name of *L. confusa*, to which the plants cannot belong.

This new species, which in some characters reminds of *L. multiflora* ssp. *frigida*, in others of *L. sudetica*, will be described in detail in BÖCHER (1950). From ssp. *frigida* var. *contracta*, which morphologically comes very near to it, it is mainly distinguished by the small flowers and seeds and the chromosome number. From *L. sudetica* it is separated by its habit, the broader basal leaves, the ecology, and the chromosome number, which in *L. sudetica* according to NORDENSKJÖLD is 2 n = 48, thus twice the number of *L. groenlandica*. There are some points indicating that *L. groenlandica* is more closely related to *L. sudetica* than to *L. frigida*.

Sisyrinchium montanum Greene (= *S. angustifolium* sensu BICKNELL) and "*S. angustifolium* Miller".

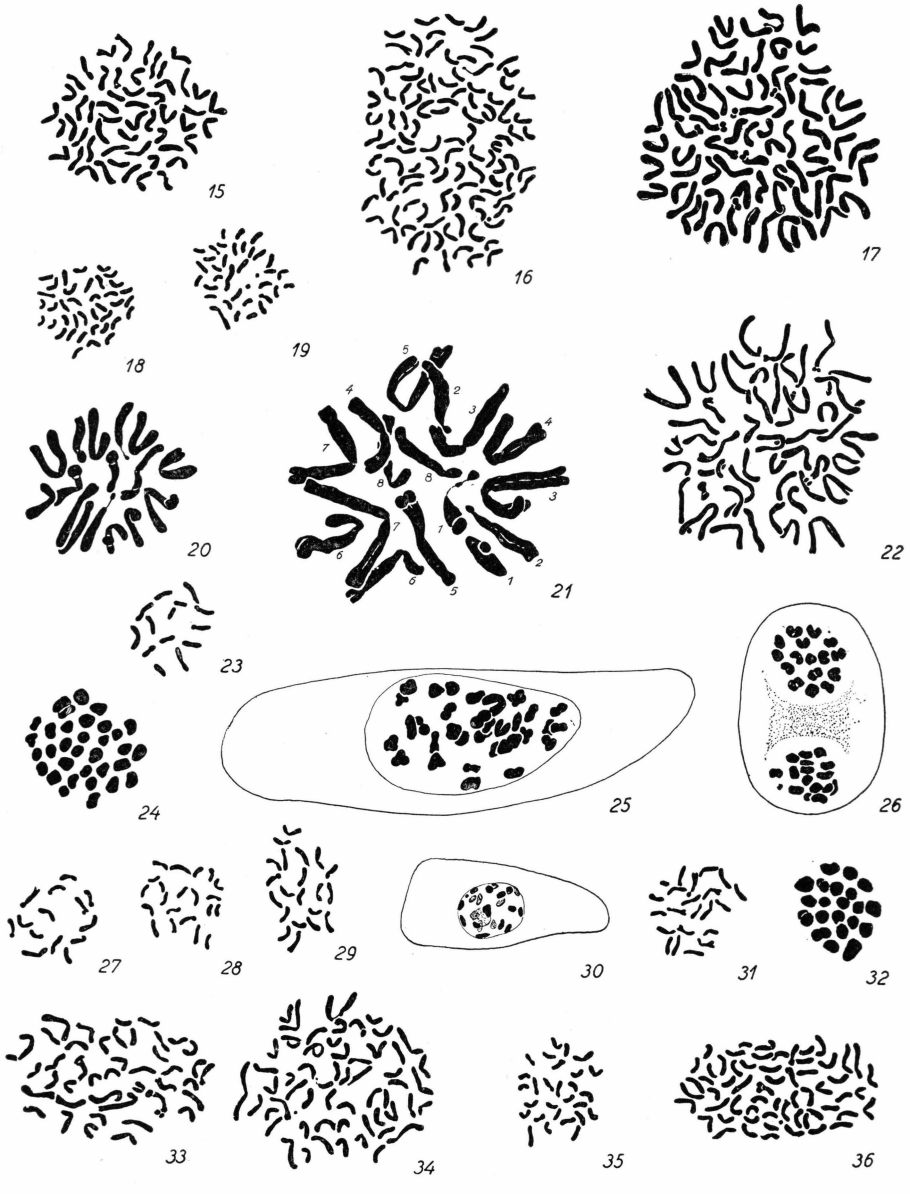
54. West Greenland. Head of Søndre Strømfjord. Station described in detail in BÖCHER 1948. Collector: T. W. B. 2 n = 32. (See fig. 11).
55. Denmark, Botanical Gardens in Copenhagen. 2 n = about 96 (see fig. 10).

No. 54 is *S. montanum*, a special variety with pale blue flowers, while No. 55 is a garden form with dark blue flowers called *S. angustifolium* Miller.

Very few chromosome numbers are known within the genus *Sisyrinchium*. CLAUSEN, KECK, and HIESEY (1940) found 2 n = 32 in *S. bellum* Wats. from California. 2 n = 96 was counted in material from the Botanical Gardens in Copenhagen, where the plants in question have been cultivated for several years. Their origin is now unknown. A difference in chromosome number in the *S. montanum* group, which is very complicated and has a peculiar world range (BÖCHER 1948), invites a closer cytological study of material from different parts of its area.

Oxyria digyna (L.) Hill.

56. West Greenland, Nugssuaq (70°41′), snowpatch vegetation on northern slope. Collector: KNUD JAKOBSEN. 2 n = 14.
57. West Greenland, Godthaab. Collector: OVE MARTENS. 2 n = 14.
58. The Kola Peninsula, wild material from Hortus Botanicus Arcto-Alpinus (U.R.S.S.). 2 n = 14.
59. Canada. Seeds from nature obtained through the Botanical Gardens in Montreal. n = 7.
60. Canada. Montreal. Botanical Gardens. 2 n = 14.



