Drawings of Scandinavian Plants 55–59

Juncus L.

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55. **Juncus filiformis** L. 1753

Perennial, 10—60 cm high, with a shortnoded, horizontally creeping and sparingly branched rhizome, light or greyish green. Stems with several usually light straw-coloured basal sheaths with a short or in the uppermost one rarely up to 20 mm long lamina; withered remnants of sheaths turning dark brown. Most shoots fertile, the sterile leaf-bearing shoots usually few. Stems and leaves faintly or in dried state markedly striate from usually c. 25 subepidermal sclerenchyma strands. Cortical parenchyma layer comparatively thick, medulla consisting of rounded cells connected by an irregular network of long, thin rays. Lowest bract (1/2—) 1—1.5 × as long as the stem. Inflorescence 4—10-flowered, dense, usually 1 cm or less across. Tepals 2.5—3.5 mm, originally ovate to narrowly ovate or inner ones ± oblong, outer ones longer and apiculate to mucronate, inner ones obtuse; later, and when dried, all much changed in form due to rolling and shrivelling of the scarious margins apically. Stamens 6, c. 1/2 as long as the tepals, anthers 0.5—0.6 mm, 1/2—2/3 × as long as the filaments. Style c. 0.2 mm, stigmata c. 1 mm. Capsule trigono-ovoidal to sphaeroidal, obtuse, with the style remaining as a mucro or falling off in ripe state, brownish green to light brown, shining, equalling outer tepals or usually slightly shorter. Seeds 0.5 mm long and c. 0.3 mm thick, ± obliquely ovoidal, reticulation partly irregular, inconspicuous and obscured by the remaining testa forming one small white appendage. Observed chromosome number $2n=84$, but $2n=80$ also reported in literature.

J. filiformis is common in different types of fens and meadows and also on open soil and on shores. It has apparently developed ecotypes which have become adapted to rather different climatic and edaphic conditions and are morphologically very dissimilar. It has a wide boreal to subarctic circumpolar distribution with scattered localities in mountains southwards to near 35° N. In Scandinavia it is common from sea level to the lower alpine region, though rare on the Baltic Islands and in the SE part of Denmark.

56. **Juncus arcticus** Willdenow 1799

Perennial, 10—40 cm high, with a creeping, sparingly branched rhizome of varying internode length, ± bluish green. Stems erect, rigid, with several straw-coloured to light brown or in part light

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[1] Nilsson is responsible for the drawings and Snogerup for the text.

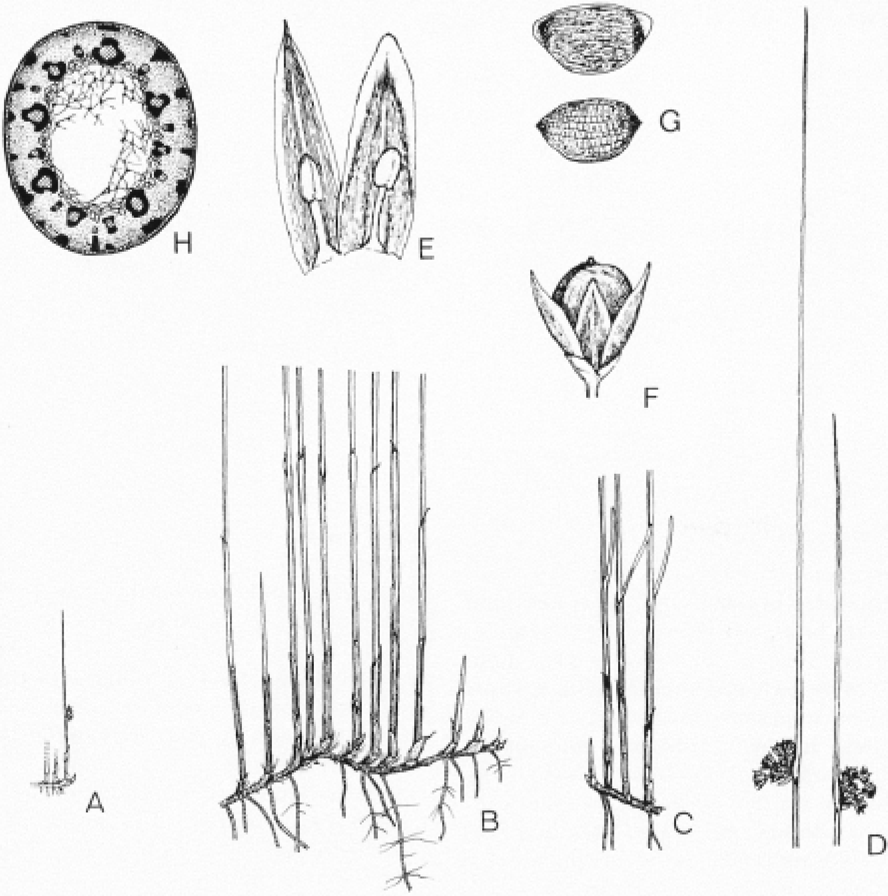

Fig. 55. *Juncus filiformis* L. — A: Habit, ×0.05. — B and C: Basal parts, ×0.5. — D: Inflorescences, ×0.5. — E: Tepals and stamens, ×10. — F: Capsule, ×6. — G: Seeds, above with, below without the testa, ×25. — H; Transect of stem below the inflorescence, ×30.

chestnut-coloured basal sheaths with no or very small lamina. Most shoots fertile, sterile leaf-bearing shoots wanting or few. Stems and leaves smooth or when dried faintly and irregularly striate, without any subepidermal sclerenchyma. Medulla consisting of rounded or irregularly formed cells connected by a network of long, thin projections. Lowest bract 1/8—1/4 as long as the stem. Inflorescence compact, 3—8-flowered, usually less than 1 cm wide. Tepals 3—4.5 mm, ovate to elliptical, inner ones when young obtuse to acute, outer ones obtuse to mucronate or apiculate, in fruiting flowers all often much changed in form due to rolling of the scarious margins. Stamens 6, 1/3—1/2 × as long as the tepals, anthers 0.5—0.7 mm, 1/3—1 × as long as the filaments. Style c. 0.5 mm, stigmata c. 1 mm long. Capsule 3.5—4.5 mm, equalling or exceeding the tepals, trigonoovoidal to trigonoellipsoidal, obtuse with a 0.2—0.3 mm long mucro, basally light, apically dark brown

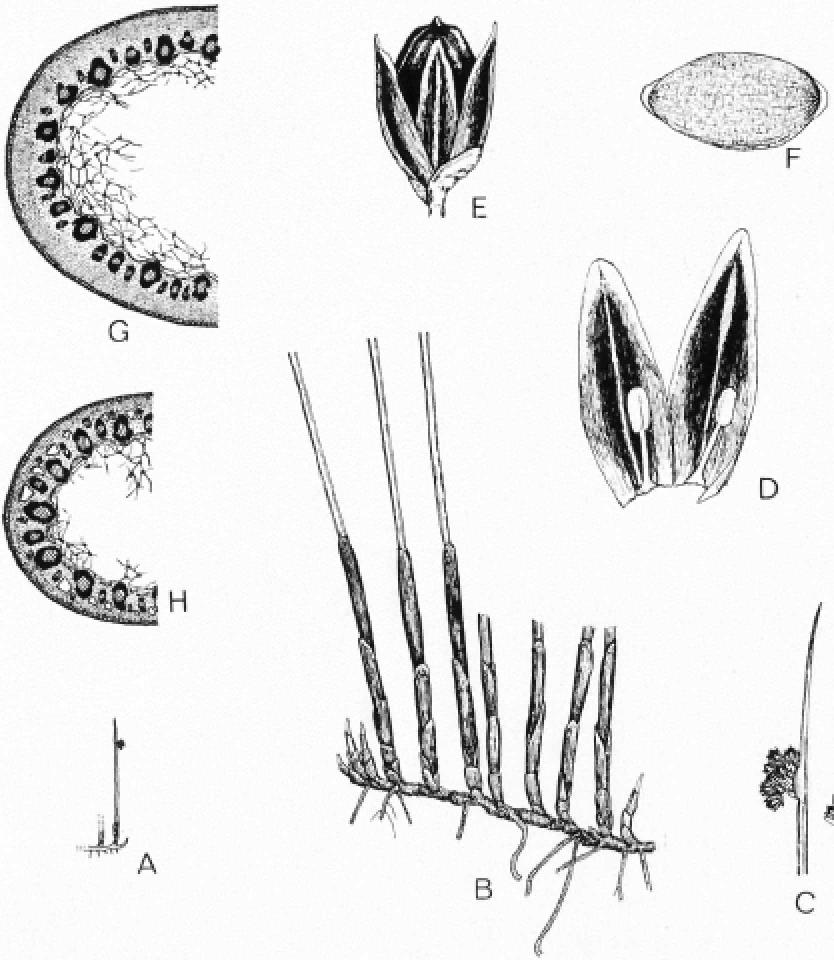

Fig. 56. *Juncus arcticus* Willd. — A: Habit, ×0.05. — B: Basal part, ×0.5. — C: Inflorescences, ×0.5. — D: Tepals and stamens, ×10. — E: Capsule, ×6. — F: Seed, ×25. — G and H: Transects of stems below the inflorescence, ×30.

to chestnut-coloured. Seeds 0.8—1.1 mm long and 0.3—0.5 mm broad, ± obliquely ovoidal, reticulate from c. 25 longitudinal ridges and many faint transverse ones, but reticulation faint and also obscured by the tight testa forming very small or quite inconspicuous appendages. Reported chromosome number $2n=80$, still needing further control; chromosomes extremely small. Hybrids between this and following species probably exist. They belong to a widespread form series which mainly occurs in America and is in need of further study.

J. arcticus occurs in fens and on open ground. It has an arctic-montane circumpolar distribution with southern outposts, e. g. in the Alps and Altai. In Scandinavia it is unevenly distributed throughout the mountainous region and in the northernmost coastal areas.

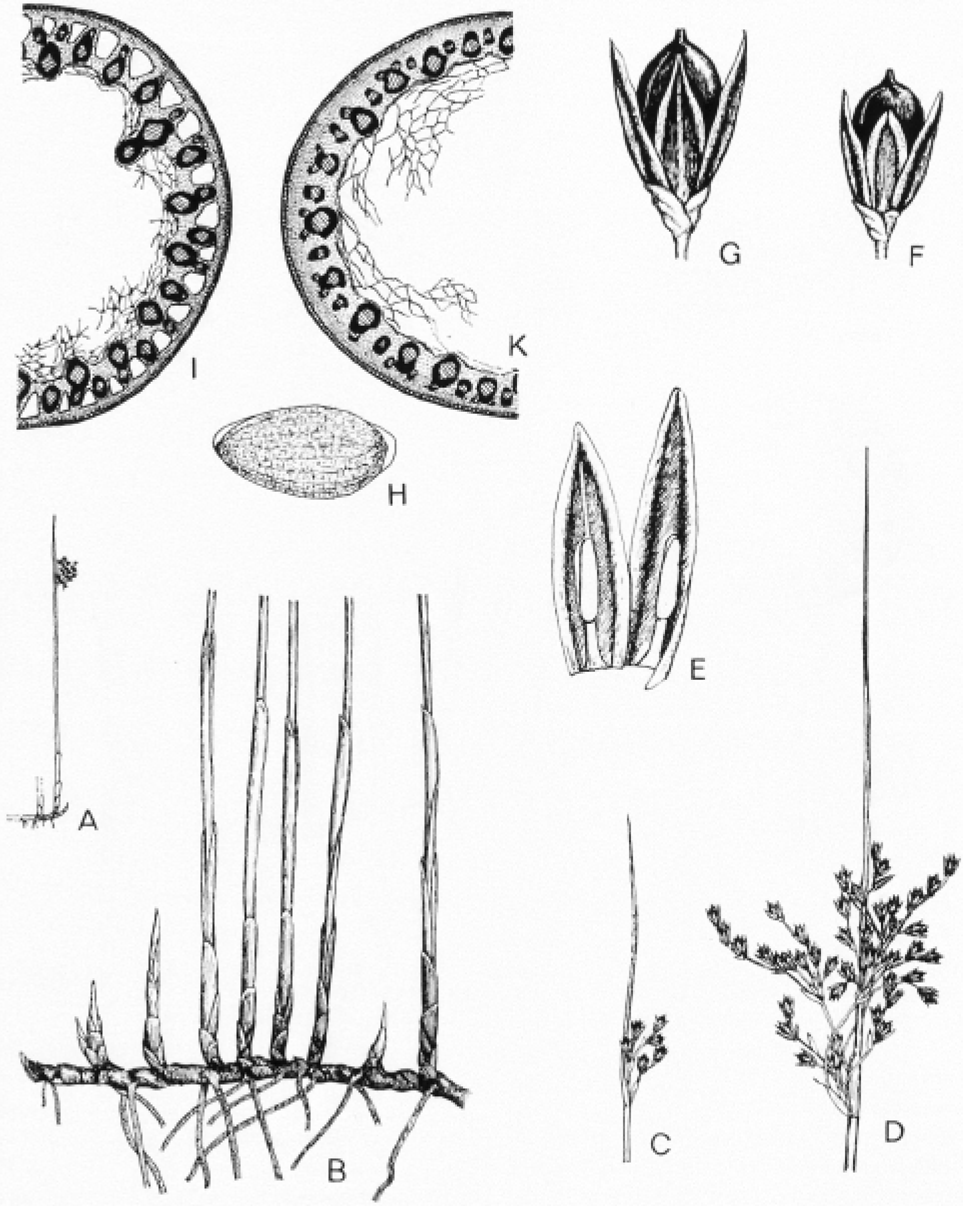

Fig. 57. *Juncus balticus* WILLD. — A: Habit, ×0.05. — B: Basal part, ×0.5. — C and D: Inflorescences, ×0.5. — E: Tepals and stamens, ×10. — F and G: Capsules, ×6. — H: Seed, ×25. — I and K: Transects of stems below the inflorescence, ×30. — C and F refer to deviating material from a locality at the Bothnian Gulf.

57. **Juncus balticus** Willdenow 1809

Perennial, 25—100 cm high, with a strong creeping and sparingly branching rhizome of short or intermediate internode length, plant in fresh state bluish green. Stems erect, rigid, with several light brown to straw-coloured basal sheaths with or without very tiny lamina. Most or all shoots fertile, sterile leaf-bearing shoots none or few. Stems and leaves smooth or when dried faintly and irregularly striated, without any subepidermal sclerenchyma. Medulla consisting of rounded or irregularly formed cells connected by an irregular network of thin projections, in old stems often disrupted and leaving large parts of the cavity open. Lowest bract 1/5—1/3 as long as the stem. Inflorescence (5—) 25—60 (—80)-flowered, lax, usually 4—8 cm across. Tepals 3.2—4.7 mm, outer ones usually slightly longer, ovate to narrowly ovate, obtuse to mucronate or apiculate, scarious margin often considerably folded in fruiting stage. Stamens 6, 2/5—1/2 × as long as the tepals, anthers 0.8—1.5 mm, 4/3—2 × as long as the filaments. Style 0.8—1 mm, stigmata 1.5—2 mm. Capsule equalling or exceeding the outer tepals, 3—4.5 mm high, trigono-ovoidal, apically pyramid-shaped, obtuse, usually light brown, shining, the style remaining for some time, then falling off and leaving only a mucro c. 0.2—0.3 mm long. Seeds 0.8—1 mm long and c. 0.4 mm broad, reticulate from 25—30 longitudinal striae and numerous fainter transverse ones, but texture inconspicuous and often irregular in part of the seed. The testa hardly visible as separate in the ripe seed but forming two very small appendages. Reported chromosome number 2n=80, still needing control, chromosomes extremely small.

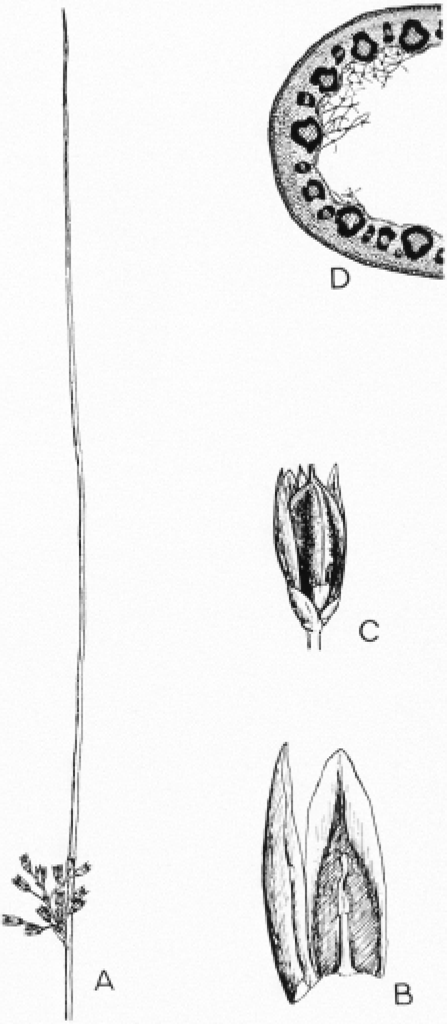

Fig. 58. *Juncus balticus* × *filiformis*. — A: Inflorescence, ×0,5. — B: Tepals and stamens, ×10. — C: Capsule, ×6. — D: Transect of stem below inflorescence, ×30.

J. balticus is mainly found on sandy shores, but also occurs in some rich fens. In typical form it is only found in NW. and N. Europe, but closely related forms occur e. g. in the Pyrenees, in Turkey, E. Asia and in N. and S. America. In Scandinavia it is unevenly distributed along the Baltic as well as the North Sea and Atlantic coasts. In the northernmost part of its area it also occurs in several inland localities. In these as well as some other northern localities deviating forms occur (cf. Fig. 57 C and F) which may have their origin in recent or former hybridisation with *J. arcticus*.

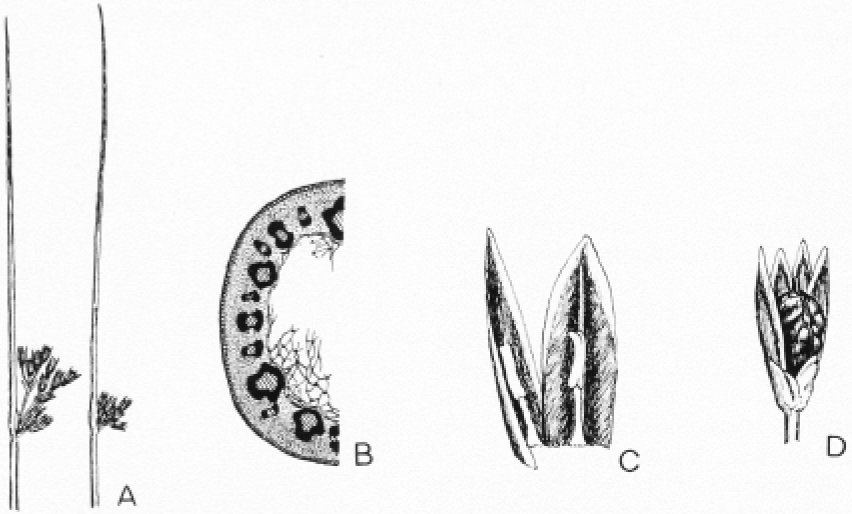

Fig. 59. *Juncus arcticus* × *filiformis*. — A: Inflorescence, ×0.5. — B: Transect of stem below inflorescence, ×30. — C: Tepals and stamens, ×10. — D: Capsule, ×6.

58. Juncus balticus × filiformis

This hybrid is in most localities taller than any of its parents. It combines the large, dark flowers of *J. balticus* with the slender habit of *J. filiformis*. In its stem anatomy the hybrid wholly resembles *J. balticus*. As in all hybrids between species lacking and having subepidermal sclerenchyma, respectively, the lack of sclerenchyma is dominant. The anthers are poorly developed. The capsule usually develops to maturity and in some flowers it contains one or a few seeds. As these seeds are often quite normally developed, it can not be stated with certainty that only primary hybrids are present.

J. balticus × *filiformis* is known from several localities especially in southern Sweden. It is vegetatively vigorous and often forms large stands. It may even be dominant in fens on sand near sea level, as e. g. in the area S of the mouth of the river Lagan. By its rapidly creeping and branching rhizomes it may no doubt propagate vegetatively for considerable distances. Thus it is probably formed only rarely, so that each locality or group of localities only contains one or a few hybrid clones. In some cases *J. balticus* is not found in the actual hybrid locality. Similar cases have been reported from Britain by Stace (1970).

59. Juncus balticus × filiformis

This hybrid has the more slender habit of *J. filiformis*, but the bract is only 1/4—1/2 as long as the stem, and the flowers are dark. The anthers are ± empty and often do not open. The capsule develops, but remains shorter than the tepals, with depressed sides due to the seeds degenerating at an early stage. Rarely do a few seeds develop to normal size, though unfilled, but no normally developed seeds have been observed. In its stem anatomy the hybrid resembles *J. arcticus*, having no subepidermal sclerenchyma.

J. arcticus × *filiformis* is apparently often formed where the parents meet, and it also forms local clones by vegetative propagation. Almquist (1949) lists it from several localities where *J. arcticus* is not known to occur.

LITERATURE CITED

Almquist, E. 1949. Dalarnes Flora. — Lund.
Stace, C. A. 1970. Unique Juncus Hybrids in Lancashire. — Nature 226: 180—181.

Studies of Bipolar Disjunct Species I

Carex

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ABSTRACT

MOORE, D. M. & CHATER, A. O. 1971. Studies of bipolar disjunct species I. Carex. — Bot. Notiser 124: 317—334.

This is the first of a series of papers on species with widely disjunct bipolar distributions. A detailed analysis of morphological variation between northern and southern populations of 6 species of *Carex* shows widely differing kinds of variation within such species. In *C. magellanica* LAM. and *C. microglochin* WAHLENB. the populations are considered to be subspecifically distinct, in *C. curta* GOODEN. varietally distinct [and the new combination *Carex curta* var. *robustior* (BLYTT ex ANDERSSON) D. M. MOORE & CHATER is proposed], while in *C. maritima* GUNN., *C. macloviana* D'URV. and *C. capitata* L. the differences are not taxonomically significant. No cytological differences have been detected between Northern and Southern Hemisphere populations. Possible causes for the dissimilar variation shown by these species, which all have comparable distributions, are discussed. Later papers will provide further information on the patterns of variation in bipolar species and how this can lead to a wider understanding of the evolution and distribution of geographically disjunct taxa.

GENERAL INTRODUCTION

The affinities existing between the floras of widely separated regions of the world have long been of interest in evolutionary and phytogeographical studies. Among these floristic elements the greatest disjunction is shown by those taxa which are common to areas at high latitudes in both the Northern and Southern Hemispheres. Such 'bipolar' disjunctions appear to have been first recognized in the early decades of the last century by WILLDENOW, HUMBOLDT and SCHOUW (see VON HOFSTEN 1916), who believed that they resulted from parallel origins in the two hemispheres. However, this explanation has found little support in most subsequent discussions since polytopic origin, although possible in certain circumstances (see e.g. DAVIS & HEYWOOD 1963 p. 448), is not generally acceptable on such a scale. In the light of modern evolutionary ideas most students of the problem have proposed that the bipolar disjunctions resulted either from long-distance dispersal over the intervening areas or by a series of shorter migrations making use of mountain ranges as 'stepping stones' through the low-latitude regions.

In his important review of the earlier

discussions on bipolar distributions Du Rietz (1940) summarized the available evidence and concluded that the disjunctions originated in the Mesozoic with the fragmentation and disappearance of more ancient transtropical highland bridges. However, Du Rietz was concerned with species, sections, genera and higher taxonomic units, the disjunction of which may be expected to result from events occurring at different periods and for which a single, all-embracing explanation seems neither called for nor likely. Whatever the timing of the disjunctions involving the higher taxonomic categories it scarcely seems plausible that the occurrence of apparently identical or closely related species at high latitudes in both hemispheres should be attributed to the period postulated by Du Rietz. When considering amphitropical disjunct distributions in the Americas Raven (1963) suggested that interchange of such plants would be easiest during the late Pliocene and Pleistocene, the most recent period when cool temperate conditions penetrated very far into low latitudes. Furthermore, this was also the time when many of the high volcanic mountains in the neotropics were raised, indeed the whole Cordilleran system in the Americas attained its present elevation then. Even during this period of maximum cold, when high latitude plants might be expected to attain their greatest extension, it should be noted that the Rocky Mountains, the Andes and the tropical mountains have never actually provided a continuous route and may be visualized as constituting a series of 'stepping stones' between which there would have to be dispersal greater than that normally shown by the species. Similar considerations undoubtedly apply in the Old World, where the Malaysian mountains have been important in the movements of bipolar groups (van Steenis 1962).

Raven (1963) made the important distinction between bipolar taxa and amphitropical groups of lower latitudes. This is because the environmental and biological histories of the warm and cold temperate regions of the world are likely to be sufficiently different for it to be necessary to consider their floras separately when investigating the factors involved in the patterns of amphitropical distributions. Furthermore, since in general terms it may be expected that disjunctions in groups of plants at different levels of the taxonomic hierarchy have occurred at different periods, and perhaps have come about under very dissimilar sets of conditions, this should also be taken into consideration in the study of such disjunctions. It is partly for these reasons, therefore, that *species* showing disjunct distributions at high latitudes have been selected for the present studies. A further reason is that the application of some of the experimental techniques available is most rewarding at this level of taxonomic and genetical relationship.

This is the first in a series of papers devoted to detailed studies of as many bipolar species as possible using a variety of approaches, such as cytology, biometrical analysis, experimental hybridization, phytochemistry, etc. The intention is to obtain a body of information at the species level in order to see what patterns and trends can be derived within this bipolar element and to provide a basis for comparison with the features of other comparable geographically disjunct elements at the same and different taxonomic levels.

The exact number of such bipolar species, is, of course, constantly subject to modification in the light of taxonomic revisions, and indeed it has tended to decrease over the years. These studies will consider those cases for which there is, or recently has been, a substantial body of taxonomic opinion for including the Northern and Southern Hemisphere populations in the same species. Such species must occur at high latitudes in both hemispheres, that is attaining the areas of the Straits of Magellan (c. 52° S. lat.)

and Alaska or Arctic Europe (c. 55° N. lat.). Of course, many of these species penetrate into lower latitudes in both hemispheres, particularly via the Andes and Rockies, but they can generally be distinguished from the amphitropical species of warmer climates. On these criteria there appear to be about 30 species which must be included in this survey. The list, which may well need subsequent modification in the light of these studies, contains the following species: *Huperzia selago* (L.) BERNH., *Hymenophyllum tunbridgense* (L.) SM., *H. peltatum* (POIR.) DESV., *Koenigia islandica* L., *Polygonum maritimum* L., *Cerastium arvense* L., *Sagina procumbens* L., *Ranunculus aquatilis* L., *Anemone multifida* POIR., *Honckenya peploides* (L.) EHRH., *Hippuris vulgaris* L., *Armeria maritima* L., *Gentiana prostrata* HAENKE, *Limosella australis* R. BR., *Plantago maritima* L., *Triglochin palustre* L., *Catabrosa aquatica* (L.) P. BEAUV., *Trisetum spicatum* (L.) RICHT., *Poa glauca* VAHL, *Deschampsia atropurpurea* (WAHLENB.) SCHEELE, *D. caespitosa* (L.) P. BEAUV., *D. flexuosa* (L.) TRIN., *Calamagrostis stricta* (TIMM.) KOEL., *Phleum alpinum* L., *Carex capitata* L., *C. curta* GOODEN., *C. macloviana* D'URV., *C. magellanica* LAM., *C. maritima* GUNN., and *C. microglochin* WAHLENB.

BIPOLAR CAREX

Carex is primarily a genus of the Northern Hemisphere, with over half its species occurring in northern temperate regions. Twelve species have been reported from cool temperate regions of both hemispheres, most of them having their Southern Hemisphere populations in South America. Of these species *C. nigra* (L.) REICHARD, *C. pseudo-cyperus* L., and *C. riparia* CURT. have not been reliably recorded from latitudes as high as 50°S.; nor has *C. marcida* BOOTT, whose northern populations, furthermore, are separated as *C. stenophylla* WAHLENB. (incl. *C. eleocharis* L. H. BAILEY). *C. gayana* DESV. does not reach further north than about 48°N. in North America where, in any case, it apparently constitutes a distinct species — *C. simulata* MACK. (MACKENZIE 1931).

Six species fulfil the requirements for bipolarity adopted above and are considered here. They are — *C. maritima* GUNN., *C. macloviana* D'URV., *C. capitata* L., *C. curta* GOODEN., *C. magellanica* LAM. and *C. microglochin* WAHLENB. All of these species are widely distributed at high latitudes in the Northern Hemisphere and all reach Tierra del Fuego in the south. One species, *C. curta,* is also known from montane Australia (Fig. 1 A—F).

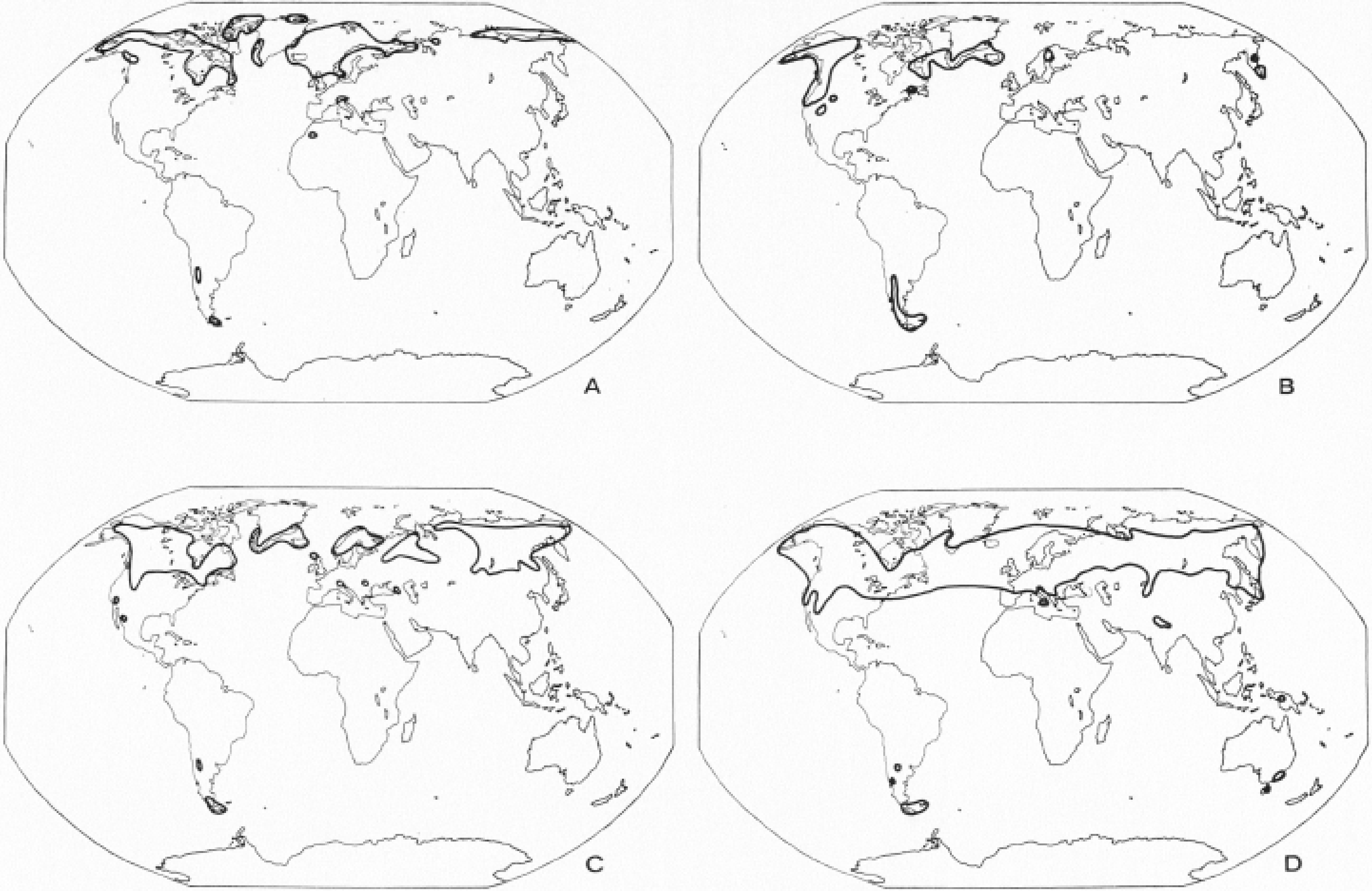
MATERIALS AND METHODS

The results described in this paper are largely derived from a study of herbarium material covering as wide a morphological and geographical range as possible, supplemented by field observations and cytological information. Since a major interest of this work is to determine the extent of differentiation in relation to bipolarity, we have primarily concentrated on examining variation between Northern and Southern Hemisphere populations and, to a lesser extent, that within the Southern Hemisphere. We have only considered variation among Northern Hemisphere plants where it is relevant to this principal theme.

The characters selected for detailed study in each species are those which earlier workers have indicated as useful for separating infraspecific groupings, particular attention being paid to quantitative characters. These characters include those which are most widely used in the genus and which most of the available evidence shows to be of greatest value in delimiting taxa. In every instance all characters of value on the above criteria were scored initially and then about ten of those showing the greatest differentiation were selected for further study. Wherever possible type specimens have been included in these observations.

RESULTS

The information is presented separately for each species. The species are consid-


A
B
C
D

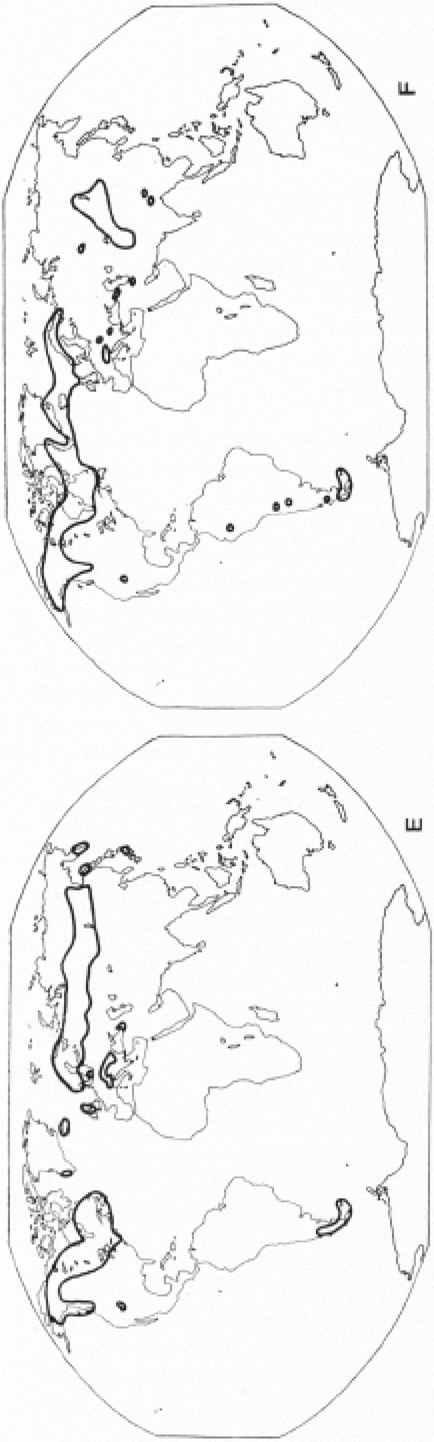


Fig. 1. Distributions of six bipolar *Carex* species. — A: *C. maritima.* — B: *C. macloviana.* — C: *C. capitata.* — D: *C. curta.* — E: *C. magellanica.* — F: *C. microglochin.*

ered in order of increasing degree of differentiation between Northern and Southern Hemisphere populations.

Carex maritima GUNN.

This was described by GUNNERUS (1772 p. 131), the type being either Fl. Danica 3(8): t. 432 (1769), from Denmark, or a specimen collected by OEDER from Fjaerestal in Norway. *Carex incurva* LIGHTFOOT, described from N. Scotland (LIGHTFOOT 1777 p. 544), has never been considered taxonomically distinct and our work confirms this. *C. misera* PHIL., described from prov. Atacama, Chile (PHILIPPI 1860 p. 388), was treated as a variety by KÜKENTHAL (1909), as also was *C. melanocystis* DESV. (GAY 1853 p. 203), described from S. Chile. *C. juncifolia* ALL. (ALLIONI 1785 p. 264), described from the W. Alps, is also in our opinion not sufficiently distinct to be worth taxonomic recognition.

Closely related taxa, which do appear to be specifically distinct but which require further investigation, include *C. perglobosa* MACK. from Colorado, *C. incurviformis* MACK. from Alberta and British Columbia, *C. acrifolia* KRECZ. from the Caucasus, *C. pseudofoetida* KÜK. from the Tien-Shan, Pamirs and Kashmir, *C. slobodovii* KRECZ. from Tibet and W. China and *C. sajanensis* KRECZ. from C. Siberia. Since none of these reach the Southern Hemisphere we have left them out of account.

C. maritima GUNN. in our sense is in the Northern Hemisphere an Arctic-Alpine in Eurasia, with a circumboreal distribution to Greenland, Alaska and southwards to SE. Canada, while in the Southern Hemisphere it is known from Tierra del Fuego and S. Patagonia, and from the Andes between c. 30°S and c. 37°S. The recorded variation within this distribution is mostly based on the number of flowers, the length and diameter of the stem, the shape and colour of the female glumes, and the width of the utricle. The

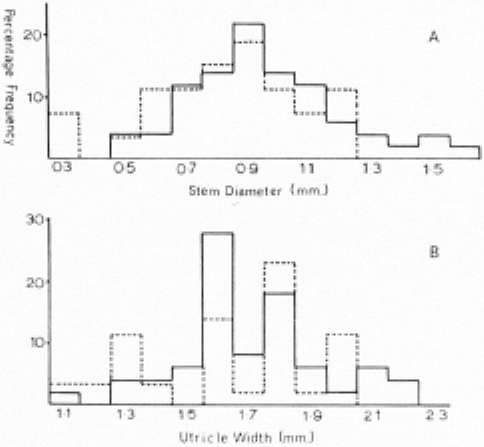


Fig. 2. Morphological characteristics of Northern (—, N=50) and Southern (- - -, N =26) Hemisphere plants of *Carex maritima*. — A: Stem diameter. — B: Utricle width.

variation does not appear to fit into any significant geographical pattern.

The following characters were studied: 1. Stem-diameter; 2. Inflorescence-length; 3. Inflorescence-width; 4. Length of female glume; 5. Width of female glume; 6. Colour of female glume; 7. Utricle-length; 8. Utricle-width. The number of flowers is omitted because detailed analysis was impracticable on herbarium material, although preliminary observations indicated that variation in this character was not significant.

In none of the 8 characters studied in detail was there any significant discontinuity in the variation pattern, but we present here (Fig. 2A, B) our results for 2 characters to indicate the sort of trends that could be seen in the variation of Northern and Southern Hemisphere material. These results confirm that the Northern and Southern Hemisphere populations of *C. maritima* are very similar and that there is no evidence for any infra-specific subdivision. It is interesting that the Southern Hemisphere material tends to lie in the middle of the variation pattern shown by that from the north. This is supported by Roivainen's (1954 p. 198) observation that "Zwischen meinen feuerländischen und in Nordeuropa gesammelten Examplaren habe ich keine nennenswerte Differenzen gefunden".

Carex macloviana D'Urv.

This species was described from Port Louis, in the Falkland Islands, by D'Urville (1825). It occurs in the Southern Hemisphere in the Andes from c. 32°S southwards to Tierra del Fuego and the Falkland Islands. In the Northern Hemisphere it occurs from N. Scandinavia through Iceland and Greenland to E. Canada, and from Alaska to Wyoming in the west; it also occurs in Hawaii and Kamchatka. Kükenthal recognized 8 varieties, differing in stem-length, leaf-width, number of spikelets, shape of glumes and utricles, etc.: only two of these are given for South America, var. *thermarum* (Phil.) Kük. and var. *pseudoleporina* Kük. (Kükenthal 1909; Barros 1935). The most significant variant recorded in the Northern Hemisphere is subsp. *pachystachya* (Cham.) Hultén (Hultén 1942), comprising the plants from W. North America.