Figs. 15—23. Metaphase plates from mitosis in the root tips. 15 *Stellaria longipes*, 16 *Stellaria monantha*, 17 *Melandrium triflorum*, 18—19 *Cerastium cerastioides*, 20 *Ranunculus Cymbalaria*, 21 *Ranunculus lapponicus*, 22 *Ranunculus affinis*, 23 *Cochlearia officinalis* (var.). — Fig. 24. I metaphase in PMC of *Draba hirta*. — Fig. 25. Diakinesis of meiosis in macrospore mother-cell in *Draba hirta*. — Fig. 26. II metaphase in PMC of *Draba incana*. — Figs. 27—31. Mitosis from root tips (fig. 30 somatic tissues in young ovule) in *Arabis Holboellii*, fig. 27 diploid, figs. 28—29 triploid, figs. 30—31 triploid with an extra chromosome of small size. — Fig. 32. I metaphase in PMC of *Braya linearis*. — Figs. 33—36. Mitoses from root tips, 33 *Braya linearis*, 34 *Torularia humilis*, 35 *Eutrema Edwardsii*, 36 *Lesquerella arctica*. × 1950.

Cultivated in Copenhagen nos. 59—60 are very tall and vigorous and flower luxuriantly. The other cultivated plants, nos. 56—58, on the other hand, are very low and sometimes rosette plants without flowers. In spite of the great differences the two types have the same chromosome number. 2 n = 14 has also been found by EDMAN, FLOVIK and LÖVE.

Stellaria longipes Goldie.

61. Canada, Hudson Bay, Churchill. Natural vegetation. Collector: Dr. MARIE HAMMER. 2 n = 52; see fig. 15.
62. As no. 61, but from another station at Churchill. 2 n = 52.

The cytological analysis was made on plants which were raised from seeds. It is very characteristic that typical *S. longipes* seeds very well, while other species of the *S. longipes* group generally propagate by vegetative means through runners, or sterile shoots which break loose.

Stellaria monantha Hultén.

63. West Greenland. Head of Søndre Strømfjord. Dwarf shrub heath. Collector: T. W. B. 2 n = 104; see fig. 16.

Stellaria monantha develops ripe seeds in several stations at the head of Søndre Strømfjord. The plants which were analysed were raised from seeds. *S. monantha* is very closely related to *S. longipes*. The number 2 n = 104 was also found in *S. crassipes* Hultén from Spitzbergen (FLOVIK 1940). Thus, we have one species with 2 n = 52 and two with 2 n = 104 in the very interesting *Stellaria longipes* group, which in particular has been studied by HULTÉN (1943).

Cerastium cerastioides (L) Britton.

64. West Greenland. The Nugssuaq peninsula. Snowpatch vegetation. Collector: KNUD JAKOBSEN. 2 n = 34 (fig. 19).
65. Southwest Greenland, Thorstein Islænders Ø. (Ydre Kitsigsut, 60°45′). Moist gravel. Collector: K. L. 2 n = 38 (fig. 18).

In the paper by BÖCHER (1938) the number 2 n = 40 for *C. cerastioides* is mentioned, although with some hesitation. After a study of the new material from Southwest Greenland (No. 65), where there can be no doubt of the correctness of the number 2 n = 38, and the paper of FAVARGER and SÖLLNER (1949), who also have found 2 n = 38 in material from the Alps, the old slides have been reexamined. For the plate pictured in BÖCHER (1938) the number 2 n = 40 may seem to be the most probable, but there is a possibility of interpreting two small chromosomes as the ends of one angular chromosome and also in another case two somewhat larger chromosomes may be interpreted as one angular one with an unusually distinct primary constriction.

The material from the Nugssuaq peninsula (no 64) deviated cytologically in several respects from the other. The metaphase plates were not easy to interpret. Professor C. A. JÖRGENSEN has kindly studied our material and we have discussed some of the clearest metaphase plates with him. There are 34 somatic chromosomes and two small bodies which may probably be trabants (see fig. 19). As no large differences in the size of the chromosomes could be demonstrated in No. 65 with 2 n = 38 nor in the material studied by FAVARGER & SÖLLNER, it was very surprising to observe a large size difference in No. 64, where two chromosomes are clearly much longer than the rest. These large chromosomes may perhaps have arisen by fusion of two shorter ones and, thus, the deviating number 2 n = 34 may be a result of an unequal interchange in a plant with 2 n = 36. In this case, however, there ought to be two small fragment chromosomes left if the centromeres in the original plant with 2 n = 36 were retained. We are not convinced that the two small bodies seen in fig. 19 and in some other plates are trabants; they may perhaps be interpreted as very short fragments. While some observations of one or two very minute dark bodies on the nucleoli of resting nuclei supports the trabant interpretation, the absence of observable trabants in the material with 2 n = 38 may be in favour of the fragment theory. In any case the presence of two very large chromosomes is interesting, suggesting that the number 2 n = 36 may even occur in *C. cerastioides*. We have studied dried material of the plants with 2 n = 34 and did not succeed in finding differences between them and other plants from Greenland.

Cerastium alpinum L.

66. West Greenland. Pujortoq at Niaqornat, 70°47′ lat. north. In weathering and ash-products on burning north-facing slaty slope. Collector: KNUD JAKOBSEN. 2 n = 54.
67. West Greenland. Head of Søndre Strømfjord. Roadside. Collector: T. W. B. 2 n = 72.
68. Southwest Greenland. Kajartalik skerry west of Arsuk, 61° 10′ lat. north. Collector: K. L. 2 n = about 72.

No. 67 is extremely lanate, the other two numbers much less so. No. 66 has large leaves in culture, but otherwise it does not seem to differ much morphologically from the plants with the high chromosome number. In culture it did not thrive very well, whereas No. 67 was very easy to cultivate in Denmark (fig. 37). 2 n = 72 corresponds to earlier statements by BÖCHER (1938) in material from Angmagssalik and LÖVE and LÖVE (1944) from Lappland. Of particular interest is the finding of a type from Northeast Greenland with the high number 2 n = 108 (SÖRENSEN and WESTERGAARD acc. to LÖVE & LÖVE). Thus, the Greenland *Cerastium alpinum* covers three different chromosome races with

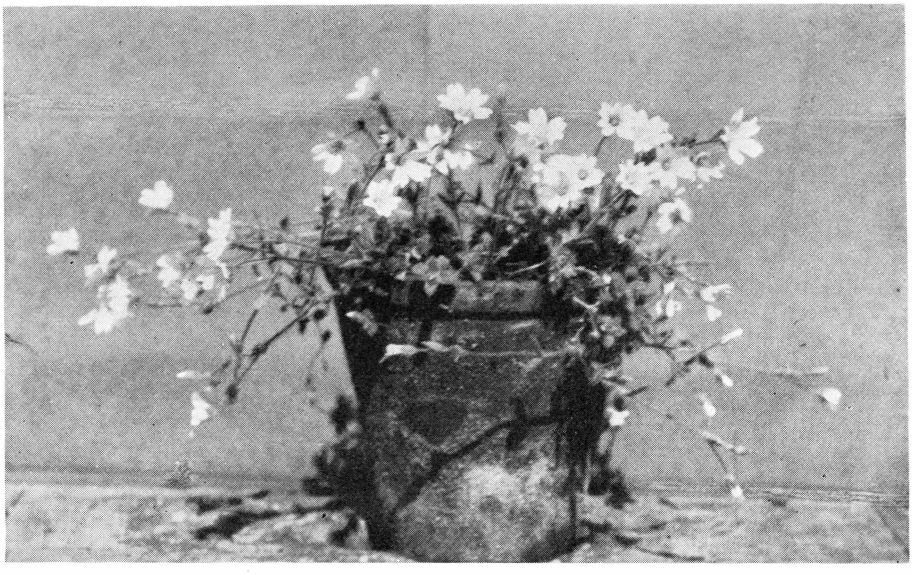


Fig. 37. Lanate type of *Cerastium alpinum* (no. 67) cultivated in Copenhagen. 2 n = 72. T. W. B. phot.

2 n = 54, 72, and 108. The taxonomical value of these races must be further investigated in future.

Arenaria norvegica Gunn.

69. Iceland, Reykjavik. Gravel on a hill. Collector: T. W. B. 2 n = 80.

The number is in accordance with that found by HORN (1948).

Melandrium affine Vahl, see PORSILD (1943) (= *M. furcatum* (Raf.) Hultén).

70. West Greenland. The Nugssuaq peninsula. Collector: KNUD JAKOBSEN. 2 n = 48.

According to recent investigations by NYGREN (1949) the same chromosome number occurs in material from Alta in northern Norway and Björkliden in Swedish Lapland (ssp. *angustiflorum*). BLACKBURN (1930) also mentions a sample of *M. affine* with the number 2 n = 48.

Melandrium triflorum (R. Br.) Vahl.

71. West Greenland. Head of Søndre Strømfjord. Subarctic steppe on sunny slope. Collector: T. W. B. 2 n = 72 (fig. 17).

The same number (n = 36) was found by BLACKBURN (1930).

Fig. 38. Flowering specimen of *Melandrium triflorum* cultivated in Copenhagen. 2 n = 72. T. W. B. phot.

Ranunculus confervoides (Fr.) Fr. (*R. trichophyllus* var. *eradicatus* (Laest.) Drew.).

72. West Greenland, Naujat at the entrance to the Sarqaq valley 70°3′ N., 52°9′W.). Collector: KNUD JAKOBSEN. 2 n = 32.

According to LÖVE & LÖVE (1948) SÖRENSEN & WESTERGAARD have recorded 2 n = 16 for the same species in material from Northeast Greenland.

Ranunculus lapponicus L.

73. West Greenland. Nugssuaq 70°41′ lat. north. Moss cushions at the bank of a brook. Collector: KNUD JAKOBSEN. 2 n = 16 (fig. 21).

The number corresponds to that stated earlier from Greenland by BÖCHER (1938) and SÖRENSEN and WESTERGAARD (unpublished data), and from Spitzbergen by FLOVIK (1936). This writer has made a special study of the chromosome morphology and measured the segments of the chromosomes. A comparison between FLOVIK's and our material is difficult because he used another fixative. Nevertheless it seems justified

to suppose that some minor morphological differences between his and our material occur. FLOVIK's F-chromosome undoubtedly corresponds to our No. 2. According to FLOVIK the short segment is here 1.0 μ and the long segment 3.6 μ, while in our material the short segment is only 0.5 μ and the long one 4.5—5 μ. The satellite of the SAT-chromosome (FLOVIK's H-type, our No. 1) may further be shorter in FLOVIK's material as compared with that of ours.

Ranunculus hyperboreus Rottb.

74. West Greenland. Nugssuaq, 70°41′. In a pool on manured ground. Collector: KNUD JAKOBSEN. 2 n = 32.

The same number has previously been recorded from Spitzbergen by FLOVIK and from West and East Greenland by BÖCHER.

Ranunculus affinis R. Br. (*R. pedatifidus* E. Sm.)

75. West Greenland. Head of Søndre Strømfjord. Bog at Store Saltsø. Collector: T. W. B. 2 n = 48 (fig. 22).

During meiosis up to 20 bivalents, some multivalents and a varying number of univalents occur. Formation of restitution nuclei, irregular tetrads, pentads, or hexads and dwarf pollen was observed, indicating a very irregular meiosis of quite the same type as described by BÖCHER (1938) for *R. auricomus* and *R. auricomus* var. *glabrata*. In nature as well as in culture *R. affinis* produces plenty of seeds, which are able to germinate.

Ranunculus acris L.