On the basis of the published information on variation the following characters were studied: 1. Stem-length; 2. Stem-diameter; 3. Leif-width; 4. Inflorescence-length (as an indication of spikelet-number); 5. Length of lowest bract; 6. Sex of flowers; 7. Length of female glume; 8. Width of female glume; 9. Utricle-length; 10. Utricle-width. Although in no case was there any significant discontinuity in the variation pattern there appears to be a slight differentiation between Northern and Southern Hemisphere material in characters 2, 3, 5 and 7 (Fig. 3A—D). In all these characters it is obvious that although there is an almost complete overlap between material from the two hemispheres that from the south tends to be slightly larger. Though the infraspecific taxonomy of the species in the Northern Hemisphere

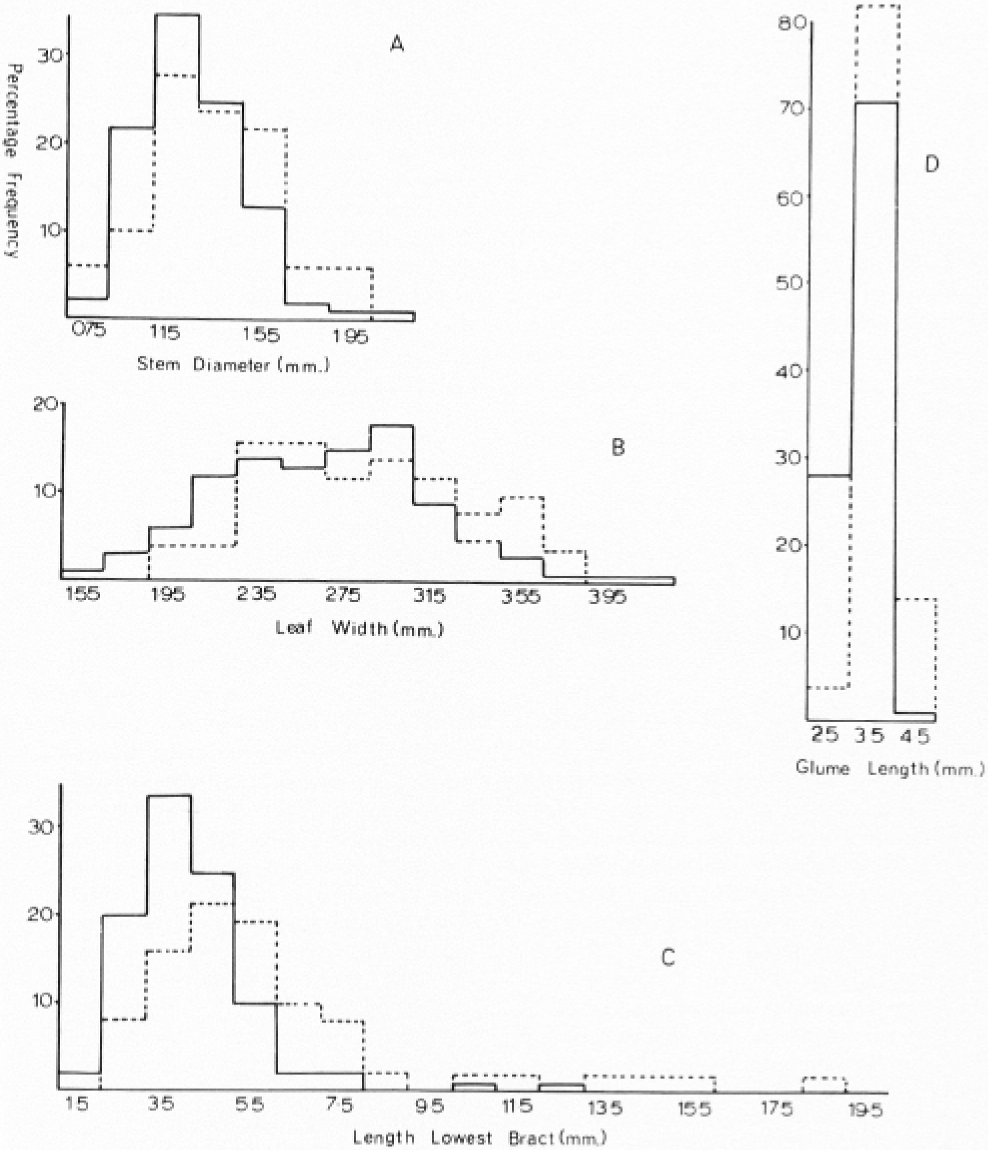


Fig. 3. Morphological characteristics of Northern (—, N=102) and Southern (- - -, N=51) Hemisphere plants of *Carex macloviana*. — A: Stem diameter. — B: Leaf width. — C: Length of the lowest bract. — D: Length of ♀ glume.

remains obscure (Hultén 1958; Calder & Taylor 1968) it is clear that there is no case for any formal separation of the Southern Hemisphere populations.

Carex capitata L.

This species was described by Linnaeus (1759 p. 1261) from a Solander specimen, probably that from Lapland in the

Linnean Herbarium. In the Northern Hemisphere it is widespread as a circumboreal in Europe and Siberia, Greenland and Canada, extending southwards in the west to N. Mexico. In the Southern Hemisphere it occurs in S. Patagonia and Tierra del Fuego, and in the Andes between c. 32°S. and 38°S.

Little infraspecific variation had been noted until the work of SMITH (1940) and ROIVAINEN (1954). *C. arctogena* H. SMITH, described from Torne Lappmark, Sweden, was distinguished from *C. capitata* principally by its shorter stems, smaller inflorescence, subacute female glumes and smaller utricle which is more abruptly contracted into a longer beak. It was said to occur in northern and montane Scandinavia, Greenland, NE. North America, S. Patagonia and Tierra del Fuego. SMITH (1940) observed that the most pronounced *arctogena* characteristics were found in South American material and ROIVAINEN (1954) described such plants from Tierra del Fuego as *C. antarctogena* ROIV. He appears to include all austral material in this species, which is stated to differ from *C. arctogena* in being stouter, having more male flowers and more (8—14) teeth on the utricle. On the other hand HULTÉN (1962) considered *C. arctogena* worthy at most of varietal rank, while RAYMOND (1949) was of the opinion that it is a forma of *C. capitata*.

The following characters were studied: 1. Stem-length; 2. Stem-diameter; 3. Inflorescence-length; 4. Inflorescence-width; 5. Length of female glume; 6. Width of female glume; 7. Utricle-length; 8. Utricle-width; 9. Length of utricle-beak. The number of teeth on the beak of the utricle was not included because of the frequent difficulty in deciding whether a beak was smooth or toothed and in counting the teeth.

No discontinuity was found in the variation pattern, but in almost all the characters studied there was a strong tendency for the Southern Hemisphere populations to fall nearer to one extreme of the variation observed in the Northern Hemisphere, as is shown in Fig. 4 A—D. This result confirms the comments on the Southern Hemisphere populations made by SMITH (1940), though it also indicates that his division of the Northern Hemisphere populations into two species is unjustified. Indeed, we concur with HULTÉN (1962) that *C. arctogena* is only varietally distinct, and we consider that the Southern Hemisphere plants also fall within this variety.

Carex curta GOODEN.

This species was described by GOODENOUGH (1791 p. 145), the type being specimen 1100.24 in the Linnean Herbarium, collected by SOLANDER from Lapland and labelled "*brizoides*" by LINNAEUS. The species has often been known as *C. canescens* L., the type of which is, however, a specimen of *C. buxbaumii* WAHLENB. (NELMES 1951a p. 444). A great deal of variation has been described and the actual limits of the species in the Northern Hemisphere may be hard to define. It has a circumboreal distribution, extending southwards to S. Italy, the Himalayas and the Rockies. In the Southern Hemisphere it occurs in New Guinea and SE. Australia, and in South America in the Falkland Islands and Tierra del Fuego and in the Andes at c. 40°S and c. 35°S. We have excluded from consideration the closely related species *C. hylaea* KRECZ., *C. arctaeformis* MACK., *C. lapponica* O. F. LANG and *C. bonanzensis* BRIST.

The following characters were studied: 1. Stem-length; 2. Stem-diameter; 3. Inflorescence-length; 4. Number of spikes; 5. Length of lowest spike; 6. Width of lowest spike; 7. Utricle-length; 8. Utricle-width; 9. Utricle-scabridity; 10. Leaf-width; 11. Distance between lowest pair of spikes; 12. Distance between 2nd lowest pair of spikes. A preliminary analysis of the above 12 characters revealed that some evidence of a discontinuous pattern was shown by 2, 7, 8 and 10 (Fig. 5 A—C).

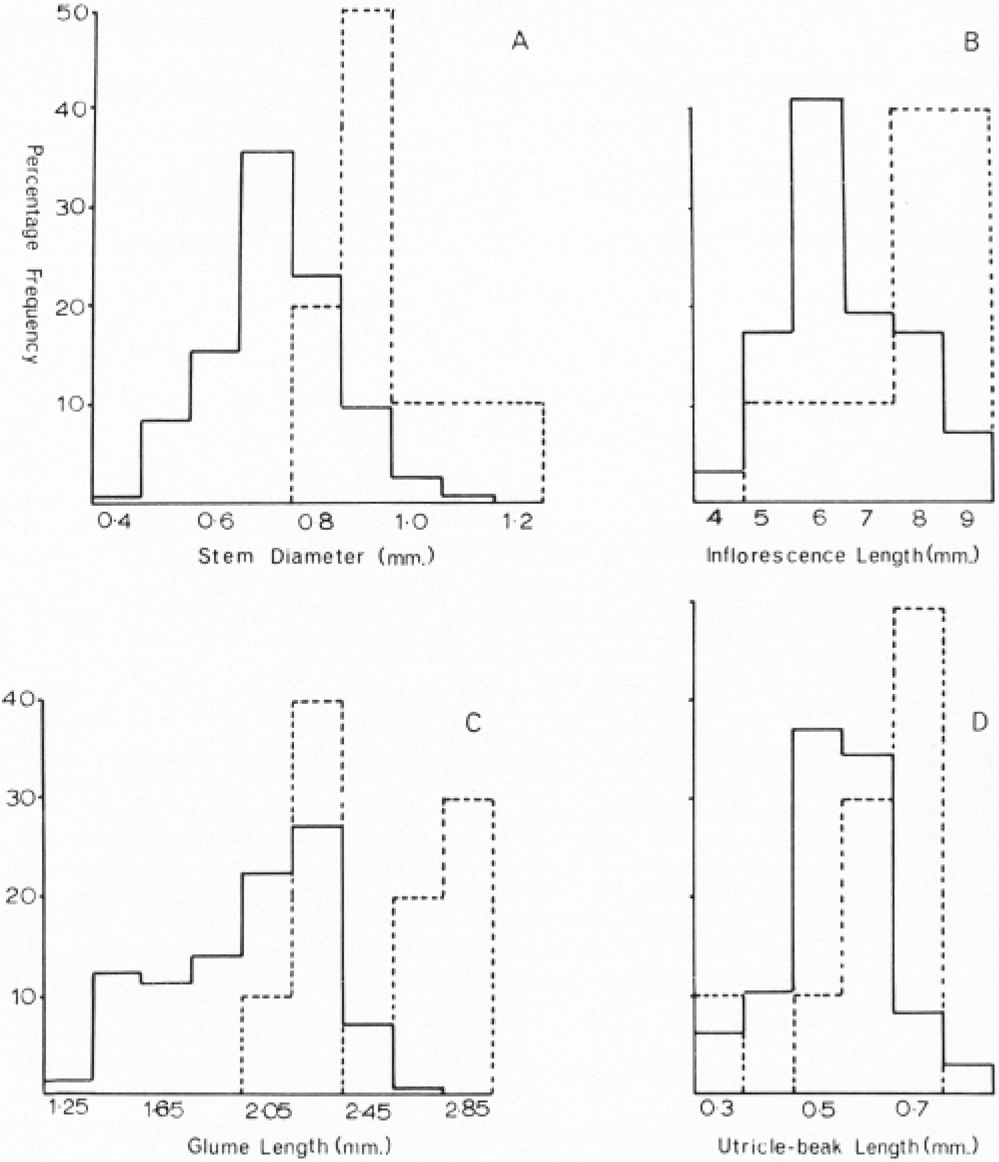


Fig. 4. Morphological characteristics of Northern (—, N=138) and Southern (- - -, N=15) Hemisphere plants of *Carex capitata*. — A: Stem diameter. — B: Length of the inflorescence. — C: Length of ♀ glume (class centres). — D: Length of utricle-beak.

Thus, despite considerable overlap, there is a tendency for Southern Hemisphere material to have a somewhat greater stem-diameter than that from the north (Fig. 5A). More pronounced, however, are the wider leaves (Fig. 5B) and wider utricles (Fig. 5C) of the Southern Hemisphere material, which also generally has a lon-

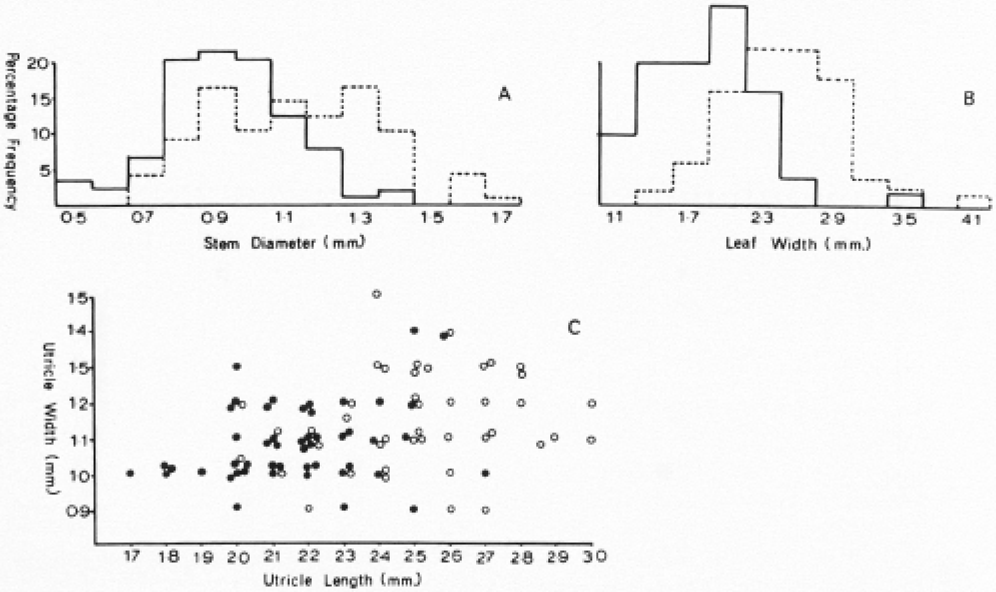


Fig. 5. Morphological characteristics of Northern (—, N=87, ●) and Southern (- - -, N=48, ○) Hemisphere plants of *Carex curta*. — A: Stem-diameter. — B: Leaf-width. — C: Utricle-length and width.

ger utricle (Fig. 5C). These data suggest that the material from the Southern Hemisphere can be considered as varietally distinct. The appropriate variety is *C. canescens* β *robustior* Blytt ex Andersson, described from Scandinavia, the type being Andersson Exsicc. VII. 83. The combination under *C. curta* Gooden. has apparently not been made and we therefore propose it as follows:

Carex curta Gooden. var. **robustior** (Blytt ex Andersson) D. M. Moore & A. O. Chater **comb. nov.** (syn. *C. canescens* [var.] β *robustior* Blytt ex Andersson, Cyp. Scand. 57, 1894).

As well as comparing Northern and Southern Hemisphere material, that from various component geographical regions such as Australia, South America, North America, Greenland, Fennoscandia, U.S.S.R. and Europe was examined for any geographical correlations at this level. Only in leaf-width was there any noticeable difference, since North American material showed a slight tendency to be narrower than material from other northern areas. Interestingly, Australian material accorded in almost all characters with the tendency shown by South American material, although in utricle-length and width it graded more into the Northern Hemisphere range than did most of the South American material. It is worth mentioning here that Nelmes (1951a) considered the New Guinea plant to be nearer to typical European material than is the Australian plant.

Carex magellanica Lam.

This species was described by Lamarck (1792 p. 385) from material collected by Commerson along the Straits of Magellan. It has a northern circumpolar distribution (Hultén 1962), with extension to the mountains of C. Europe, W. Asia and south along the Rockies to Colorado, while

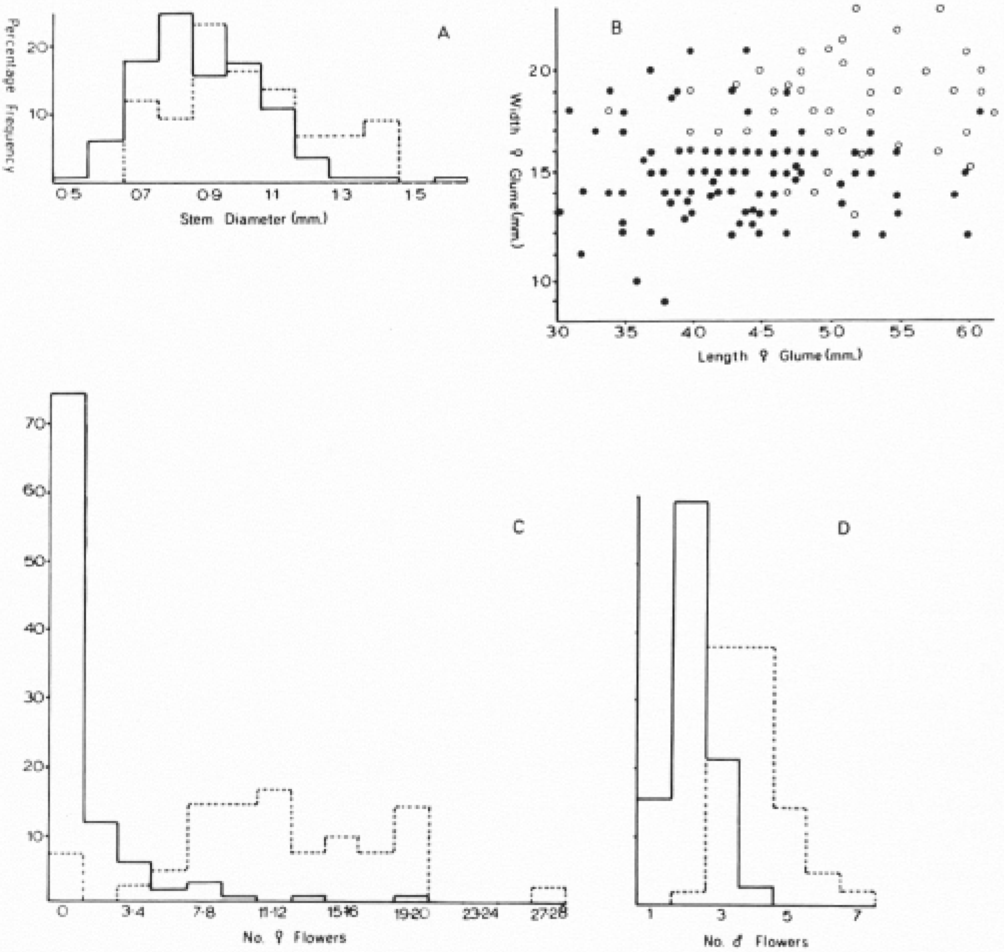


Fig. 6. Morphological characteristics of Northern (—, N=102, ●) and Southern (- - -, N=48, ○) Hemisphere plants of *Carex magellanica*. — A: Stem diameter. — B: Length of middle ♀ glume. — C: Number of ♀ flowers in terminal spike. — D: Number of ♂ flowers in lower lateral spike.

in the Southern Hemisphere it occurs from Tierra del Fuego and the Falkland Islands north along the Andes to about 40°S lat. The Northern Hemisphere populations have been distinguished as *C. paupercula* MICHX. or *C. irrigua* WAHLENB. ROIVAINEN (1954) reported that the South American plants differ from those in the Northern Hemisphere by having dioecious upper and lateral spikes, more male flowers and narrower utricles. On the basis of this HULTÉN (1962) separated the Northern Hemisphere material as ssp. *irrigua* (WAHLENB.) HULTÉN.

The following characters were studied: 1. Stem-length; 2. Stem-diameter; 3. Total number of spikes; 4. Number of female flowers in terminal spike; 5. Number of male flowers in lower lateral spike; 6. Length of female glume (middle of spike);

7. Width of female glume; 8. Utricle-length; 9. Utricle-width. Of these, characters 2, 4, 5, 6 and 7 appeared to show the most noticeable discontinuities (Fig. 6A—D).

It is evident that, once again, the Southern Hemisphere plants have stouter stems than those from the North, although there is considerable overlap (Fig. 6A), and the lower lateral spike has more male flowers in Southern than Northern Hemisphere plants, although again there is an overlap at 3 flowers (Fig. 6D). The three remaining characters show the major distinction between Northern and Southern Hemisphere plants, the latter having more female flowers in the terminal spike, and longer and wider female glumes. Almost 75 % of the Northern Hemisphere plants have the terminal spike completely male, as compared with only 7 % of Southern Hemisphere plants.

Geographical variation of characters in the Northern Hemisphere was examined by comparing material from different regions, such as Canada, U.S.A., Iceland, Fennoscandia and Europe, but none of these was morphologically closer than the others to the Southern Hemisphere material. Interestingly, material from Fennoscandia covers virtually the whole range of variation in all characters encountered in the Northern Hemisphere.

In view of the general modal difference between Northern and Southern Hemisphere populations of *C. magellanica* in the sex of the terminal spike and in glume-size, it seems appropriate to recognize them as different subspecies. We would concur with HULTÉN (1962), therefore, that the southern plants belong to ssp. *magellanica*, while those in the Northern Hemisphere are separated as ssp. *irrigua* (WAHLENB.) HULTÉN.