76. Southwest Greenland. Ivigtut. Willow scrub. Collector: T. W. B. 2 n = 14.
77. Southwest Greenland. Grønnedal. Meadow. Collector: T. W. B. 2 n = 14.
78. South Greenland. Julianehaab. The settlement. Collector: T. W. B. 2 n = 14.

No. 76 was very tall with big flowers; still, it proved to be diploid like all other races from the North Atlantic area (BÖCHER 1938).

Ranunculus Cymbalaria Pursh.

79. West Greenland. Head of Søndre Strømfjord. Lille Saltsø. In clay on the beach. Collector: T. W. B. 2 n = 16. Fig. 20.

The number corresponds to that stated earlier by LARTER (1932).

Lesquerella arctica (Wormskj.) Watson.

80. West Greenland. Mountain top east of Mt. Hassell. 470 m above sea level. Head of Søndre Strømfjord. Collector: T. W. B. 2 n = 60; see fig. 36.

ROLLINS (1939) has studied a number of other species of *Lesquerella* and found the numbers 2 n = 10, 20, and 30 as well as some aneuploid numbers (2 n = 12 and 16). *L. arctica* with 2 n = 60 as far as we know has the highest chromosome number in the genus.

Cochlearia officinalis L (incl. var. *groenlandica* Gelert and var. *arctica* (Schlecht.) Gelert).

81. West Greenland. Nugssuaq, 70°41′. Collector: KNUD JAKOBSEN. 2 n = 14.
82. West Greenland. Sukkertoppen. Collector: T. W. B. 2 n = 14.
83. Southwest Greenland. Kajartalik 61°10′ N. on moist gravel. Collector: K. L. 2 n = 14. Fig. 23.

The number is in accordance with that found earlier by FLOVIK (1940) and SØRENSEN and WESTERGAARD (acc. to LÖVE and LÖVE).

Draba incana L.

84. Southwest Greenland. Grønnedal in Arsukfjord. Collector: T. W. B. n = 16; see fig. 26.

n = 16 has been found previously by HEILBORN (1927) in material of *D. incana* f. *hebecarpa* from three stations in Scandinavia and in one plant with unknown origin.

In our material meiosis proceeds very regularly. In some PMCs two minute stainable bodies were observed during the second metaphase (fig. 26). They were always placed in the same distance from the old equatorial plane of metaphase I. Quite similar bodies were seen during metaphase II in *Arabis alpina*. They may be constantly present although not always observable. Their nature is obscure, but they remind of centrosomes.

Draba hirta L. (*D. daurica* D. C.).

85. West Greenland. Head of Søndre Strømfjord. Saline lake north of Mt. Keglen. Lake shore. Collector: T. W. B. n = 32; see fig. 25.
86. West Greenland. Head of Søndre Strømfjord. Roadside in the main camp. Collector: T. W. B. n = 32; see fig. 24.
87. West Greenland. Head of Søndre Strømfjord. Store Saltsø. Lake shore. 2 n = 64.

Very typical and vigorous specimens cultivated in Copenhagen had a regular meiosis. In some few metaphases in the PMCs a single quadrivalent occurred. HEILBORN (*l. c.*) using the name of *D. magellanica* ssp. *borea* Ekm. has also found the number n = 32 in material from Lapland, Dovre, and Greenland.

Arabis alpina L.

88. West Greenland. The Nugssuaq peninsula. Collector: KNUD JAKOBSEN. 2 n = 16.

The same number has previously been found in material from Southeast Greenland (BÖCHER 1938).

Arabis petraea (L.) Lam.

89. Iceland. Reykjavik. On gravel on a hill. Collector: T. W. B. n = 8, 2 n = 16.

Meiosis very regular. The number 2 n = 16 has also been found by G. KNABEN (acc. to LÖVE and LÖVE).

Arabis Holboellii Hornem.

90. Alaska. Seeds obtained through the Bot. Gardens in Copenhagen. 2n = 14.
91. West Greenland. Disko Island. Østerlien at Godhavn. Collector: C. A. JØRGENSEN. 2 n = 14; see fig. 27.
92. West Greenland. Itivdlinguaq in Søndre Strømfjord (66°30′ N.), Collector: T. W. B. 2 n = 14.
93. West Greenland. Eqaluit (70°24′ N., 51°14′ W.). Sunny scree in gravel together with *Artemisia borealis*, *Viscaria alpina*, *Poa glauca* a. o. Collector: KNUD JAKOBSEN. 2 n = 21; see fig. 29.
94. West Greenland. Head of Søndre Strømfjord. *Carex supina-Artemisia borealis*-steppe. Collector: T. W. B. 2 n = 21; see fig. 28.

No. 90 is var. *retrofracta* Rollins, the other numbers belong to var. *typica* Rollins. This material of *Arabis Holboellii* gives an interesting supplement to that described earlier by ROLLINS (1941) and BÖCHER (1947). Within the *A. Holboellii* complex the following chromosome numbers are now known.

2 n = 14 (var. *retrofracta* and var. *typica*, cf. fig. 27).
2 n = 21 (var. *typica*, cf. figs. 28—29).
2 n = 21 + 1 f (var. *typica*, cf. figs. 30—31 and BÖCHER 1938 and 1947).
2 n = 28 (var. *retrofracta* and var. *pinetorum*).
2 n = 42 (var. *pinetorum*).

Cultivation experiments with diploid and triploid material from West Greenland are carried out at present and material for a closer study of meiosis and the embryogenesis have been collected.

Eutrema Edwardsii R. Br.

95. West Greenland. Kugssuaq at Sarqaq. (70°4′ N., 52°6′ W.). *Dryas integrifolia* heath. Collector: KNUD JAKOBSEN. 2 n = 28; see fig. 35.
96. West Greenland. Nugssuaq (70°41′, 54°35′). Wet *Carex-Vaccinium* bog. Collector: KNUD JAKOBSEN. n = 14.

n = 14 has also been found in material from Pearyland (K. HOLMEN, kind oral information).

SOKOLOWSKAJA and STRELKOVA (1941) in material originating from Kolguev Island found the chromosome number 2 n = 42.

Braya linearis Rouy.

97. West Greenland. Head of Søndre Strømfjord. Roadside in the main camp. Collector: T. W. B. 2 n = 42, fig. 33.
98. West Greenland. Head of Søndre Strømfjord. Lake shore, Store Saltsø. Collector: T. W. B. n = 21, fig. 32.

This species has a much disrupted range. In Greenland it occurs in two different areas in the west, viz. the region around the inner parts of Søndre Strømfjord (66°30′—67°) and Igneritfjord (71°3′—71°7′), and furthermore in the northeast. Material from the latter region has been studied cytologically by SØRENSEN and WESTERGAARD, who according to LÖVE and LÖVE found 2 n = 64, a number being twice that of *Braya alpina* (cp. MANTON 1932), which may be rather closely related to *B. linearis*.

Undoubtedly the tribe of *Brayinae* is difficult from a taxonomical point of view (cf. ABBE 1948), nor is it easy in respect of the chromosome cytology. The difficulties are due to great differences in the size of the chromosomes and a tendency to precocious separation of some of the bivalents during meiosis. In spite of these difficulties the number 2 n = 42 (n = 21) is well established. Thus, we may either have to reckon with two very different chromosome numbers (2 n = 42 and 64) or suppose that some errors with regard to the identity of the material should exist. The material studied by us covers root tips and flower buds fixed on very typical plants cultivated in Copenhagen.

In the tribe of *Brayinae* there are other species with 7 as a basic number (see *Torularia* below). Furthermore 7 is a basic number in the related genera *Sisymbrium*, *Descurainia*, *Eutrema* and perhaps *Alliaria*, whereas 8 occurs as the basic number in *Phryne* (*P. pinnatifida* = *Braya pinnatifida* or *Sisymbrium dentatum*), see FAVARGER (1949).

A great difference in chromosome number would presumably be accompanied by some morphological differences. We have searched for such differences among the material from Northeast and West Greenland, but did not succeed in finding any important or general distinction.

Torularia humilis (C. A. M.) Schulz.

99. West Greenland. Umivit, Vandfaldskløften at the head of Søndre Strømfjord, together with *Carex microglochin* and *Juncus castaneus*. Collector: T. W. B. 2 n = 56, see fig. 34.
100. West Greenland. Head of Søndre Strømfjord on sand and clay at the air base. Collector: T. W. B. 2 n = 56.

Also in this species the chromosomes vary considerably in size. A study of the *Torularia humilis* complex in Greenland is found in BÖCHER (1950).

Saxifraga tricuspidata Rottb.

101. West Greenland. Head of Søndre Strømfjord. Sunny rocky wall. Collector: T. W. B. 2 n = 26 (see fig. 39).

Saxifraga nivalis L.

102. West Greenland. Head of Søndre Strømfjord. Mt. Hassell. Collector: T. W. B. 2 n = 60.

FLOVIK (1940) and SØRENSEN and WESTERGAARD (acc. to LÖVE and LÖVE) also mention plants with 2 n = 60. The closely related species *S. tenuis* Sm. has 2 n = 20 (BÖCHER 1938), a number which later has been confirmed by FLOVIK (1940), LÖVE and LÖVE (1944) and SÖRENSEN and WESTERGAARD. The basic number in this species group must presumably be 10, and, thus, the count made by SKOVSTED (1934), n = 14 for *S. nivalis*, may be erroneous. Perhaps the plants studied by SKOVSTED may have had 2 n = 30, a number which would fit in very well with the two other numbers. In the uppermost second anaphase plate pictured by SKOVSTED (*l. c.* fig. 4) there are 13 small and medium-sized chromosomes and one big configuration which perhaps might be interpreted as two chromosomes.

Saxifraga groenlandica L.

103. Southwest Greenland. Thorstein Islænders Ø (Ydre Kitsigsut, 60°45′ N, 48°30′ W.). Moist gravel. Collector: K. L. 2 n = 80; see fig. 40.

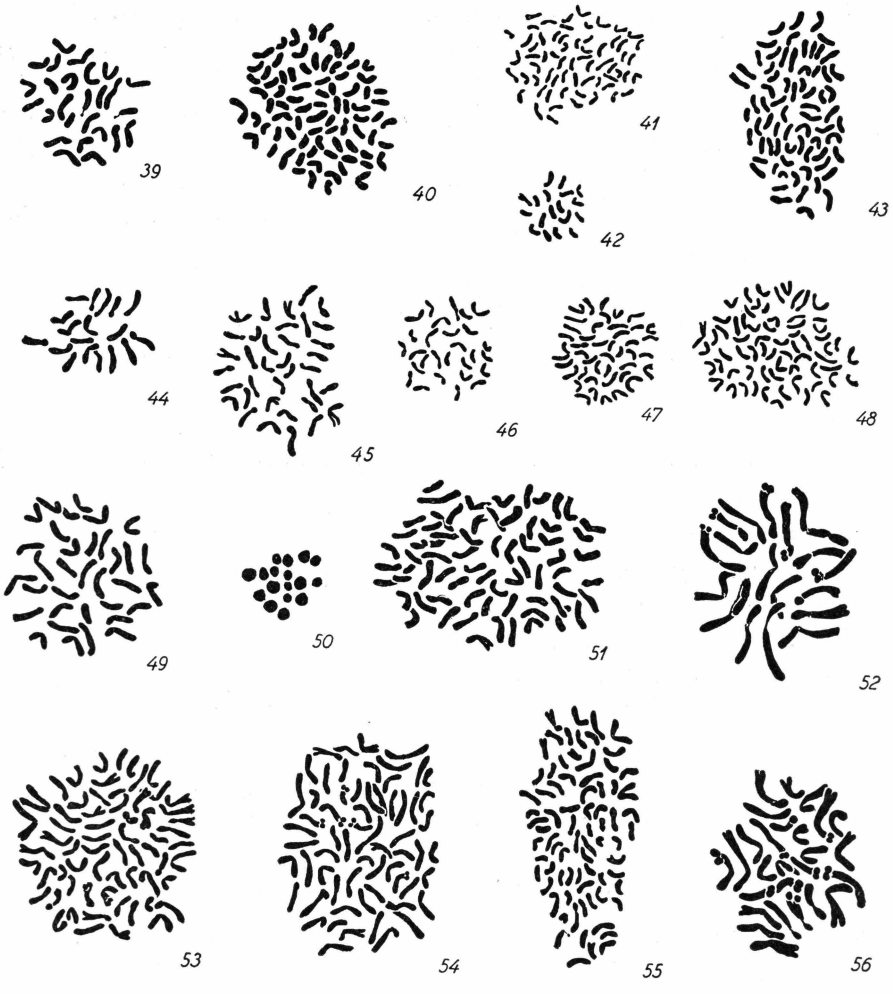
FLOVIK (1940) and HARMSEN (acc. to LÖVE and LÖVE) also found 2 n = 80 in *S. groenlandica*. BÖCHER's count (1938) 2 n = about 84 (material from East Greenland) was based upon analysis of some few mitoses in young ovaries. The metaphases here, however, were not sufficiently clear to establish the chromosome number. The plants in question may thus presumably also have had 2 n = 80. Of other numbers in the *S. caespitosa* complex we may mention 2 n = 32 (SCHÜRHOFF, WHYTE), 2 n = 64 (PHILP), and some deviating numbers (2 n = 56, 60, 63, and 65) found by SKOVSTED (1934).