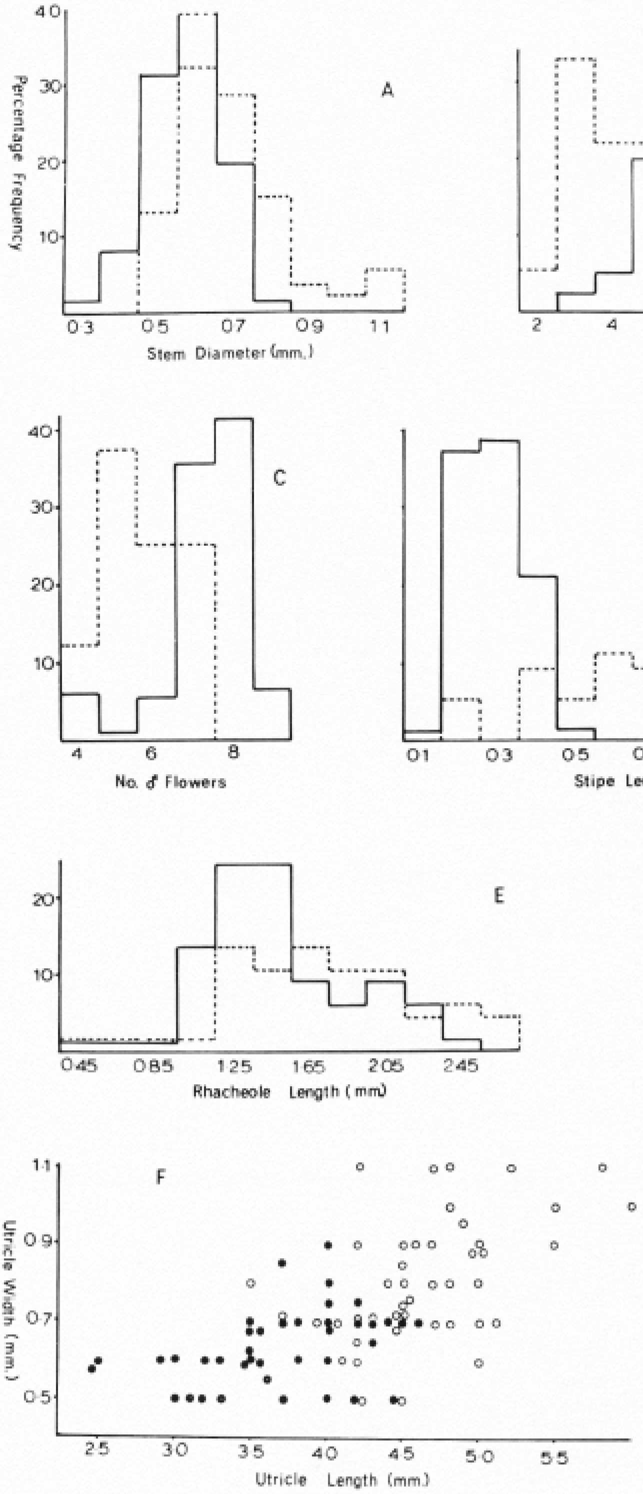
Carex microglochin WAHLENB.

This species, originally described from North Lapland (WAHLENBERG 1803 p. 140), is widespread in the Northern Hemisphere, where it occurs from the mountains of C. Europe east to the Caucasus, Altai and Himalayas, in C. and N. Russia, N. Europe, Greenland, N. North America and south along the Rockies to Colorado. In South America the species occurs sporadically along the Andes south from Ecuador, but is most frequent at their southern limit and in Tierra del Fuego and the Falkland Islands. These southern plants have been distinguished as *C. camptoglochin* KRECZ. (*C. oligantha* BOOTT non STEUDEL) the type of which comes from Bahía Orange on Peninsula Hoste in southern Fuegia, as *C. microglochin* subsp. *fuegina* KÜK., or as *C. microglochin* var. *oligantha* (BOOTT) KÜK., by having tall culms, sparsely flowered spikes and long, long-stipitate utricles. ROIVAINEN (1954) considered that two species, *C. microglochin* and *C. oligantha,* should be recognized in Tierra del Fuego, differing in utricle-length, numbers of male and female flowers and in habitat preference.

The following characters were studied: 1. Stem-length; 2. Stem-diameter; 3. Length of longest leaf; 4. Number of male flowers; 5. Number of female flowers; 6. Length of largest utricle; 7. Width of largest utricle; 8. Emergent length of rhacheole; 9. Stipe-length.

The Northern and Southern Hemisphere populations did not differ in either stem- or leaf-width, but in all the other 7 characters there was some differentiation (Fig. 7 A—F). There is a general tendency for the Southern Hemisphere material to have slightly stouter stems (Fig. 7A), somewhat fewer male and female flowers (Fig. 7B, C) and the rhacheole projects further

Fig. 7. Morphological characteristics of Northern (—, N=62, ●) and Southern (- - -, N=53, ○) Hemisphere plants of *Carex microglochin.* — A: Stem diameter. — B: Number of ♀ flowers. — C: Number of ♂ flowers. — D: Stipe-length. — E: Emergent length of rhacheole (class centres). — F: Utricle-length and width.


A
Percentage Frequency
40
30
20
10
0·3
0·5
0·7
0·9
1·1
Stem Diameter (mm.)
B
2
4
6
8
10
No. ♀ Flowers
C
40
30
20
10
4
6
8
No. ♂ Flowers
D
0·1
0·3
0·5
0·7
0·9
1·1
1·3
Stipe Length (mm.)
E
20
10
0·45
0·85
1·25
1·65
2·05
2·45
Rhacheole Length (mm)
F
Utricle Width (mm.)
1·1
0·9
0·7
0·5
2·5
3·0
3·5
4·0
4·5
5·0
5·5
Utricle Length (mm.)

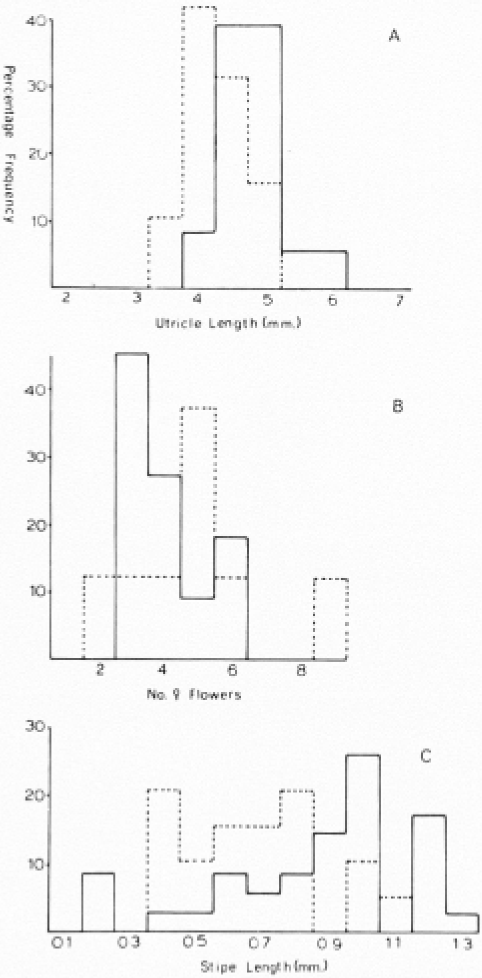


Fig. 8. Morphological characteristics of plants of *Carex microglochin* from lower (- - -, N=20) and higher (—, N=35) rainfall areas of Tierra del Fuego and adjacent parts of southernmost South America. — A: Utricle length. — B: Number of ♀ flowers. — C: Stipe-length.

from the utricle (Fig. 7E) than in plants from the Northern Hemisphere. However, the greatest differentiation is shown in the size of the utricle and in the stipe-length, which are clearly greater in Southern Hemisphere plants (Fig. 7D, F). It seems clear that these latter characters give abundant reason for the separation of two subspecies within *C. microglochin*, with lesser support from characters 2, 4, 5 and 8. The result of this would be that all Northern Hemisphere material be included in ssp. *microglochin*, while South American plants comprise ssp. *fuegina* Kük.

We have followed up Roivainen's (1954) suggestion that two species occur in Tierra del Fuego, *C. microglochin* being characteristic of the drier central and eastern parts of Fuegia and *C. camptoglochin*, with larger utricle, longer stipe and fewer male and female flowers, occurring in the higher rainfall areas of the west and south-west. From our data on this relationship (Fig. 8 A—C) there is a suggestion of the trend noted by Roivainen but the large overlap precludes recognition of two taxa on the basis of these characters.

After studying 5 Northern and 3 Southern Hemisphere plants Kukkonen (1970) suggested that anatomical differences exist between material referred to *C. microglochin* and *C. camptoglochin*. Examination of a wider sample (12 Northern and 11 Southern Hemisphere plants), whilst not confirming the validity of all the characters used by him, does generally support his findings. Thus, Northern Hemisphere material is anatomically distinguishable from most, but not all, Southern Hemisphere material. The southern plants having a similar anatomy to ssp. *microglochin* show some tendency to be closer to it than do the other Southern Hemisphere plants in stipe-length, number of female flowers and utricle size, but there is a considerable overlap which precludes formal separation at present. Furthermore, the two anatomically different groups exhibit no discernible differences in climatic or ecological requirements and can be virtually sympatric in southern Fuegia. In a situation of modal separation of two subspecies, such as is encountered here, some plants similar to the Northern Hemisphere taxon will be found in the south but there is clearly a

Table 1. Chromosome numbers in bipolar *Carex* species.

Species	Hemisphere	2*n*	References
capitata L.	N	50	Heilborn 1928, Löve & Löve 1956.
[as *arctogena*]	N	50	Jørgensen et al. 1958, Löve & Löve 1966.
curta Gooden.	N	56	Jørgensen et al. 1958, Löve & Löve 1948.
	S	56	Moore 1967.
macloviana D'Urv.	N	82	Böcher 1938.
		86	Heilborn 1939, Jørgensen et al. 1958, Löve & Löve 1956.
magellanica Lam.	N	58	Heilborn 1928, Favarger 1959.
	S	58	Moore unpub. (Tierra del Fuego).
maritima Gunn.	N	60	Holmen 1952, Jørgensen et al. 1958, Löve & Löve 1942, 1956, Löve & Ritchie 1966.
microglochin Wahlenb.	N	58	Löve & Löve 1942, 1956.
	S	58	Moore unpubl. (Tierra del Fuego).

need for further information on the causes of the anatomical variation and a continued search for features correlated with the rather abrupt discontinuity shown by the anatomical characters.

CHROMOSOME STUDIES

Chromosome numbers are known for material of all six species from the Northern Hemisphere, although in most cases only from one or two localities. Southern Hemisphere material of three species has been studied cytologically and in each case the chromosome number is the same as that reported from the Northern Hemisphere. These data are summarized in Table 1. It has not been possible to examine chromosome pairing in artificial hybrids between material from the two hemispheres to see whether structural changes in the chromosomes have occurred or to determine whether cytogenetic barriers to gene flow are present.

DISCUSSION

It has long been accepted by students of speciation and evolution that geographical separation is a major factor in disrupting the patterns of gene flow and is therefore involved to a considerable extent in the differentiation of such separated populations. In relation to bipolar distributions this differentiation is shown by genera such as *Caltha, Chrysosplenium, Euphrasia* and *Litorella,* in which the Northern and Southern Hemisphere populations have diverged sufficiently to be clearly distinguished as distinct species, in some cases belonging to different sections. On the other hand, the bipolar species listed in the introduction have not diverged to any comparable extent, at least with regard to taxonomically recognizable characters, while the genus *Empetrum* may be cited as an example occupying an intermediate position in that the Northern and Southern Hemisphere populations, although traditionally referred to distinct species, have been shown to be only modally different (e.g. Moore et al. 1970). Such differences in the extent of differentiation between taxa having comparable disjunct distributions can be considered to result from substantial differences in the speed of their non-geographical evolutionary processes (e.g. Löve 1967 p. 325), from differences in the age of the disjunction (e.g. Raven 1963 p. 157) or from some combination of these factors.

The six taxa considered in this paper all belong to a single genus, albeit not to the same subgenus, and they have been selected on fairly stringent distributional criteria. It is interesting, therefore, that even within such a restricted group we find a rather wide variation in the extent to which there is differentiation between the Northern and Southern Hemisphere populations. Thus, in *Carex magellanica* and *C. microglochin* they are subspecifically distinct, in *C. curta* they are varietally distinct, while in the remaining three species no formal taxonomic separation can be made, only slight differences being found in *C. capitata* and *C. macloviana* and virtually none in *C. maritima.* Interestingly, in every case, even where the difference is slight, the Southern Hemisphere plants tend to be more robust than those from the Northern Hemisphere, particularly in stem-diameter and some floral characters. The reasons for this are not clear and it will be interesting to see whether a similar tendency is found in bipolar species belonging to other genera and, if so, with what environmental or biological features they may be correlated. In *Carex* the available information (ROIVAINEN 1954; MOORE unpub.) suggests that the species occupy very similar habitats in the Northern and Southern Hemispheres.

If the various degrees of differentiation between Northern and Southern Hemisphere populations shown by the *Carex* species are due to their dissimilar rates of evolution then one must conclude that the evolutionary processes were most rapid in *C. microglochin* and *C. magellanica,* and progressively slower in *C. curta, C. capitata* and *C. macloviana,* with *C. maritima* showing relative stability. However, the latter two species, for example, show a considerable amount of variation in the Northern Hemisphere, where their evolution does not seem to have proceeded at an unusually low rate. If, on the other hand, the age of the discontinuity is of major importance in the differentiation, then the data suggest that these six *Carex* species have crossed the tropics at different times, *C. microglochin* and *C. magellanica* being the earliest migrants and *C. maritima* the most recent. As noted above, (p. 318) the most likely period for amphitropical migration seems to be during the Late Pliocene and Pleistocene and if the movements of the different species took place at intervals during this period then it could be suggested that the northern and southern populations of *C. magellanica* and *C. microglochin* have taken anything up to 3,000,000 years to diverge into different subspecies while *C. maritima* has shown virtually no divergence during at least the 10,000 years since the Pleistocene. The possibility of post-Pleistocene migration of *C. maritima* cannot be discounted, but this would involve very long distance dispersal since the northern and southern cool temperate regions have generally moved further apart during this period.

At this juncture it is not proposed to go any further into these various possibilities until we have collected more information on these and other bipolar species. It should be noted, however, that even within this group of species, belonging to the same genus and having very similar bipolar distributions, the major geographical discontinuity across the low latitudes is not constantly correlated with any correspondingly major discontinuity in the variation pattern. In this respect it is simply as though the Southern Hemisphere distribution was another outlier of the main range. All six *Carex* species have their widest distribution in the Northern Hemisphere, where *C. maritima, C. macloviana* and *C. capitata* show greater variation in most characters than in the Southern Hemisphere. This would be consistent with the usual view (e. g. RAVEN 1963 p. 155) that the species migrated from the north. However, *C. microglochin,* for which an austral origin has been postulated (NELMES 1951b), does show greater variation in the Southern Hemisphere; but *C. curta* and *C. magellanica* are similarly more variable in the Southern Hemisphere and there seems little doubt that these two species evolved in the Northern Hemisphere where their closest relatives occur.

In warm temperate America a taxonomically heterogeneous group of amphitropical species has been shown to display various stages of both morphological and cytogenetical differentiation (MOORE and RAVEN 1970), and this may be considered an analogous situation to the one we are considering here. Our cytological data for the *Carex* species are confined to observations on chromosome numbers, which show no amphitropical differences, and the difficulty of obtaining artificial hybrids in this genus suggests that we will not easily obtain information on cryptic cytogenetical changes. However, such data can be obtained more readily from bipolar species in other genera and it should be possible eventually to gather a broadly based body of information on the biologically important characteristics of these taxa. Such data will permit a clearer understanding of the processes responsible for the patterns of variation in bipolar species and how these are related to the general problem of evolution and distribution in taxa showing wide geographical disjunction.

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Northerly Localities for three Aquatic Plants, Lemna trisulca L., Ceratophyllum demersum L., and Myriophyllum spicatum L.

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ABSTRACT

Holmquist, C. 1971. Northerly localities for three aquatic plants, Lemna trisulca L., Ceratophyllum demersum L., and Myriophyllum spicatum L. — Bot. Notiser 124: 335—342.

Three aquatic plants, *Lemna trisulca* L., *Ceratophyllum demersum* L., and *Myriophyllum spicatum* L. have been found north of their known distribution range on several localities in northern Alaska and northwestern Canada. The new records are accounted for geographically and ecologically. It is suggested that more records will be available once a more systematic search for aquatic plants in arctic areas is performed.

During six summers' investigation of the invertebrate fauna of about one hundred lakes of northern Alaska and northwestern Canada, some vascular plants were also taken in the bottom dredge. Some of these seemed of special interest since they were found north of their known distribution range. The three species are *Lemna trisulca* L., *Ceratophyllum demersum* L. and *Myriophyllum spicatum* L. The survey, which was undertaken over the period from 1961 to 1970, has been sponsored by the Arctic Institute of North America under contractual arrangements with the Office of Naval Research, Washington, D.C., and by the Naval Arctic Research Laboratory, Barrow, Alaska.

The localities for the three species are seen in Table 1 and Figs. 1—3. All physico-chemical data from the various sampling occasions are given. They may be of use in a possible future analysis of the ecological demands of the topical plants at their northern border of occurrence. It must be remembered, though, that the records given represent only single samples. They are not absolute, but they give a fair idea about the conditions of the lake at a certain date. Not least the temperatures are correlative to date and weather, as shown by the records for Caribou Lake, S. Crossley Lake and the lake at about 68°N 139°W sampled in August 1969. There had been heavy snowfalls on the days immediately preceding the visit to these lakes. A scrutiny of Table 1 also tells that the absence of a record from a sampling occasion is not invariably evidence of nonexistence of a topical species in the topical locality. Mostly only one or two dredge hauls were made during each visit to a lake. For instance, the first visit to Lake Narvakrak in the Noatak River valley in 1964 yielded only *Lemna trisulca* of the three topical species, the second in 1968 also *Myriophyllum*, and finally the third in 1970 gave *Ceratophyllum* as well.

In manuals, all three species are said

to occur in shallow quiet water. This statement fits the present records well. If any tendency can be read from Table 1, it is that *Myriophyllum* seems to be met with in deeper lakes than are *Lemna* and *Ceratophyllum*, though not exclusively so. *Myriophyllum* was also taken in some more northerly lakes than were the other two (Figs. 1—3). *Ceratophyllum* has not yet been found north of the Brooks Range, viz. on the northern exposures of the Arctic Slope of Alaska. The latter fact is not significant, though, since S. Crossley Lake of northwestern Canada, where *Ceratophyllum* was taken in abundance, is not sheltered to the north by a mountain range either.

Hultén, in his Atlas of Vascular Plants in NW Europe (1950), referred the three topical species to "Boreal-circumpolar plants lacking large gaps in their area". The meaning of the word boreal is just northerly but has been used largely and often quite loosely to indicate a kind of climatic distribution, viz. cold-temperate climate. The word was used, among others, in denoting a period of the postglacial time in Scandinavia having a summer-dry maritime climate (cf. Magnusson, Granlund & Lundqvist 1949). In phyto- and zoogeographical sense it is used for northerly areas south of the tree-line. It will not be denied that the three aquatic plants now found in more northerly localities in the main have what is called a boreal distribution. Of more interest are the local climatic conditions which these plants encounter in this northern area, called arctic and subarctic.

Naturally, the climate and length of the vegetation period are of importance for the occurrence of the various species, but the winter conditions are of equal importance for their survival. The lakes in Table 1 are all, except the last one, within the area of continuous permafrost. This does not mean, though, that all lakes of such an area are underlaid by permafrost. It has been stated that a body of water deeper than the maximum thickness of the developing ice has an unfrozen zone beneath to a depth in correlation to the depth of the lake and the amount of unfrozen water (Brewer 1958; Lachenbruch, Brewer, Greene & Marshall 1962). Lakes deeper than about 2 m do not freeze to the bottom on the Arctic Slope of Alaska. Location and exposure of a lake influence the thickness of the ice cover. As to the present survey, it is doubtful that Aniralik Lake will freeze solid in the winter. Depths much greater than the one noted are unlikely, since moose were seen grazing almost as far as the middle of the lake. The two lakes at Umiat may be at the bounds of freezing solid.

Most probably nothing is known about the frost-hardiness and the minimum temperatures endured by the three topical species, and yet these factors are of great importance for the survival of species reaching thus far north. It was noted for Aniralik Lake that a large amount of the *Lemna* and *Potamogeton* found on the sampling date (July 27) looked dead and at the beginning of decay. The date of breaking up of the ice that year (1970) is not known for this area, but on the Arctic Slope it did not occur until the first half of July. At least *Lemna* and *Ceratophyllum* are not supposed to overwinter in the area, as do more hardy seeds. Even in milder countries, such as Sweden, flowers are rare things. *Lemna* overwinters as such, but *Ceratophyllum* develops special winter buds with rather tough, tight leaves. These buds sink to the bottom for the winter period. *Myriophyllum* was never found flowering in the area either, and also here propagation may proceed through shoots. *Myriophyllum* taken on September 19, 1970, in Niglaktak Lake and a lake further east also showed winter buds with tighter leaves than other buds.