Potentilla nivea L.

104. West Greenland. Nuvfiumanoq (70°26′ N., 51°28′ W.), dry vegetation on scree, together with *Calamagrostis purpurascens*. Collector: KNUD JAKOBSEN (cf. herbarium KNUD JAKOBSEN no. 841, 16.8.1947). 2n = 63.
105. West Greenland. Tunorssuaq (70°44′ N., 53°35′ W.). Open alpine vegetation dominated by *Carex nardina*. Collector: KNUD JAKOBSEN (cf. herbarium KNUD JAKOBSEN no. 917, 29.8.1947). 2 n = 63; see fig. 41.

Potentilla chamissonis Hultén.

106. West Greenland, Eqaluit (70°24′ N., 51°14′ W.). Open vegetation (*Poa glauca*) on dry scree. Collector: KNUD JAKOBSEN (cf. herbarium KNUD JAKOBSEN no. 761, 13.8.1947). 2 n = 56.



Figs. 39—56. Metaphase plates from mitoses in the root tips (fig. 50 metaphase I in PMC). — 39 *Saxifraga tricuspidata*, 40 *Saxifraga groenlandica*, 41 *Potentilla nivea*, 42 *Dryas integrifolia*, 43 *Sorbus decora* (*S. americana groenlandica*), 44 *Veronica alpina*, 45 *Veronica Wormskjoldii*, 46 *Bartschia alpina*, 47 *Galium boreale* from Iceland, 48 *Galium boreale* from Alaska, 49 *Campanula rotundifolia* from West Greenland, 50 do. from South Greenland, 51 do. from Iceland, 52 *Artemisia borealis*, 53 *Antennaria glabrata*, 54 *Erigeron compositus*, 55 *Arnica alpina*, 56 *Hieracium groenlandicum*. × 1950.

107. West Greenland. Head of Søndre Strømfjord. Mt. Hassell. Sunny slope dominated by *Carex supina*. Collector: T. W. B. (cf. herbarium T. W. B. no. 802, 18.8.1946). 2 n = 56.

The very interesting *Potentilla nivea* group, which has been studied recently by HULTÉN (1945), seems to be interesting also from a cytological point of view. The two species occurring in Greenland, *P. nivea*

and *P. chamissonis*, have different chromosome numbers. This is also the case outside Greenland, but the numbers in LÖVE and LÖVE (1948) from Scandinavia do not agree with those above-mentioned from Greenland. Thus ERLANDSSON in material of "*P. nivea*" from Torne Lappmark found the number 2 n = 56, while MÜNTZING in material of *P. chamissonis* found 2 n = 77. As ERLANDSSON's count was made before the publication of HULTÉN's paper there is a possibility that this material may have belonged to *P. chamissonis*.

Sorbus decora (Sarg.) C. K. Schn.

108. Southwest Greenland. Arsuk fjord. Ivigtut valley. Scrub. Collector: T. W. B. 2 n = 68 (fig. 43).

The same number (n = 34) was first found by K. HOLMEN (not yet published) in material from another station in the vicinity of Ivigtut.

The Greenland *Sorbus* belongs to East American *S. americana-decora*-complex, but perhaps to a special variety (*S. americana* var. *groenlandica* C. K. Schn.). SAX (1931) records the chromosome number 2 n = 34 for *S. americana*.

Dryas integrifolia Vahl.

109. Southwest Greenland. Mount Guldfjæld at Ivigtut. Scree in ravine in alpine situation. Collector: T. W. B. 2 n = 18 (fig. 42).

The same number, 2 n = 18, has previously been found in *Dryas octopetala* by BÖCHER, MAUDE, FLOVIK, and LÖVE and LÖVE, and in *D. caucasica* by SOKOLOWSKAJA and STRELKOVA (1940).

Epilobium anagallidifolium Lam.

110. West Greenland. Kangamiut (65°50′ N.), in moss cushions on bank of a rivulet. Collector: T. W. B. 2 n = 36.

In material from Swedish Lappland a corresponding number (n = 18) was found by BÖCHER 1938.

Epilobium lactiflorum Hauskn.

111. Southwest Greenland. Grønnedal in Arsukfjord. Collector: T. W. B. 2 n = 36.

Chamaenerium angustifolium (L.) Scop.

112. Southwest Greenland. Grønnedal in Arsukfjord. Collector: T. W. B. 2 n = 36.

The same number has been found by JOHANSEN (1929) and LÖVE and LÖVE.

Chamaenerium latifolium (L.) Spach.

113. West Greenland. Sandflugtsdalen at the margin of the inland ice (about 67° N.) in dunes in the valley. Collector: T. W. B. 2 n = 72.

The same number 2 n = 72 has been recorded by JOHANSEN (1929), BÖCHER (1938, 2 n = 72, material from East Greenland), HARMSEN (unpublished), and LÖVE and LÖVE (unpublished).

Veronica alpina L.

114. West Greenland. Kugssuaq at Sarqaq (70°10′), herb field. Collector: KNUD JACOBSEN. 2 n = 18; see fig. 44.

BÖCHER (1938) in material from East Greenland found the same number, and later it has been found by MAUDE (1939), LÖVE and LÖVE (1944), and FAVARGER (1949).

Veronica Wormskjoldii Roem. and Schult.

115. Southwest Greenland. Ivigtut. Meadow on bank of rivulet. Collector: T. W. B. 2 n = 36; see fig. 45.

It is very remarkable that this subarctic and subalpine species is tetraploid, while the closely related arctic-alpine *V. alpina* is diploid.

Bartschia alpina L.

116. West Greenland. The Nugssuaq peninsula. Collector: KNUD JAKOBSEN. 2 n = 28; cf. fig. 46.

A number of root tips of small seedlings raised from seeds collected in Greenland were fixed. In many metaphase plants about 28 chromosomes were counted, unfortunately, only one plate was sufficiently clear to establish the chromosome number. It was in no case possible to interpret any of the plates as having 24 chromosomes, a number which is found by WITSCH (1932) in material presumably from Central Europe. The species has further been studied recently by DOULAT (1946), who in material from France (Col du Lautaret, 2095 m above sea level) found 2 n = 36. It would be very interesting if the arctic material belonged to a series with the basic number 7 and the central European material belonged to a series with 6 as basic number. Further studies are evidently much needed.

Galium boreale L.

117. Iceland, Thingvellir. Collector: T. W. B. 2 n = 44.
118. Iceland, Guldfoss, meadow. Collector: T. W. B. 2 n = 44; see fig. 47.
119. Denmark, Ølstykke Mose. Meadow. Collector: T. W. B. 2 n = 44.
120. Alaska. Seeds from nature obtained through the Botanical Gardens in Copenhagen. 2 n = 66; see fig. 48.

The two numbers in this species have previously been found by FÄGERLIND (1934, 2 n = 44, Swedish material) and TURESSON (1938, 2 n = 66, material from Shansi in N. China collected by Dr. H. SMITH).

The material from Iceland belongs to a low-growing ecotype which at present is cultivated in Denmark and compared with other races.

Campanula rotundifolia L.

121. West Greenland. Head of Søndre Strømfjord. Southern slope (together with *Roegneria violacea*). Collector: T. W. B. 2 n = 34; see fig. 49.
122. South Greenland. Ikersuaq (60°55′ N., 46°35′ W.), luxuriant vegetation in a valley at the margin of the inland ice. Collector: K. L. n = 17; see fig. 50.
123. Northeast Greenland. Traill Island. Collector: TH. SÖRENSEN. n = 17.
124. Canada. Botanical Gardens, Montreal. 2 n = 68.
125. Iceland. Natural vegetation. Collector: G. THORLÁKSSON. 2 n = 68; see fig. 51.
126. The Kola Peninsula. Wild material from Hortus Botanicus Arcto-Alpinus (U. R. S. S.). 2 n = 68.

Meiosis was studied in nos. 122—123 and proved to proceed very regularly.

In culture the diploid No. 121 deviates from Nos. 124 and 126 in a number of characters. Compared with a tetraploid type from East Greenland which was cultivated earlier, the diploid plant (No. 121) has comparatively small flowers. In nature the diploids from West and South Greenland (nos. 121—122) are tall, with many, rather small flowers. Thus there seems to be no connection between a low chromosome number and a low growth or a low number of flowers (cf. BÖCHER 1936). Accordingly, the var. *uniflora* Lge. may only be a dwarfish modification.

A survey of all counts made in *Campanula rotundifolia* (see BÖCHER, 1936, 1938) gives the following picture: Diploid races are only known from four stations in Greenland (West, South, Southeast, and Northeast Greenland). Tetraploid races, on the other hand, have been found in Canada, Southeast Greenland (two stations), Iceland, Norwegian mountains, the Kola Peninsula, Denmark (three stations), and France. The diploid races are widely distributed in Greenland, but may perhaps be restricted to this country.

Erigeron borealis (Vierh.) Simm.

127. Southwest Greenland. Ivigtut. Herb field. Collector: T. W. B. n = 9 and 2 n = 18.

In material of very vigorous plants cultivated in pots in Copenhagen (see fig. 57) meiosis was very regular. The chromosome number corresponds to that found formerly by CHIARUGI (1927).

Erigeron uniflorus L.

128. Southwest Greenland. Ivigtut. Herb field. Collector: T. W. B. 2 n = 18.

According to HOLMGREN (1919) the closely related high arctic species *E. eriocephalus* Vahl also has 2 n = 18.

Erigeron compositus Pursh.

129. West Greenland. Head of Søndre Strømfjord. Southern slope of Mt. Hassell. Collector: T. W. B. 2 n = 63; see fig. 54.
130. Canada, Montreal, Botanical Gardens, 2 n = 54.

The material from Canada was sent to us under the name of *E. compositus* var. *discoidea* Gray. The chromosome number of this variety deviates from that of the typical plant from West Greenland. Perhaps

Fig. 57. Luxuriantly flowering specimen of *Erigeron borealis* (2 n = 18), cultivated in Copenhagen. T. W. B. phot.

this variety belongs to a special subspecies with a more southerly distribution. The number 2 n = 63 for the West Greenland type is interesting by suggesting an apomictic seed development.