The summer climate of the lakes in Table 1 may be quite warm at times, and the shallow water is apt to warm up fairly quickly. For instance, the shallow

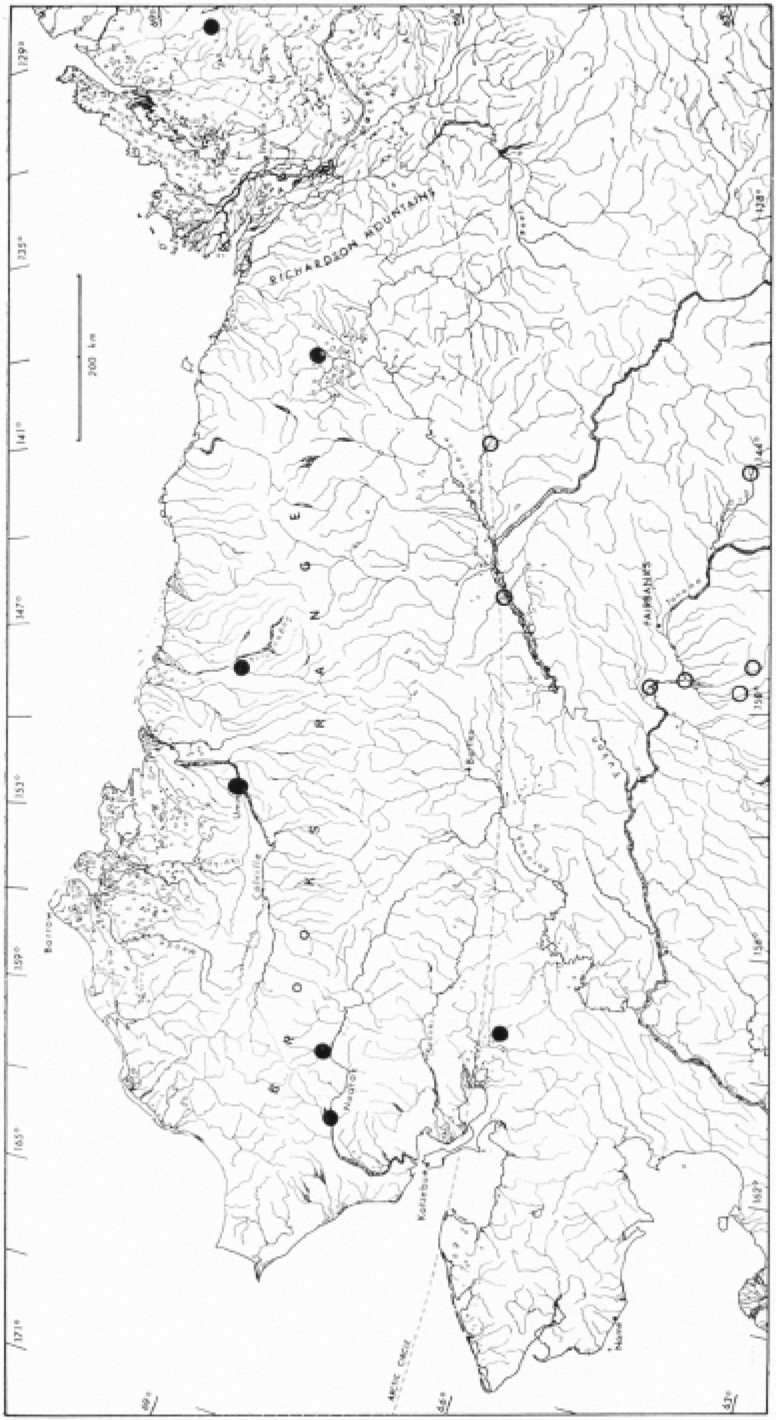

Fig. 1. *Lemna trisulca.* Dots = records of the present survey. Circles = records from HULTÉN (1968).

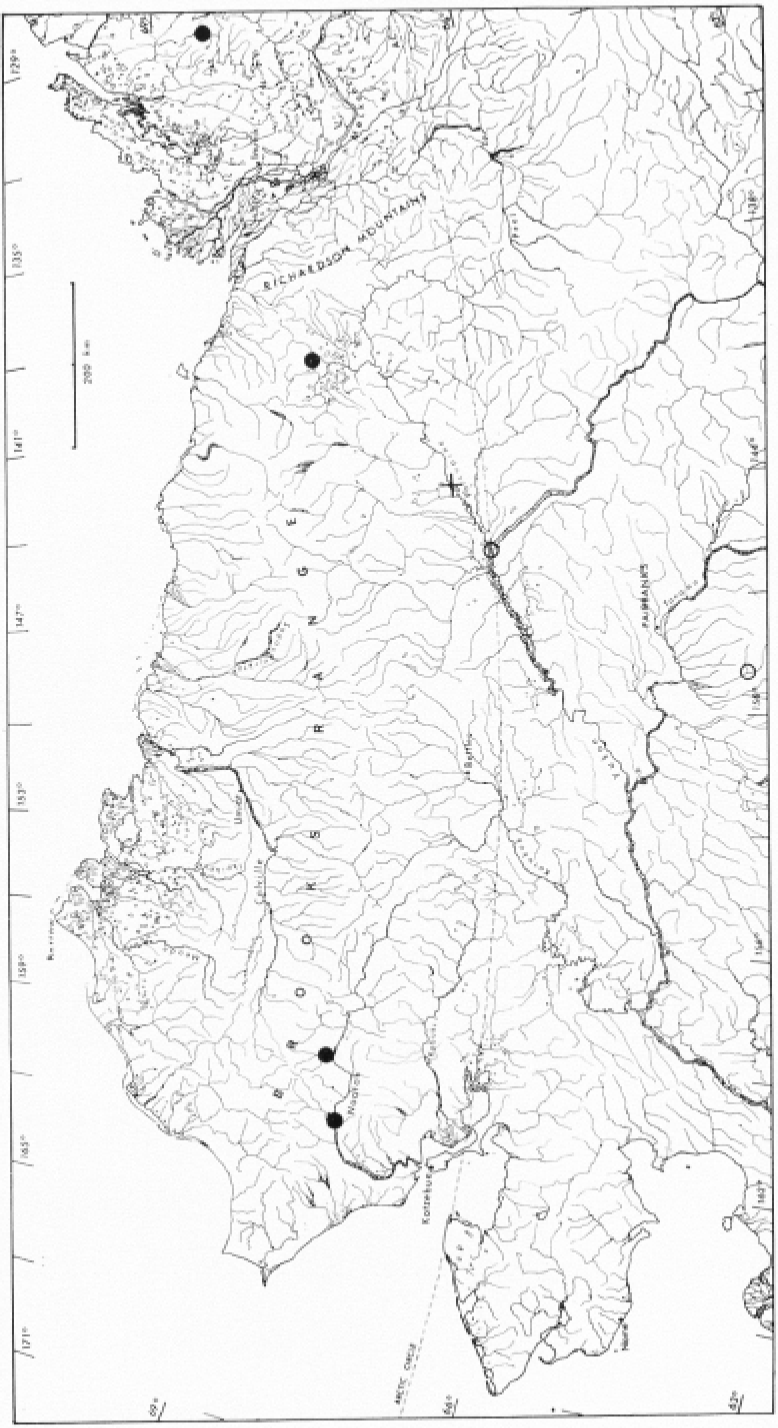

Fig. 2. *Ceratophyllum demersum*. Dots and circles, see Fig. 1. Cross = record from LIKENS & JOHNSON (1968). East of the mapping area the species has been recorded by TERASMAE & CRAIG (1958) at c. 64°N 102°W and HULTÉN (1968) at c. 63°N 114°W.

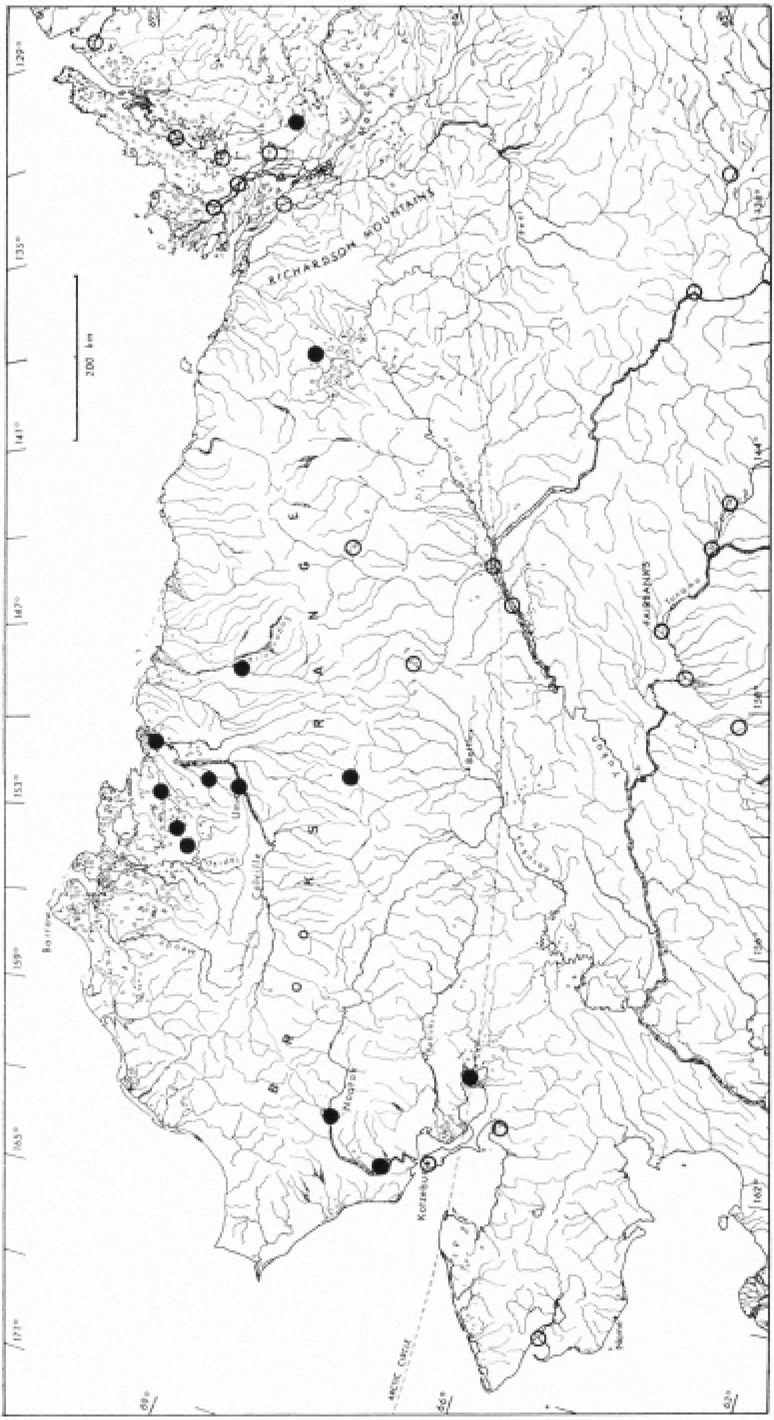

Fig. 3. *Myriophyllum spicatum.* For legends see Fig. 1.

Table 1. Ecological data for the sampling localities. L=*Lemna trisulca*, C=*Ceratophyllum demersum*, M=*Myriophyllum spicatum*. Further explanation in the text.

Locality	Altitude m (abt.)	Size km (abt.)	Max. depth noted m	Temp. C°	Cl′ mg/l	CaCO$_3$ mg/l	Cond. micro mho 25°C	pH	at depth m	Transparency m	Date	Plant
— 70°14′N 152°28′W	32	3.75 × 2.5	3.0	7.75 7.75	12 12	62 62	157 160	8.0 8.0	0 2.5	bottom	4.VIII. 1963	M
— 70°14′N 150°52.5′W	0—3	1 × 0.25	4.25	12.0 12.0	11 11	— 71	143 143	7.8 7.8	0 3	bottom at 2.7	23.VII. 1970	M
— 70°01.17′N 153°36′W	50	1.25 × 1	18.56	8.5 8.5 8.5	6.8 6.8 6.8	58 58 —	124 120 —	8.0 8.0 —	0 5 10	8.75	6.VIII. 1963	M
— 69°56.6′N 154°05.9′W	70	5 × 3	3.25	11.0 11.0	5.3 5.3	28 —	78 78	7.5 7.5	0 2.75	bottom	15.VIII. 1968	M
				—	7.1	29	77	7.6	0	bottom	24.VII. 1969	
— 69°42′N 151°59′W	87	2.5 × 1.25	2.9	8.5	7.1	86	196	8.4	0	bottom	17.VIII. 1964	M
Umiat Lake 69°23′N 152°05.7′W	105	1.5 × 0.1	1.83	11.0	2.7	34	91	7.6	0	bottom	28.VIII. 1970	L
— 69°22.1′N 152°07.2′W	105	0.5 × 0.1	—	0.5	8.9	48	156	6.4	0	—	18.IX. 1970	L M
— 69°21′N 148°38.4′W	223	1.75 × 1	2.1	17.5 17.5	3.6 3.6	46 43	62 62	7.6 7.6	0 1.75	bottom	17.VII. 1968	L M

161°43'W		4.25											
				15.0	3.6	25	65	8.2	1.5	0.7	21.VIII. 1968	L	M
				5.5	3.6	39	88	7.7	0	0.75	7.IX. 1970	LC	
Aniralik Lake 68°12'N 159°50'W	213	3 × 2	1.35	20.0	2.7	43	77	9.2	0	bottom	27.VII. 1970	LC	
Summit (Eleanor) Lake 68°10'N 151°45'W	650	0.75 × 0.25	14.0	9.0 9.0	1.8 1.8	30 —	68 68	7.7 7.7	0 5	5.15	26.VIII. 1964		M
— 68°12'N 139°23'W	300	6 × 2.25	2.25	14.5	1.8	57	142	8.2	0	2.0	12.VIII. 1964	LC	
				6.5 7.0	3.6 3.6	— 53	130 130	7.8 7.8	0 1.5	1.11	18.VIII. 1969	L	M
Caribou Lake 68°00'N 132°52'W	198	13 × 6	2.21	4.5 5.0	5.3 5.3	— 21	68 68	7.4 7.4	0 1.75	1.16	17.VIII. 1969		M
S. Crossley Lake 68°33'N 129°53'W	138	10 × 5	2.65	6.0 6.5	3.6 3.6	— 39	103 103	7.6 7.6	0 2	0.82	23.VIII. 1969	LC	
— 67°23'N 162°40'W	6	2.75 × 2.25	2.2	14.0	1.8	30	63	8.4	0	—	2.VIII. 1964		
				15.0	1.8	27	76	7.9	0	1.45	21.VIII. 1968		M
Niglaktak Lake 66°35.5'N 159°56'W	2	4.5 × 4.25	1.79	14.0	7.1	25	81	7.6	0	0.73	22.VIII. 1968		
				4.0	6.9	57	310	7.5	0	1.17	19.IX. 1970		M
— 66°21'N 158°38'W	60	3.25 × 1.25	1.99	14.5	1.8	16	57	6.9	0	0.77	22.VIII. 1968	L	
				3.5 4.0	4.4 4.4	— 16	62 62	7.4 7.4	0 1.5	1.24	19.IX. 1970	L	

Aniralik Lake showed a surface temperature of 20°C on July 27, 1970; next in the Table is a lake close to the Sagavanirktok River with 17.5°C on July 17, 1968, and there is a lake in the lower Noatak River valley with 14°C on August 2, 1964, and 15°C as late as August 21, 1968. All the lakes of Table 1 lie a good way from the coast, and the summer in the inland of northern Alaska may be quite sunny and warm. The vegetation period may be short, though, viz. about three months, and the winters rather cold. Still it is hard to find any reasons why for instance *Ceratophyllum* could not live north of the Brooks Range in lakes of 2—3 m depth, as well as in Aniralik Lake and Lake Narvakrak on the southern slope of the Range, or in S. Crossley Lake some way east of the Mackenzie River Delta. It may be added that S. Crossley and Narvakrak Lakes are situated at the northern limit of trees, Aniralik Lake north of it. The reason why no other records of the three plants are available throughout my survey of about one hundred lakes of the area may be that generally deeper lakes were sought, as well as the deeper parts of every lake, and plants were not the main object of my survey.

In 1958, Terasmae & Craig reported on fossil *Ceratophyllum* from an area east of Great Slave Lake in Canada, viz. at 64°19′N 102°41′W. Because the northernmost record at that time in North America obviously was from 59°14′N 11°34′W, they drew some conclusions on a warmer climate in the Great Slave Lake area at the time of deposition, viz. 5000—6000 years B.P. They also stated that the topical area at that time had forests. It could well be that the actual area was warmer than it is today. However, Hultén in his Flora of Alaska and Neighboring Territories (1968 p. 451) marked a recent locality on the northern side of Great Slave Lake as well as at the Telon River, and the recent finding of *Ceratophyllum* in S. Crossley Lake at 68°33′N also shows that the climate of the Great Slave Lake area of today could not be blamed for the scanty records here. With the experience of six summers' field work on the lakes in northern Alaska and northwestern Canada, I would rather say that shortage of investigations is the reason. Hultén's distribution maps of the three topical species (1968 pp. 282, 451, 684) are also based on occasional records from lakes rather than a systematical survey, quite naturally, since such a survey would make a task of its own, not too easy to perform in a country without roads and without a boat on every lake. A few localities of the present survey are included in Hultén's maps and the rest were later passed on to him as well for use in other contexts. Once a more systematic search for aquatic plants in arctic areas is performed, I think the picture of their distribution will change, just as it has done for some invertebrate animals.

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Studies on Parmelia Subgenus Xanthoparmelia (Lichenes) in South Africa

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ABSTRACT

Hale, M. E., Jr. 1971. Studies on Parmelia subgenus Xanthoparmelia (Lichenes) in South Africa. — Bot. Notiser 124: 343—354.

The evolutionary trends in morphology and chemistry of *Parmelia* subgenus *Xanthoparmelia* are discussed. Africa has a higher proportion of biogenetically "primitive" acids (hypoprotocetraric, protocetraric acids) and greater morphological diversity than are present in the North American and Australian populations. Twelve new species from South Africa are described; *P. almbornii, P. atroventralis, P. diadeta, P. dichromatica, P. encrustans, P. frondosa, P. heterodoxa, P. hyporhytida, P. lecanorica, P. neocongensis, P. quintaria,* and *P. subdomokosii.*

INTRODUCTION

Parmelia subgenus *Xanthoparmelia* is especially well represented in Africa with about 50 species, at least 30 of them endemic to South Africa. This compares with 29 species for all of North America and 100 on the world level. While I have been able to examine all type specimens in *Xanthoparmelia* and study the very extensive collections made by Almborn, Höeg, and others, it is still too early to make a definitive treatment of the African species. Further collecting and ideally field studies must be made. This preliminary report presents some generalizations on the taxonomy and evolution of the subgenus and descriptions of 12 new species.

I wish to give special thanks to Dr. Ove Almborn, whose large collections have provided a sound base for the lichen flora of South Africa. Dr. S. Kurokawa helped with early crystal tests of many of the specimens cited but all of them have now been analysed with thin-layer chromatography [Brinkmann pre-coated plates using two solvent systems: benzene-dioxane-acetic acid (90:25:4) and hexane-ether-formic acid (9:4:1), sprayed with 10 % H_2SO_4 and heated for 10 minutes at 110°C].

Specimens of *Xanthoparmelia* contain yellow usnic acid in the cortex (excepting a few "albino" strains), are usually collected on rocks in drier areas, and have a simple but highly plastic morphology. Growth form in some of the species can be influenced rather significantly by environment, and since the group as a whole inhabits pioneer, desert, and even alpine habitats, environmentally induced morphological modifications can be troublesome indeed for the taxonomist. Given the problems of unstable morphology and dearth of such taxonomically useful characters as cilia and rhizine variation, one cannot blame lichenologists for exploring the possible application of chemistry to the systematics of *Xanthoparmelia*. Chemistry is a distinctive, easily identifiable character, particularly now that we have thin-layer chromatography. While slavish reliance on chemistry may lead to a rather uninspired kind of one-character taxonomy, one can achieve a more comprehensive understanding of the biology and evolution of lichens by using chemistry in combination with other traits than would ever be possible by using only external morphology without chemical tests.

There are three major areas, South Africa, Australia, and North America, with a high concentration of species which seem to have evolved more or less independently in chemistry and morphology. Both South America and Asia have fewer species and much less diversity for reasons not at once obvious. Lowland tropical areas are practically devoid of *Xanthoparmelia* species, while the Arctic has a unique assemblage of species, *P. centrifuga* (L.) ACH., *P. incurva* (PERS.) ACH., *P. separata* TH. FR., and *P. subcentrifuga* OXNER, all of which contain alectoronic acid and are geographically remote from the rest of the subgenus.