Antennaria glabrata (Vahl) Greene.

131. West Greenland. Sarqaq valley (about 70°3′), 400 m above the sea level. Snowpatch vegetation. Collector KNUD JAKOBSEN. 2 n = 63; see fig. 53.

Artemisia borealis Pall.

132. West Greenland. Head of Søndre Strømfjord. Mt. Hassell. Collector: T. W. B. 2 n = 18; cf. fig. 52.

133. West Greenland. Head of Søndre Strømfjord. Mt. Keglen. Collector: T. W. B. 2 n = 18.
134. Canada, Montreal, Botanical Gardens. 2 n = 18.

ERLANDSSON (1939) also found 2 n = 18 in material from West Greenland (Ameralik Fjord) and further 2 n = 36 in the closely related *A. bottnica* Lundstr.

Arnica alpina (L.) Olin.

135. West Greenland. Head of Søndre Strømfjord. Mountain northeast of Mt. Keglen. Collector: T. W. B. 2 n = 76; see fig. 55.

This number does not agree with those previously found. FLOVIK and SØRENSEN and WESTERGAARD found 2 n = 56, and AFZELIUS (1936) 2 n = 60. In *A. montana* the latter writer found 2 n = 36, and SAKAI (1934) counted 2 n = 40 in the East Asiatic *A. unalaschensis*. Everything would be easily understood if *A. montana* and *unalaschensis* had 2 n = 38 and the material of *A. alpina* studied by earlier writers 2 n = 57. 19 would be the basic number and we should have a series of chromosome numbers being the basic number multiplied by 2, 3, and 4. This, of course, must be studied more closely in future. As according to AFZELIUS *A. alpina* is agamospermous, the chromosome number 2 n = 57 would not be surprising.

Hieracium alpinum (L) Backh.

136. West Greenland, Tigssaluk (61°20′ N., 48°6′ W.). Luxuriant vegetation in a valley. Collector: K. L. 2 n = 27.
137. East Greenland. Angmagssalik. On a gravelly slope by the river. Collector: K. L. 2 n = 27.

The number is in agreement with that found by ROSENBERG (1926).

Hieracium groenlandicum Almqv.

138. Southwest Greenland. Ivigtut. Willow scrub. Collector: T. W. B. 2 n = 27; see fig. 56.

Hieracium hyparcticum Almqv.

139. Southwest Greenland. Kajartalik west of Arsuk (61°10′ N., 48°40′ W.). Collector: K. L. 2 n = 36.

Compared with *Hieracium alpinum* the two other species (Nos. 138—139) have shorter chromosomes. The chromosome numbers 27 and 36 have preciously been found in several apomictic species of *Hieracium*.

SUMMARY

139 chromosome countings were made in 80 different arctic or boreal species. 25 species have not been studied before cytologically, see Nos. 13, 14, 15, 26—27, 31, 32, 33, 50—53, 54—55, 61—62, 63, 75, 80, 99—100, 101, 108, 109, 111, 115, 128, 129—130, 131, 138, 139.

In 20 cases different chromosome numbers were found in plants belonging to the same species or to the same complex of closely related species. Only in three cases, *Cerastium cerastioides*, the *Braya linearis* complex, and *Bartschia alpina*, aneuploidy was made probable. In all the other cases the numbers are multiples of the same basic number. A list of such cases is given below:

No.	Low chromosone number	2 n	No.	High chromosome number	2 n
1–2	Anthoxanthum odoratum**	10	3–6	Anthoxanthum odoratum**	20
*	Calamagrostis arundinacea	28	14	Calamagrostis purpurascens	56
*	Deschampsia brevifolia	?26	15	Deschampsia brevifolia var. pumila	39
19	Trisetum spicatum.	28	20	Trisetum spicatum.	42
23	Poa glauca**	63	*	Poa glauca**	70
37–38	Elymus mollis**	28	34–36	Elymus arenarius**	56
50-53	Luzula groenlandica	24	46–49	Luzula multiflora	36
54	Sisyrinchium montanum	32	55	Sisyrinchium "angustifolium" ab.	96
61-62	Stellaria longipes	52	63	Stellaria monantha	104
66	Cerastium alpinum	54	67–68	Cerastium alpinum	72
*	Ranunculus confervoides	16	72	Ranunculus confervoides	32
90-92	Arabis Holboellii**.	14	93-94	Arabis Holboellii**.	21
95-96	Eutrema Edwardsii	28	*	Eutrema Edwardsii	42
106-107	Potentilla chamissonis	56	104-105	Potentilla nivea	63

No.	Low chromosone number	2 n	No.	High chromosome number	2 n
*	Sorbus americana .	34	108	Sorbus amer. var. groenlandica	68
114	Veronica alpina ...	18	115	Veronica Wormskjoldii.....	36
					36
117–119	Galium boreale**..	44	129	Galium boreale**..	66
121–123	Campanula rotundifolia**	34	124–126	Campanula rotundifolia**	68
130	Erigeron compositus	54	129	Erigeron compositus	63
*	Arnica alpina	?57	135	Arnica alpina	76

* based upon investigations made by earlier writers.
** the same two numbers found by earlier writers.

In Nos. 15, 23, 93—94, 104—105, 129, 136—138 uneven somatic chromosome numbers occur, suggesting apomictic seed development or hybrid origin. In No. 75, *Ranunculus affinis*, apomixis is made very probable through the investigation of the meiosis, which in this case is extremely irregular.

The material of chromosome numbers mentioned in the present paper in several cases makes a closer study very desirable. Such special studies have already been commenced, in particular with *Trisetum spicatum*, *Luzula groenlandica-multiflora*, the *Stellaria longipes* group, *Ranunculus affinis*, *Arabis Holboellii*, and *Campanula rotundifolia.*

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