MORPHOLOGICAL EVOLUTION

The main lines of morphological evolution are in adnation and configuration of the lobes, ranging from subcrustose to umbilicate in adnation and from conspersoid (short, rotund lobes; cf. Fig. 1 D) to stenophylloid (long, narrow lobes; cf. Fig. 3 A) in lobation. For example, a large series of species in Africa are remarkable in having very close to nearly subcrustose adnation: *P. adhaerens* NYL., *P. conspersula* NYL., *P. encrustans* HALE (Fig. 2 A), *P. domokosii* GYEL., and *P. worcesteri* STEIN. & ZAHL. More distinctly foliose but still very closely appressed are *P. congensis* STEIN and *P. neocongensis* HALE (Fig. 2 D). Of these species only *P. congensis* occurs outside of Africa. At the other extreme we find *P. hottentotta* (ACH.) ACH. an umbilicate endemic that may even be regarded as a separate genus, and closely related *P. frondosa* HALE (Fig. 2 B). Neither the Australian or American populations have such extremes in development. Australia, however, does share with Africa the rapid evolution of narrow or stringy-lobed suberect species with a black lower surface and without or with very sparse rhizines. In Africa we have as examples of this *P. benovszyana* GYEL., *P. constrictans* NYL., *P. eradicata* (NYL.) GYEL., *P. hypoleia* NYL., *P. hypoprotocetrarica* KUROK., *P. tananarivensis* GYEL., and *P. suberadicata* DES ABB. In Australia there are *P. cheelii* GYEL., *P. dichotoma* MÜLL. ARG., and *P. furcata* MÜLL. ARG. No such types are known in North America, where instead there is a trend toward "vagans" type lobation with suberect unattached convoluted lobes and a pale lower surface, as in *P. chlorochroa* TUCK., *P. wyomingica* (GYEL.) HALE (basionym: *P. digitulata* var. *wyomingica* GYEL., Ann. Mycol. 36: 277, 1938), and *P. vagans* NYL. [and in the steppes of Russia the classical *P. camtschadalis* (ACH.) ACH.]. Convoluted growth forms in Africa (*P. amphixanthoides* STEIN. & ZAHL.) and in Australia (*P. australiensis* CROMB., *P. convoluta* KREMPLH., and *P. subdistorta* KUROK.) are by comparison much rarer.

Another unusual morphological development in the African population is strong maculation or white spotting in the cortex, seen most clearly in the *P. hottentotta* group (cf. Fig. 2 B) but in more normally foliose *P. hypoleia* NYL., *P. hypoprotocetrarica* KUROK., and *P. conturbata* var. *exornata* ZAHL. This trait is lacking in North America and occurs in only one Australian species, *P. notata* KUROK. (KUROKAWA et al. 1971). These maculae are correlated with disruptions in the algal layer, the color contrast between algae-filled areas and algae-free areas accounting for the white-spotted effect. The full significance of maculation is not yet clear, whether for example it has any physiological function, but it seems to be a consistent, taxonomically valuable character in *Parmelia*.

CHEMICAL EVOLUTION

The comparative biogenesis of lichen acids is a new but slowly developing field. Unfortunately the poor growth of lichen fungi in culture has hampered progress here, but much indirect evidence based on comparative biochemistry and taxonomic information, is already at hand (CULBERSON & CULBERSON 1970). C. CULBERSON (1969), for example, postulates that depsidones are not necessarily derived from depsides. This is corroborated in part by data which show that "primitive" lichen genera and families produce mostly beta-orcinol depsidones whereas more "advanced" groups in the same genus or family often produce more depsides and fewer depsidones (see HALE 1966). As a matter of fact, the preponderance of P+ depsidones in *Xanthoparmelia* and its simple morphology both mark the group as the least advanced subgenus in *Parmelia*.

The African population of *Xanthoparmelia* is unusual in two respects. For one, it has three species that are C+ red, *P. worcesteri* STEIN. & ZAHL., *P. lecanorica* HALE, both with lecanoric acid, and *P. heterodoxa* HALE with olivetoric acid, indicating evolution of a small group of species on a higher plane than P+ red species. Secondly, hypoprotocetraric acid, a P— depsidone closely related to and apparently biogenetically less advanced than protocetraric acid, is widespread. It occurs in six species: *P. domokosii* GYEL., *P. encrustans* HALE, *P. hypoprotocetrarica* KUROK., *P. neocongensis* HALE, *P. subdomokosii* HALE, and *P. weberi* HALE. Two protocetraric acid-containing counterparts are known: *P. hypoprotocetrarica*—*P. hypoleia*, and *P. subdomokosii*—*P. dichromatica*. Protocetraric acid also occurs in *P. schenckiana* MÜLL. ARG. and *P. austroafricana* STIRT.

American species are generally characterized by populations with the stictic acid complex (stictic, constictic, and norstictic acids) or salazinic acid. Protocetraric acid is unknown in North America and hypoprotocetraric acid is known only in the rather rare *P. weberi* HALE. Lecanoric acid occurs in the rare *P. lecanorica* HALE, which also occurs in South Africa. Of considerable significance, however, is the production of psoromic acid in at least two species, *P. kurokawae* HALE and *P. psoromifera* KUROK. If hypoprotocetraric acid is correctly assumed to be biogenetically "primitive," then psoromic acid must rank as biogenetically advanced among the P+ depsidones.

Australia stands alone as the center of distribution for species containing norlobaridone, a P—, KC+ red substance that probably ranks much higher biogenetically than any of the P+ depsidones. It occurs in the widespread *P. scabrosa* TAYL. (ranging northward to Japan and with sporadic occurrence even in South Africa) and in *P. australiensis* CROMB., *P. dichotoma* MÜLL. ARG., *P. filarszkyana* GYEL., *P. furcata* MÜLL. ARG., *P. metamorphosa* GYEL., *P. subdistorta* KUROK., and *P. thamnioides* KUROK., all Australian endemics (KUROKAWA 1969). An acid related to hypoprotocetraric acid, 4—0-methylhypoprotocetraric acid, has been discovered in one Australian species, *P. notata* KUROK. (KUROKAWA et al. 1971), but both hypoprotocetraric and protocetraric acid appear to be lacking on this continent.

The chemical evidence, interpreted broadly and tentatively, would place the South African population lowest on the evolutionary scale and therefore closest to the ancestral stock of *Xanthoparmelia*. Western North America would seem somewhat more divergent because of the presence of psoromic acid, while a very small gene pool for hypoprotocetraric and lecanoric acids has persisted. Australia has been isolated the longest time because of the high concentration of species with norlobaridone. In morphological diversity and speciation Africa ranks first by a wide margin, followed by Australia and North America.

NEW SPECIES

Parmelia almbornii HALE, sp. nov.

Thallus laxe adnatus, saxicola, 6—9 cm latus, marginem versus flavicans, centro obscurascens, lobis linearibus, elongatis, divaricatis, circa 1 mm latis, dichotome furcatis, tenue nigromarginatis, superne nitidus, emaculatus, isidiis sorediisque destitutus, cortex superior 12—14μ crassus, stratum gonidiale 20—25μ crassum, medulla alba, 150—180μ crassa, cortex inferior 10μ crassus, subtus castaneus, sparse rhizinosus, rhizinis 1—2 mm longis, attenuatis, castaneis. Apothecia ignota. Cortex K—, P—, medulla K—, P+ intense rubro-aurantiaca, acidum usnicum, acidum fumaroprotocetraricum continens.

HOLOTYPE: Near Upper Cableway Station, on rocks, 3000 ft., Table Mountain, Distr. Cape, Cape Province, South Africa, O. ALMBORN 1728, 4 August 1953 (LD; isotypes in TNS, US). — Fig. 1 A.

Parmelia almbornii is one of the more distinctive Table Mountain endemics although it was only first collected by ALMBORN in 1953. The chemistry is rather unusual since other similarly narrow-lobed species, such as *P. eradicata* (NYL.) GYEL., usually contain salazinic acid or related depsidones. These species, too, differ in having a black lower surface nearly devoid of rhizines and do not form the firm flattened pulvinate mats so characteristic of *P. almbornii*.

SPECIMENS EXAMINED: Distr. Cape, near Upper Cableway Station, ALMBORN 1729; Table Mountain, KOFLER (LD), DEGELIUS SA-296, SA-319 (DEG).

Parmelia atroventralis HALE, sp. nov.

Thallus adnatus, terricola vel humicola, subpulvinatus, 2—4 cm latus, viridi-flavicans, lobis angustis, linearibus, 1—2 mm latis, congestis, imbricatis, valde nigromarginatis, superne planus, nitidus, emaculatus, sorediis isidiisque destitutus, cortex superior 8—12μ crassus, stratum gonidiale 20—40μ crassum, continuum, medulla alba, 75—120μ crassa, cortex inferior 12μ crassus, subtus niger, sparsissime rhizinosus, rhizinis crassis, simplicibus. Apothecia ignota. Cortex K—, medulla K—, P—, C—, KC—, acidum aliphaticum ignotum (acidum protolichestericum?) et acidum usnicum continens.

HOLOTYPE: Black Mt., 10,000 ft., Distr. Qachas Nek, Basutoland, L. KOFLER, 6 Feb. 1963 (LD; isotype in US). — Fig. 1 B.

The strong black margins of the lobes suggest an exposed alpine habitat for this species. It is unlike any other African species in lobe configuration. In chemistry it is similar to *P. subdecipiens* VAIN., a lowland species with a pale lower surface. The type specimen represents the only collection so far.

Parmelia diadeta HALE, sp. nov.

Thallus arcte adnatus, saxicola, usque ad 5 cm latus, obscure flavicans, lobis linearibus, confluentibus, 1.0—1.5 mm latis, superne nitidus, aetate rimosus, emaculatus, isidiatus, isidiis cylindricis, simplicibus, cortex superior 6—8μ crassus, stratum gonidiale 10—15μ crassum, medulla alba, 60—80μ crassa, cortex inferior 6—8μ crassus, subtus niger, modice rhizinosus, rhizinis nigris, simplicibus. Apothecia rara (holotypus sterilis), adnata, circa 1 mm diametro, sporis 4—5 × 7—9μ. Cortex K—, P—, medulla K+ rubescens, P+ intense aurantiaca, acidum salazinicum et acidum usnicum continens.

HOLOTYPE: On boulders near road, 2 miles NE of Potsdam, Distr. East London, Cape Province, South Africa, O. ALMBORN 10683, 24 Nov. 1953 (LD; isotype in US).

Superficially *P. diadeta* (Fig. 1 C) seems to be close to *P. congensis* STEIN but the lobes are larger and not so tightly adnate. Chemically these species are distinct, *P. congensis* producing stictic acid along with constictic and norstictic acids. On the other hand, *P. diadeta* is much smaller

Fig. 1. Photographs of typical specimens. — A: *Parmelia almbornii* HALE (holotype). — B: *P. atroventralis* HALE (holotype). — C: *P. diadeta* HALE (ALMBORN 8644). — D: *P. dichromatica* HALE (holotype). — Enlargement about 1.5 ×.

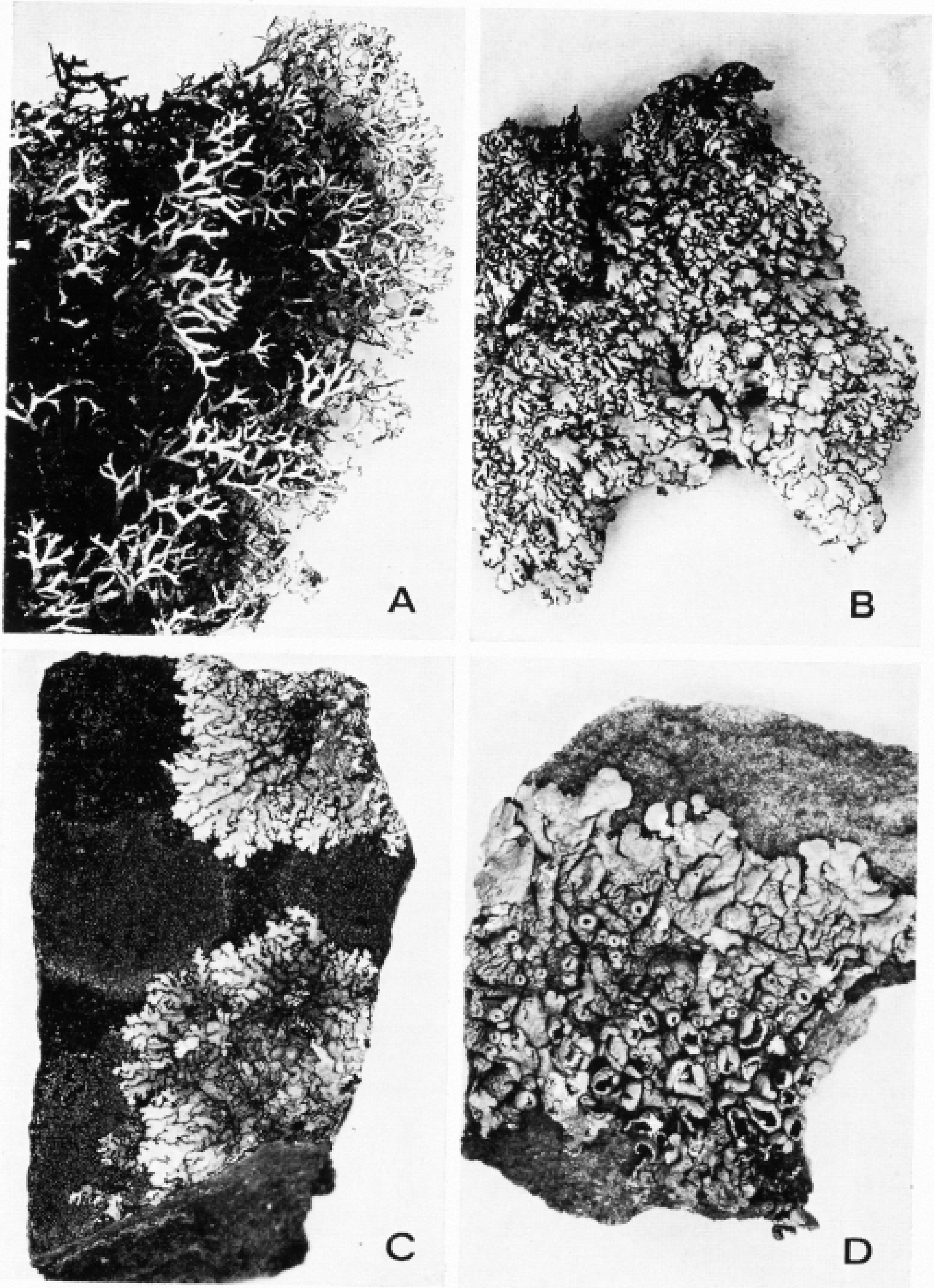

Fig. 1.

than *P. tinctina* Mah. & Gill., a widespread species with similar chemistry but with thicker almost subglobose isidia. *P. diadeta* is rather common in Africa from Uganda to the Cape growing in fairly sheltered habitats. There is no obvious nonisidiate counterpart.

SPECIMENS EXAMINED: Uganda, Distr. Karamoja, southern slopes of Mt. Moroto, Swinscow 2U35/5 (US). South Africa: Transvaal, Distr. Heidelberg, Vereeniging, Höeg, 4 Jan. 1930 (TRH). — Natal, Distr. Lions River, Boschfontein Forest, Almborn 8644 (LD); Distr. Impendhle, Upper Umkomaas, Höeg, 6 Oct. 1929 (TRH); Distr. Pietermaritzburg, Natal Table Mountain, Almborn 8563 (LD); Distr. Mtunzini, Thlobenyana Hill, Höeg, 11 Sept. 1929 (TRH). — Cape Province: Distr. Oudtshoorn, 5 miles N of Cango Caves, Almborn 4301 (LD).

Parmelia dichromatica Hale, sp. nov.

Thallus adnatus, saxicola, 4—8 cm latus, flavescenti-viridis, lobis subirregularibus, contiguis, 2—5 mm latis, aetate rugosis vel late plicatis, superne opacus, emaculatus, isidiis sorediisque destitutus, pycnidiis numerosis, cortex superior 12—15μ crassus, stratum gonidiale 30—40μ crassum, medulla alba et praecipue circa pycnidia intense purpurea, 120—150μ crassa, cortex inferior 12—15μ crassus, subtus pallide castaneus, modice rhizinosus, rhizinis simplicibus, pallidis. Apothecia numerosa, adnata, 3—5 mm diametro, sporis octonis, 5×7—8μ, microconidiis 1×5—7μ. Cortex K—, P—, medulla alba K—, P+ aurantiaca, medulla pigmentacea K+ purpurascens, acidum protocetraricum, acidum usnicum et materiam pigmentaceam ignotam continens.

HOLOTYPE: Mt. Thabanchu, 5500—7000 ft., Orange Free State, South Africa, O. A. Höeg, 12 August 1929 (TRH; isotype in LD). — Fig. 1 D.

The most conspicuous feature of this conspersoid lichen is the development of spots of a deep wine red anthraquinone in the medulla, mostly near pycnidia. At least two pigments are involved but neither has been identified yet. No other *Parmelia* has this trait, although similar pigments are found throughout the medulla in *P. endomiltoides* Nyl. and *P. violacea* Kurok. This thick rugose thallus with a pale brown lower surface brings to mind *P. subdomokosii* Hale, which is P— (hypoprotocetraric acid) and has no pigment. These two species are obviously closely related, but *P. dichromatica* is quite rare in the Cape region where *P. subdomokosii* is common. Both are common in Basutoland.

SPECIMENS EXAMINED: South Africa: Basutoland, Masite Mtn., Hewitt, 1929—30; summit of Masite Mtn., Hewitt, 1929—30 (TRH); Distr. Leribe, Oxbow Valley, Kofler 3-11-2922a. (LD); Distr. Maseru, Blue Mountain Pass, Maluti Range, 2900 m, Kofler, 2 June 1963 (LD, US); Distr. Qachas Nek, 6 miles from Ramat-seliso, Kofler, 13 Nov. 1963 (LD); Mokhotlong, Kofler, 7 Feb. 1963 (LD); — Orange Free State, Fauresmith, Henrici, 1939 (PRE). — Cape Province, Distr. Middleburg, Rosmead, Höeg, 3 Dec. 1929 (TRH).

Parmelia encrustans Hale, sp. nov.

Thallus arcte adpressus, centrum versus fere subcrustosus, saxicola, 3—6 cm latus, viridi-flavescens, lobis subirregularibus, brevibus, circa 1 mm latis, planis vel mox convexis, congestis, superne nitidus, emaculatus, isidiis sorediisque destitutus, cortex superior fragilis, 10—12μ crassus, stratum gonidiale 40×90μ altum, medulla circa 80μ crassa, cortex inferior 10—12μ, subtus pallide castaneus, modice rhizinosus, rhizinis simplicibus. Apothecia numerosa, adnata, sporis octonis, 6×8μ; pycnidia numerosa, microconidiis 1×5μ. Cortex K—, P—, medulla alba K—, C+, KC+ pallide aurantio-flavescens, acidum hypoprotocetraricum et materiam ignotam continens.

HOLOTYPE: On rocks, between O'okiep and Springbok, Distr. Namaqualand, Cape Province, South Africa, O. Almborn 4792, 15 Sept. 1953 (LD; isotype in US). — Fig. 2 A.

Parmelia encrustans is very closely related to *P. domokosii* Gyel. in chemistry and external morphology but differs in having a consistently pale lower surface. The two species have never been collected together in the same locality, though both are rather common in Cape Province.

SPECIMENS EXAMINED: Cape Province: Distr. Clanwilliam, Pakhuis Pass, ALMBORN 4530 (LD, US); Distr. Montagu, Langeberg Mountains, MAAS GEESTERANUS 6726 (L); Distr. Namaqualand, between O'okiep and Springbok, ALMBORN 4787 (LD); Distr. Laingsburg, 18 km S of Laingsburg, ALMBORN 5773 (LD, US); Distr. Cape, near Kloof Nek, Table Mountain, DEGELIUS SA-122 (DEG).

Parmelia frondosa HALE, sp. nov.

Thallus suberectus, saxicola, 5—8 cm latus, rigidus, coriaceus, flavescenti-viridis, lobis subirregularibus, elongatis, 3—5 mm latis, superne nitidus, valde albomaculatus, apicem versus pycnidiis numerosis, isidiis sorediisque destitutus, cortex superior 11—14μ crassus, stratum gonidiale 25—75μ crassum, interruptum, medulla alba, circa 250μ crassa, cortex inferior 10—11μ crassus, subtus castaneus, apicem versus modice rhizinosus, rhizinis crassis, simplicibus vel sparse dichotome divisis, basin versus nudus, cartilagineus. Apothecia numerosa, adnata, 3—5 mm diametro, sporis 3—4×7—8μ; pycnidia numerosa, microconidiis 1×6—7μ. Cortex K—, P—, medulla alba K+ flavescens, P+ aurantiaca, acidum sticticum et acidum usnicum continens.

HOLOTYPE: On rocks at edge of stream, Upper Witels Kloof, Distr. Ceres, Cape Province, South Africa, ESTERHUYSEN 21848, 8 October 1953 (BOL; isotypes in LD, US). — Fig. 2 B.

This remarkable lichen is related to *P. hottentotta* (ACH.) ACH., the well known Cape endemic. *P. hottentotta,* itself a rather variable species, differs in these respects: rhizines very dense, black, and usually simple, projecting out almost as cilia in a black fringe around lobe margins; apothecia ciliate; and chemical constituent norstictic acid. Both species have tough leathery thalli and conspicuous white maculae in the cortex. The MACOWAN specimen seen is tentatively identified as *P. frondosa;* the chemistry agrees but rhizines are almost completely lacking.

SPECIMEN EXAMINED: Cape Province, Distr. Cape, MACOWAN, Herb. Musei Austro-Africani 46972 (SAM).

Parmelia heterodoxa HALE, sp. nov.

Thallus arcte adnatus, saxicola, orbicularis, 1.0—1.5 cm diametro, viridi-flavicans, lobis linearibus, angustis, circa 0.5 mm latis, contiguis, superne planus, emaculatus, isidiis sorediisque destitutus, cortex superior 10—12μ crassus, stratum gonidiale 10—15μ crassum, medulla alba, 40—50μ alta, cortex inferior 10—12μ crassus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota. Cortex K—, P—, medulla K—, P—, C+, KC+ rubescens, acidum olivetoricum (?) et acidum usnicum continens.

HOLOTYPE: On rocks, Natal Table Mountain, Distr. Pietermaritzburg, South Africa, O. ALMBORN 8595, 30 October 1953 (LD; isotype in US). — Fig. 2 C.

This species, known only from the type collection, is unusual in chemistry and the small size. Only one other C+ acid is known in *Xanthoparmelia,* lecanoric acid. Olivetoric acid, tentatively identified on TLC plates, is probably biogenetically unrelated to lecanoric acid, and for this reason *P. heterodoxa* may represent a separate line in the chemical evolution of the subgenus, perhaps comparable to norlobaridone or alectoronic acid. Although the thallus is very small, the lobes are discrete and can be freed from the sandstone substrate with a needle. Other species with lobes less than 1 mm wide, such as *P. congensis* STEIN and *P. conspersula* NYL., are very tightly appressed and cannot be removed intact from the substrate.

Parmelia hyporhytida HALE, sp. nov.

Thallus adnatus vel subadscendens, saxicola, 5—8 cm latus, viridi-flavescens, lobis linearibus, divaricatis, 2—4 mm la-

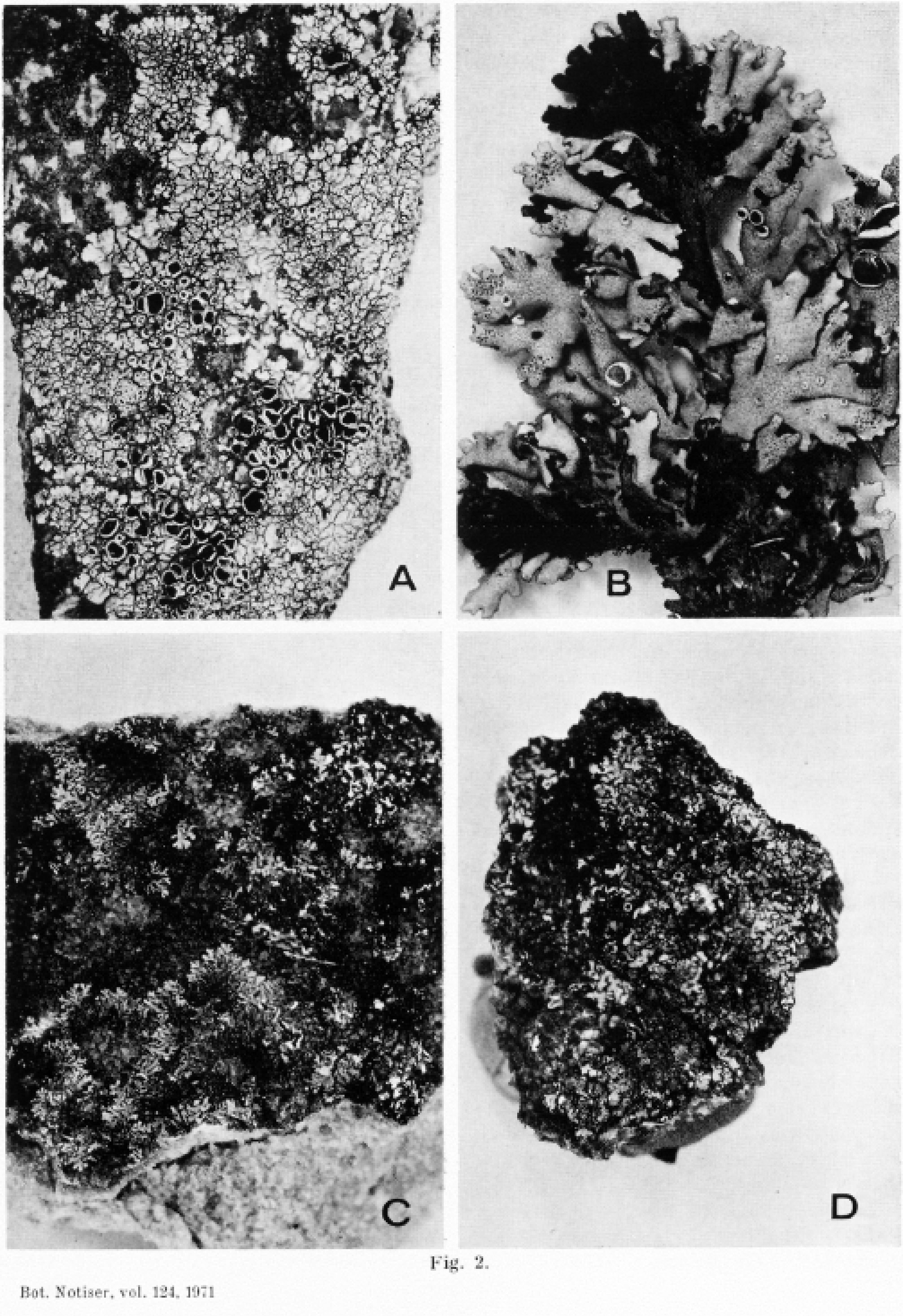

Fig. 2.

tis, isidiis sorediisque destitutus, superne planus, opacus, emaculatus, cortex superior 25μ crassus, stratum gonidiale 20—30μ crassum, medulla alba, 130—150μ alta, cortex inferior 20—28μ crassus, subtus niger vel centrum versus castaneus, valde rugosus, rhizinis nullis vel sparse evolutis, simplicibus. Apothecia cupuliformia, usque ad 8 mm diametro, sporis 4—5×6—8μ. Cortex K—, P—, medulla K+ rubescens, P+ intense aurantiaca, acidum salazinicum et acidum usnicum et rarius "chalybeizans unknown" continens.

HOLOTYPE: On rocks N of Clanwilliam, Distr. Clanwilliam, Cape Province, South Africa, L. Kofler, 15 Sept. 1963 (LD; isotype in US). — Fig. 3 A.

This remarkable species is characterized by the suberect habit and a black nearly bare rugose lower surface. A habitat photograph with Mattick no. 7 shows the species with ascending lobe tips covering large boulders in open semidesert areas. Its growth form is somewhat similar to *P. hypoleia* Nyl., another desert lichen which differs in having protocetraric acid, a smooth lower surface, and heavy maculation in the upper cortex. The chemistry of *P. hyporhytida* is not constant. Salacinic acid is the diagnostic component but the "chalybeizans" unknown may or not be present. This unknown occurs in *P. chalybeizans* (Stein. & Zahlbr.) Gyel., an unrelated species; it forms a streak above and covering salacinic on TLC plates. It is whitish fluorescent on the plates under UV light.

SPECIMENS EXAMINED: Cape Province: Distr. van Rhynsdorp, Kofler, 1963 (c. fr.) (LD); Distr. Namaqualand, Bitterfontein area, Kofler, 15 Sept. 1963 (LD); Komaschochland-Pad, 10 Meilen landeinwärts, Mattick 7 (M, US).

Parmelia lecanorica Hale, sp. nov.

Thallus adnatus, saxicola, 3—5 cm latus, viridi-flavicans, lobis subirregularibus, congestis, superne planus vel rugosus, emaculatus, isidiis sorediisque destitutus, cortex superior 24—26μ crassus, stratum gonidiale 25—45μ crassum, medulla circa 120μ crassa, cortex inferior 10—12μ crassus, subtus niger, modice rhizinosus, rhizinis simplicibus, nigris. Apothecia adnata, 2—3 mm diametro, sporis octonis, 5×9—10μ, microconidiis 1×5—6μ. Cortex K—, P—, medulla K—, P—, C+, KC+ rubescens, acidum lecanoricum et acidum usnicum continens.

HOLOTYPE: Northeast of Clanwilliam, Pakhuis Pass, Cape Province, South Africa, O. Almborn 4531, 12 Sept. 1953 (LD; isotype in US). — Fig. 3 B.

Parmelia lecanorica is distinguished by the presence of lecanoric acid, a very rare substance in subgenus *Xanthoparmelia* known previously only in *P. worcesteri* Stein. & Zahlbr., a subcrustose species. The conspersoid habit of *P. lecanorica* reminds one of *P. hypopsila* Müll. Arg., a rare species in Africa containing stictic and norstictic acids. The remarkable occurrence of the species in western United States is not entirely unexpected. Two other African species occur in North America: *P. subdecipiens* Vain. (P—, protolichesterinic acid) and *P. weberi* Hale (hypoprotocetraric acid).

SPECIMENS EXAMINED: South Africa: Cape Province: Distr. Clanwilliam, 9 miles S of Clanwilliam, Almborn 4945 (LD). United States: Texas: 15 miles SE of Casa Piedra, Wire Gap, Presidio Co., Hubricht B912 (F).

Parmelia neocongensis Hale, sp. nov.

Thallus arcte adnatus, saxicola, 1—2 cm latus, viridi-flavescens, lobis sublinearibus, contiguis, 0.5—1.0 mm latis, nigromarginatis, superne planus, aetate transversim fissus, opacus, isidiatus, isidiis densis, cylindricis, simplicibus, 0.6 mm diametro, 0.5—1.5 mm altis, cortex superior 10—12μ crassus, stratum gonidiale 15—20μ crassum, medulla alba, 90—120μ

Fig. 2. Photographs of holotype specimens. — A: *Parmelia encrustans* Hale. — B: *P. frondosa* Hale. — C: *P. heterodoxa* Hale. — D: *P. neocongensis* Hale. — Enlargement about 1.5 ×.

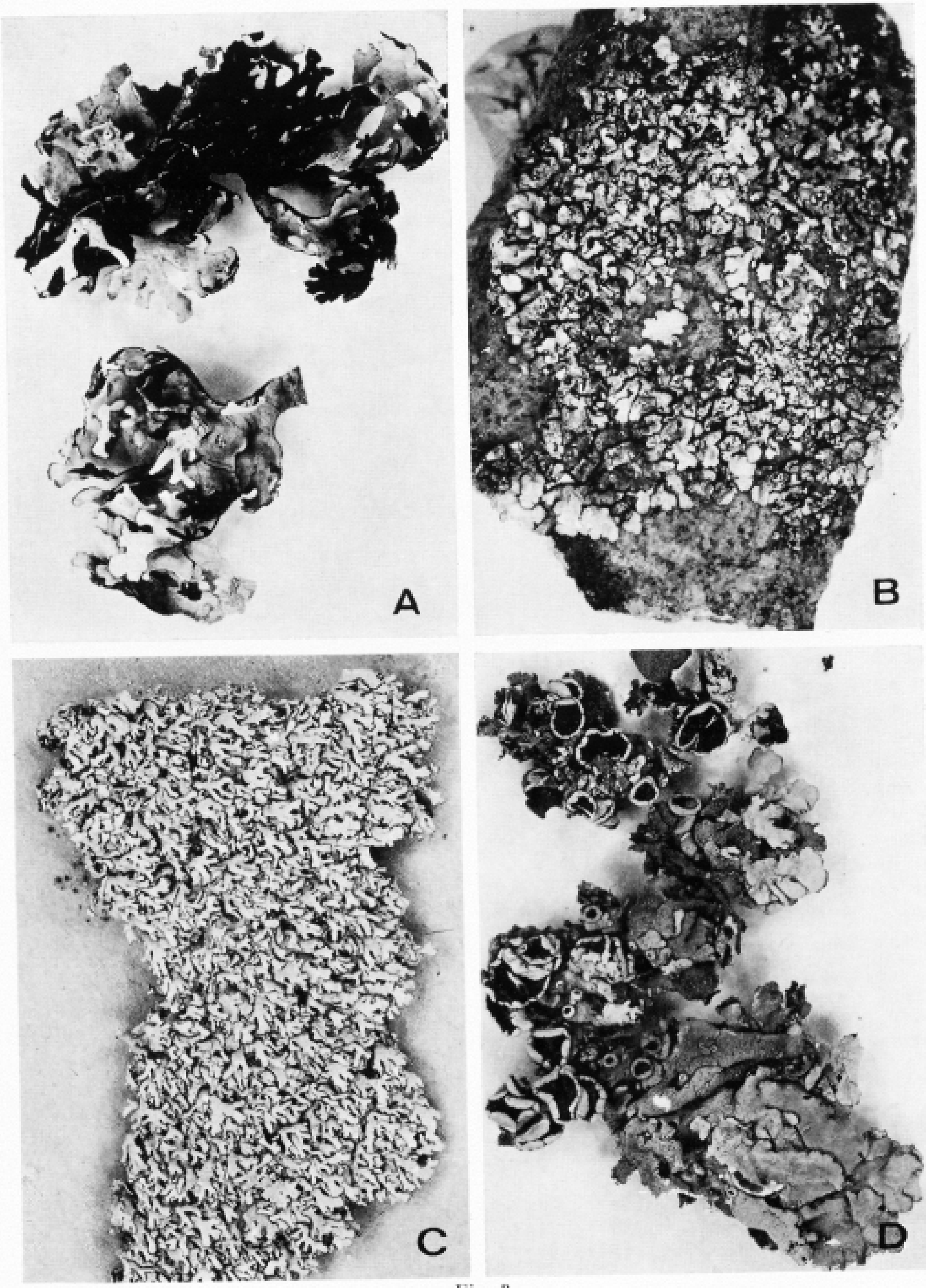

Fig. 3.

crassa, cortex inferior 10—12μ crassus, subtus niger, modice rhizinosus, rhizinis simplicibus. Apothecia usque ad 1 mm diametro, sporis octonis, 3—4×7—8μ. Cortex K—, P—, medulla K—, C+, KC+ pallide aurantio-flavescens, acidum hypoprotocetraricum et materiam ignotam continens.

HOLOTYPE: On granite, Zimbabwe, Rhodesia, O. A. HÖEG, 2 Feb. 1930 (LD; isotypes in US, TRH). — Fig. 2 D.

This species appears to be morphologically identical with *P. congensis* STEIN., which contains the stictic acid complex. The isidia in *P. neocongensis,* however, are generally better developed than in *P. congensis.* Additional collections may bring other differences to light. TLC plates show hypoprotocetraric acid and associated unknowns. This species is known only from the type collection in Rhodesia.

Parmelia quintaria HALE, sp. nov.

Thallus adnatus, saxicola, 3—8 cm latus, viridi-flavescens, lobis sublinearibus, 1—2 mm latis, subdivaricatis vel congestis, superne planus, emaculatus, isidiis sorediisque destitutus, cortex superior 10—14μ crassus, stratum gonidiale circa 30μ crassum, medulla alba, 90—110μ alta, cortex inferior 10—12μ crassus, subtus castaneus, pro parte nigricans, sparse rhizinosus, rhizinis simplicibus. Apothecia (holotypus sterilis) adnata, 1—2 mm diametro, sporis octonis, 4—5×7—9μ. Cortex K—, P—, medulla alba K+ rubescens, P+ pallide aurantia, acidum usnicum et materiam ignotam continens.

HOLOTYPE: On marine rocks, Hottentots Huise, Distr. Cape, Cape Province, South Africa, O. ALMBORN 950, 23 July 1953 (LD; isotypes in TNS, US). — Fig. 3 C.

Parmelia quintaria is morphologically rather variable. The holotype has congested, linear, almost divaricate lobes, while some of the other specimens have shorter lobes and a more conspersoid habit. It would appear to be related to *P. hypopsila* MÜLL. ARG., but the lower surface is bare and shiny toward the tips, becoming sparsely to moderately rhizinate toward the center. The most unusual character for the species is the chemistry as seen on TLC plates, five spots, one usnic acid, the other four brilliant orange or purplish with H_2SO_4. Mr T. ESSLINGER (in litt.) has found the same unknowns in a specimen of *Melanoparmelia* from western North America. None of them have yet been identified. *Parmelia quintaria* was collected at least twice on seashore rocks, a habitat it seems best developed in.

SPECIMENS EXAMINED: Cape Prov.: Distr. Cape, Hottentots Huise, ALMBORN 963b (LD); near Caltex Garage, Camps Bay, ALMBORN 4398 (c. fr.) (LD); near Kloof Nek, Camps Bay Road, ALMBORN 830 (LD); Banty Bay, DEGELIUS SA-37 (DEG).

Parmelia subdomokosii HALE, sp. nov.

Thallus adnatus, saxicola, 5—7 cm latus, flavescenti-virescens, lobis subirregularibus, contiguis, 2—5 mm latis, superne planus, nitidus, aetate valde rugosus, isidiis sorediisque destitutus, cortex superior 15—18μ, stratum gonidiale 30—35μ, medulla alba, 150—200μ, cortex inferior 12μ crassus, subtus pallide castaneus, modice rhizinosus, rhizinis simplicibus, pallidis. Apothecia numerosa, usque ad 8 mm diametro, sporis octonis, 4—5× 6—8μ. Cortex K—, P—, medulla alba, K—, P—, C+, KC+ pallide aurantia, acidum hypoprotocetraricum, acidum usnicum et materiam ignotam continens.

HOLOTYPE: Small hill exposed to the sun, 7 miles W of Heidelberg, Distr. Swellendam, Cape Province, South Africa, O. A. HÖEG, 12 June 1929 (TRH; isotypes in LD, US). — Fig. 3 D.

Fig. 3. Photographs of holotype specimens. — A: *Parmelia hyporhytida* HALE. — B: *P. lecanorica* HALE. — C: *P. quintaria* HALE. — D: *P. subdomokosii* HALE. — Enlargement about 1.5 ×.

The distinguishing features of this common lichen are the adnate conspersoid habit and pale lower surface. The chemical constituent, hypoprotocetraric acid and associated unknowns, is unusual and accounts for the P— reaction. A very similar species, *P. dichromatica* HALE, produces the biogenetically more advanced protocetraric acid (P+ red) in addition to an anthraquinone pigment. *P. encrustans* HALE, with identical P— chemistry, is appressed and has narrow lobes but is otherwise closely related. *P. subdomokosii* is apparently widespread in Cape Province.

SPECIMENS EXAMINED: South Africa: Orange Free State, Distr. Thabanchiu, Mt. Thabanchiu, HÖEG, 12 Aug. 1929 (TRH); 5 miles W of Ladybrand, 2000 m, MAAS GEESTERANUS 6524 (L). — Natal, Botha's Hill, HÖEG, 15 Aug. 1929 (TRH). — Basutoland, Distr. Maseru, near Blue Mountain Pass, KOFLER, 2 June 1963 (LD); Distr. Qachas Nek, Black Mountain, KOFLER, 9 Feb. 1963 (LD). — Cape Province, Distr. Clanwilliam, N of Clanwilliam, KOFLER, 15 Sept. 1962 (LD); Distr. van Rhynsdorp, Koekenaap, KOFLER, 16 Sept. 1963 (LD); Distr. Calitzdorp, Calitzdorp—Kruisrivier, MAAS GEESTERANUS 6703 (L); Div. Namaqualand, KOFLER, 18 Sept. 1963 (LD); Distr. Cape, Camps Bay, near Caltex Garage, ALMBORN 4396 (LD); Distr. Uitenhage, HÖEG, 6 July 1929 (TRH); Distr. Oudtshoorn, Cango Caves, ARNELL 1449, 1451 (LD).

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Lithospermum Goulandriorum Rech. f., eine neue, bemerkenswerte Art der griechischen Flora

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ABSTRACT

Rechinger, K. H. 1971. Lithospermum Goulandriorum Rech. f., eine neue, bemerkenswerte Art der griechischen Flora. — Bot. Notiser 124: 355—358.

Lithospermum Goulandriorum Rech. f., a distinct new species, is described from Mt. Tymphi in Epirus, N. Greece. The subdivision of *Lithospermum* and related genera is discussed.

Lithospermum Goulandriorum Rech. f., sp. nov.

Perenne, saxicolum. Rhizoma pluriceps, verisimiliter verticale, caules et foliorum rosulas plures emittens; collum parce atrisquamosum et cataphyllis nonnullis lanceolatis, acutis, herbaceis, 10—15 mm longis comosum. Folia rosularia petiolo 2—4 cm longo suffulta; lamina lanceolata, usque ad 15 cm longa, 1.2—2 cm lata, utrinque longe aequaliter attenuata, apice acuta, in sicco membranacea, atriviridis, plana; costa mediana subtus paulum prominens, brunnescens; nervi laterales tenuissimi, angulo acuto a costa mediana abeuntes, saepe vix visibiles; indumentum utrinque subaequale, e pilis albidis antrorsis brevibus strigulosis, nodulo nudo insidentibus consistens. Caulis folia basalia non usque ad summum duplo superans, arcuato-ascendens, foliatus, infra inflorescentiam non ramosus; indumentum e pilis simplicibus quam in foliis longioribus mollioribus, in parte inferiore caulis patulis, in superiore ± antrorsis nodulis non insidentibus consistens. Folia caulina quam basalia multoties minora, inferiora lanceolata, basi attenuata sessilia, media increscentia, ovato-lanceolata basi subsemiamplexicaulie, summa decrescentia in bracteas anguste lanceolatas calyces aequantes transeuntia. Inflorescentia cincinnata, conferta, post florendum non elongata. Flores breviter pedicellati. Calyx florifer 5—7 mm longus, fructifer paulo accrescens, in lacinias anguste lineari-subulatas sursum sensim longe attenuatas divisus; indumentum calycis antrorse strigulosum, in marginibus laciniarum quam in facie densius. Corolla rotata infundibularis 15 mm longa, 8—9 mm diametro, in vivo amoene cyanea (e collectore), in sicco haud mutata, extus sparse appresse pilosa, tubo in limbum sensim ampliato, lobis ± 5 mm longis, late rotundatis; corolla infra faucem secus nervum medianum cuiusque lobi leviter subplicato-impressa, impressionibus omnibus aequalibus; impressio c. 5×2 mm, intus leviter prominens, pallescens, secus nervum medianum minutissime papillosa, basi distinctius rotundato-marginata. Antherae omnes aequa altitudine c. 1.5 mm supra basin tubi insertae, filamentis brevissimis vix visibilibus, vix ultra 1 mm longae, 0.5 mm latae, thecis apice minute apiculatis. Germen quadrisulcatum; stylus distinctus, supra stigma quadrilobum in apiculum brevem productus. Fructus submaturus cum stylo

Fig. 1. *Lithospermum Goulandriorum* Rech. f. — Holotypus.

4×2.3 mm, compresso-ovoideus, laevissimus, laccatus, albido-nitidissimus, erectus, in stylum brevem leviter curvatum subabrupte attenuatus, latere interno carinatus.

Graecia, Epirus: Montes Tymphi, in praeruptis calc. ad austro-orientem lacus Drakolimin, 1900—2000 m, 12.VIII. 1969, E. Stamatiadou 7244 (holotypus W, isotypus herb. Goulandris).

Nach den Merkmalen der Korolle und der Frucht läßt sich die neue Art der Sektion *Margarospermum* Reichb. der Gattung *Lithospermum* im weiteren Sinne

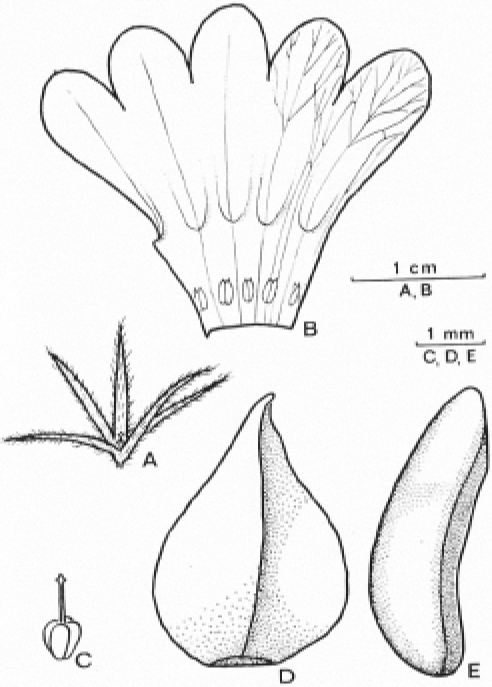

Fig. 2. *Lithospermum Goulandriorum* RECH. F. — A: Kelch. — B: Korolle ausgebreitet. — C: Gynoecium. — D: Klause von innen. — E: Klause von der Seite.

einordnen. Nach der engeren, von JOHNSTON (1954) inaugurierten Fassung der Gattung *Lithospermum* würde diese Sektion zur Gattung *Buglossoides* MOENCH gehören. Die Sektion *Margarospermum* umfaßt bisher nur vier sehr deutlich voneinander verschiedene Arten, nämlich *Lithospermum purpureo-coeruleum* L. (westliches & südliches Europa ostwärts bis Nordpersien), *L. Zollingeri* A. DC. (China, Japan, Korea), *L. calabrum* TENORE (Süditalien) und *L. Gastoni* BENTH. ex DC. (französische Westpyrenäen). Bei allen deutlich ausgeprägten Verschiedenheiten im Einzelnen stimmen diese vier Arten vegetativ in wesentlichen Zügen miteinander überein. Sie treiben nämlich aus einer kürzeren oder längeren horizontalen Grundachse ausschließlich steif aufrechte, ± dicht mit nach oben hin an Größe zunehmenden Blättern besetzte Blütensprosse, jedoch keine Blattrosetten. Im Gegensatz dazu ist *Lithospermum Goulandriorum* durch eine offenbar vertikale Grundachse gekennzeichnet, die groß- und reichblättrige Blattrosetten und bogig aufsteigende, mit viel kleineren Blättern besetzte Blütensprosse entsendet. Die neue Art entspricht in dieser Hinsicht genau gewissen, in Südosteuropa endemischen Arten der Gattung *Alkanna,* wie ich sie ausführlich beschrieben habe (RECHINGER 1965) und steht somit vegetativ in scharfem Gegensatz zu allen übrigen Arten von *Lithospermum*. Auch ökologisch steht die neue Art als Chasmophyt in der Gattung *Lithospermum* offenbar isoliert. Die große, leuchtend blaue, aus einer weiten Röhre allmählich in den breit trichterigen Saum übergehende Korolle mit ihren flach nach innen vorgewölbten, am unteren Rande etwas schärfer bogig begrenzten Einstülpungen, die blasser gefärbt und längs des Mittelnerves der Koroll-Lappen fein papillös sind, lassen sich immerhin als eine Abwandlung des für *Lithospermum* bezw. *Buglossoides* Sect. *Margarospermum* charakteristischen Korollbaues deuten. Die Ausbildung eines winzigen, sterilen Spitzchens über der Narbe und die kurz bespitzten Antherenfächer sowie die glatte, glänzende Oberflächenbeschaffenheit der Frucht des *Lithospermum Goulandriorum* fügen sich gut in den Rahmen der Sektion *Margarospermum*. Bei *L. purpureo-coeruleum, L. Zollingeri* und *L. calabrum* ist das Nüßchen glatt und oben abgerundet. Nur bei *L. Gastoni* ist es rugos und geschnäbelt. Somit ist *L. Goulandriorum* mit seinen glatten und geschnäbelten Nüßchen, ebenso wie mit den feineren Details der Korolle und seiner vegetativen Eigentümlichkeiten einzigartig.

Die Entdeckung dieser prächtigen neuen Art, die einen der bemerkenswerten Endemiten der nordgriechischen Flora darstellt, ist Frau ELLI STAMATIADOU zu verdanken, die in drei Jahren bereits mehr als 10.000 Nummern Herbarpflanzen für das Botanische Museum Goulandris gesammelt hat, und der die Entdeckung mehrerer neuer Arten zu verdanken ist. Die neue Art ist den Mäzenen der griechischen Botanik, Herrn ANGELOS und Frau NIKI GOULANDRIS gewidmet. Diskussionen mit Herrn Univ. Doz. Dr. H. RIEDL verdanke ich Anregungen, Frau Dr. HELENE SCHIMAN-CZEIKA die Blütenanalyse und Zeichnung.

LITERATURVERZEICHNIS

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New Species of Bupleurum from Turkey

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ABSTRACT

Snogerup, S. 1971. New species of Bupleurum from Turkey. — Bot. Notiser 124: 359—375.

Eight new annual *Bupleurum* species are described from Turkey, viz. *B. pendikum* Snog., *B. davisii* Snog., *B. turcicum* Snog., *B. orientale* Snog., *B. eginense* (Wolff) Snog., *B. lycaonicum* Snog., *B. zoharii* Snog., and *B. polyactis* Post ex Snog. The affinities of the new species are briefly commented on.

INTRODUCTION

During the preparation of an account of the annual *Bupleurum* species for Davis' Flora of Turkey, it proved necessary to accept 8 new species. As it is not possible to publish new taxa in the Flora, they are briefly presented here. Comments on allied species are kept rather short, because a full revision is planned for the near future. In the citation of localities the grid system and vilayet names are used according to the system introduced by Davis (1965).

The sectional nomenclature is as yet insufficiently investigated and some future changes in the subdivision of the genus seem necessary. For these reasons I prefer not to give any sectional names with the new species but only point out their probable closest relatives.

I avoid using the term *bracteol* commonly accepted in British floras for the involucellar leaves, because they are not bracteols in the correct morphological sense of that term. Instead, I take up the term *bractlet* often found in American literature.

THE ENDEMISM IN BUPLEURUM

All the species described below have rather limited distribution areas. *B. pendikum* and *B. davisii* are known only from one locality each. Up to the present a number of ± local endemics are known among annual *Bupleurum* species, e. g. *B. Wittmanii* Steven, *B. schistosum* Woron., *B. capillare* Boiss., *B. erubescens* Boiss., *B. pulchellum* Boiss. & Heldr., *B. aira* Snog., *B. Sintenisii* Asch. & Urb., *B. dichotomum* Boiss., *B. anatolicum* Hub.-Mor. & Reese, *B. Wolffianum* Bornm., and *B. Postii* Wolff. All these local endemics occur in common place habitats like phrygana, dry grassland and rocky slopes. The distribution of these biotopes is wide and comparatively continuous in the area in question, Greece, Cyprus, Anatolia, Transcaucasia and W. Iran. The local distribution may be caused by the restricted dispersal of the seeds, which are comparatively heavy and in most species lack specialized means of dispersal. The most widespread annuals of the genus, e. g. *B. rotundifolium* L. and *B. odontites* L. (syn. *B. Fontanesii* Guss.), belong to an element of old segetal weeds and have probably reached large parts of their distribution areas with early cultivation.

All the annuals of *Bupleurum* show rather constant and distinct, though often small, differences, and intergradations are very rare. No hybrids, either natural or experimental, are known. Thus sterili-

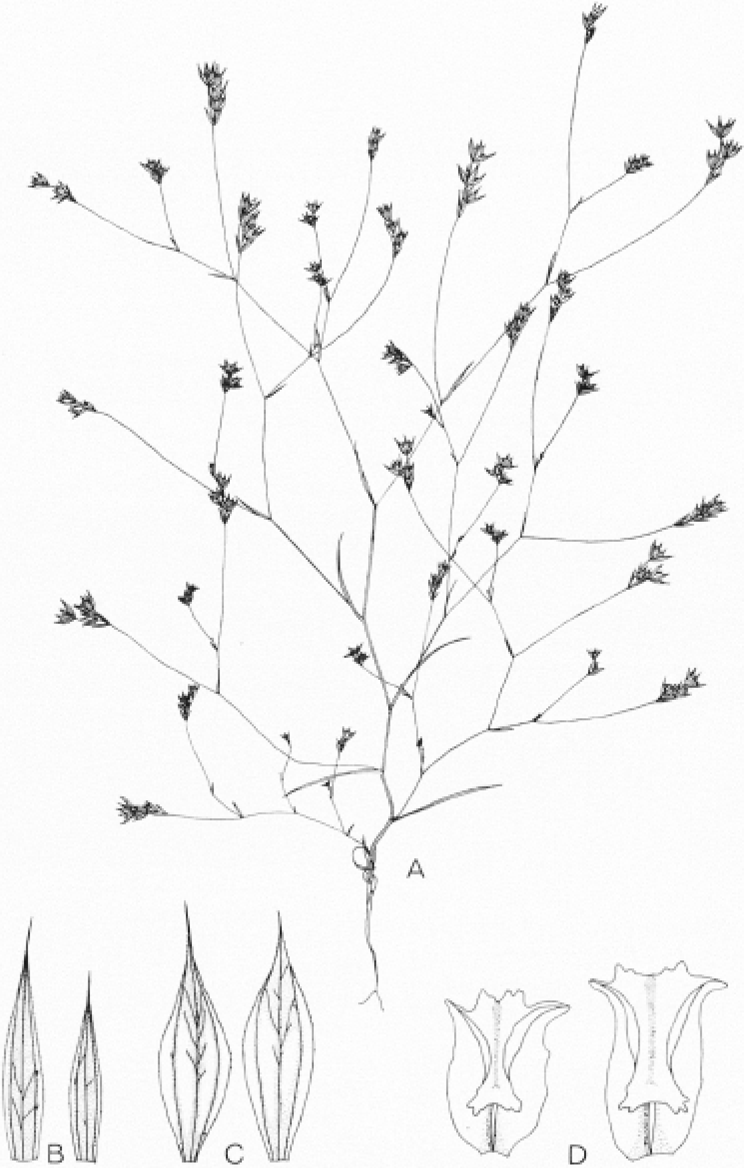

Fig. 1. *Bupleurum pendikum* Snog. — A: Habit, ×0.5. — B: Bracts, ×6. — C: Bractlets, ×6. — D: Petals, ×24. — Type collection.

ty barriers are probably strong and rapidly built up.

Bupleurum pendikum Snogerup, sp. nov. (Fig. 1)

B. thracicum Velen. sensu Post & Aznavour in sched, et Dörfler Herb. Norm. 5074 non Velenovsky 1892.

Typus: Aznavour leg. 8. 7. 1906 (M holotypus, LD, W, GB, PRC, JE, C, G, FI).

Annuum, gracile. Caulis raro ultra 15—25 cm altus, a basi pseudodichotome ramosissimus, ramis tenuibus erectopatentibus vel subarcuatim adscendentibus. Umbellae numerosae, 3-radiatae, radiis suberectis valde inaequalibus. Involucri phylla 3, anguste ovata usque lanceolata, 4—8 mm longa, margine anguste membranacea, subtiliter serrulata, apice in aristam 1—1.5 mm longam producta. Involucelli phylla 5.5—7.5 mm longa, lanceolata, margine et ad nervum medium subtiliter serrulata, acuminata, in aristam 1—1.5 mm longam producta, 3-nervia, nervis parce venulosis, maxima parte scariosa, semipellucida, ad nervos et inter venulas partim herbacea. Petala ovato-oblonga, margine integra vel subintegra, superne obtuse quadridentata, nervo crasso percursa, lobulo inflexo infra medium valde angustato apice iterum dilatato, bifurcato instructa. Fructus oblongus, 2.2—2.4 mm longus, juga filiformia.

Annual, 15—25 or rarely up to 40 cm high, erect, from near the base pseudodichotomously branched. Branches secondarily branched, usually with 2—3 well-developed umbels each. First leaves imperfectly known, small, soon withering, from a sheathy base petiolated, lamina probably lanceolate to narrowly lanceolate. Cauline leaves from an amplexicaul base linear to very narrowly lanceolate, 2—5 cm long, 0.5—1.5 mm broad, narrowly apiculate, finely serrate especially at apical parts of margin and ventral midrib. Upper leaves successively shorter, uppermost ones very narrowly ovate. Umbel rays 3, or rarely in single umbels 2 or 4, 3—15 mm, very unequal, at flowering time divergent, in fruit all erect, crowded. Bracts 3, equal, 1/2—2/3 as long as as longest umbel ray, (4—) 6—7 (—8) mm long, 0.7—1.2 mm broad, narrowly ovate to lanceolate, aristate with a 1—1.5 mm long awn, finely serrate at margin and midrib, especially in the apical parts, 3-veined with inconspicuous veinlets, herbaceous between the veins and in a narrow field outside them, scarious margin c. 0.15 mm broad. Bractlets 5.5—7.5 mm long, 1.2—2 mm broad, higher than the flowers and enclosing them before and after the flowering, lanceolate, aristate with a 1—1.5 mm long arista, serrate like the bracts, 3-veined with few veinlets especially between the apical parts of the veins, small external veinlets rarely present. Bractlets in their major part scarious, semipellucid, herbaceous only at the base, along the veins and apically between the strongest vienlets in fruit often purplish. Umbellules usually 6—8-flowered, pedicels 0.5—1.5 mm, subequal. Petals 0.9—1.0 mm long, 0.4—0.5 mm broad, from a slightly ovate base narrowing, then again wider apically, their sides quite entire or with small, blunt irregularities, upper bend with 2 lateral projections and 2 low ones near the middle, often partly finely granulose-papillulose, median vein strong though thin, inflexed lobe 0.7—0.8 mm, tapering to 0.15—0.2 mm breadth, apically bifid, c. 0.3 mm wide, its lobes often irregularly lobulate. Petal colour not exactly known, probably yellow, turning white when dried. Anthers c. 0.3 mm long and equally broad, filaments c. 0.5 mm. Mature stylopodium 0.6—0.7 mm broad, its base c. 0.2 mm high, broader than the ovarium, in fruit shriveling, narrower. Styles late developing, 0.4—0.5 mm long, longer than the stylopodium radius. Ripe mericarp 2.2—2.4 mm long, 0.9—1 mm broad and 0.7 mm thick, rounded prismatic to almost ellipsoidal, smooth but slightly glaucous, blackish brown, ridges filiform, commissural surface flat with a narrow furrow.

The name is formed from the name of the village Pendik, in the neighbourhood of which both the known collections were made.

MATERIAL REVISED: A2/A Kocaeli: In collibus graminosis prope Pendik. 8.7. 1906. Aznavour. (partly as Dörfler Herb. Norm.

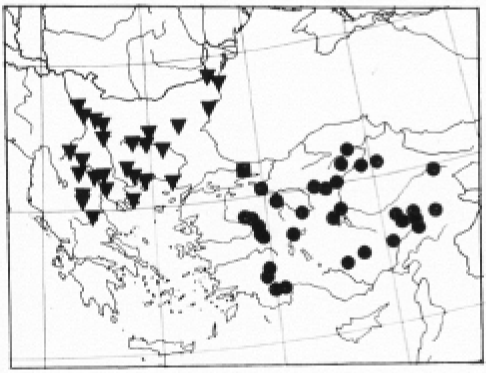

Fig. 2. Distributions according to revised material. — ▼: *Bupleurum apiculatum* FRIV. — ■: *B. pendikum* SNOG. — ●: *B. sulphureum* BOISS. & BAL.

5074). Typus (M, LD, W, G, GB, PRC, JE, C, G, FI). — A2/A Kocaeli; Entre Pendik et Dolaiba, 16.6. 1895. AZNAVOUR (G).

B. pendikum was labelled, by its collector as well as in DÖRFLERS Herb. Normale, as *Bupleurum thracicum* VELENOVSKY (1892). This name, however, is a synonym of *B. flavum* FORSKÅL (1775), as revised in SNOGERUP (1962), and thus not relevant for the species from Pendik. In his monograph of the genus, WOLFF (1910) did not mention the material, which he most probably never studied.

B. pendikum seems to be most closely related to *B. apiculatum* FRIV. of the northern Balkan Peninsula and to *B. sulphureum* BOISS. & BAL. of the Anatolian inland. The distributions of the 3 species are given in Fig. 2. *B. pendikum* differs from *B. apiculatum*, e.g. in having only 3 bracts and 3 umbel rays, whereas *B. apiculatum* has 4—5 bracts and 6—7 rays. There are also differences in the size and general habit of the plants, in the form and size of bracts and bractlets, and in the size of the fruit, which is 2.2—2.5 mm in *B. pendikum* but only 1.8—2.1 mm in *B. apiculatum*. The new species is distinguished from *B. sulphureum* by smaller and narrower bracts and by its 3 umbel rays, the umbels of *B. sulphureum* being usually 4-rayed. The petals of *B. pendikum* have entire sides and only few papillae of the bend, whereas those of *B. sulphureum* have irregularly serrate sides and an irregularly lobed and papillose bend. The best key character, however, is the form and texture of the bractlets, which are narrower, mainly scarious, with few veinlets in *B. pendikum*, broader and mainly herbaceous with many well-developed veinlets in *B. sulphureum*. The mentioned characters make determination rather easy, but the 3 species are nevertheless similar. *B. pendikum*, with an intermediate geographical position, is also morphologically intermediate in some characters, e.g. in habit and in petal form. Thus I find it most probable that the 3 species mentioned are differentiated products from a common ancestral stock.

B. pendikum also has certain similarities to *B. gracile* D'URV. of the southern Aegean area, e.g. in the mainly scarious bractlets and the general habit. It is, however, very unlike that species in the long aristae and comparatively well-developed veinlets of its bractlets as well as in the form of its petals and in the small number of umbel rays.

Bupleurum davisii SNOGERUP, sp. nov. (Fig. 3)

Typus: Turkey, C3 Antalya: Bozburun Dag between Tazli yayla and Tozlu Dere, 1600 m. DAVIS 15721 (E holotypus, K).

Annuum, 10—15 cm altum, pseudodichotome ramosum. Folia 1—4 cm longa, angustissime obovata, integra, uninervia, mucronata. Umbellae paucae, pedunculo 10—35 mm longo suffultae, 2—3-radiatae, radiis inaequilongis, 3—5 mm longis. Involucri phylla normaliter 2, 0.5—5 mm longa. Involucelli phylla 5, 3.5—4 mm longa, 1.5—1.8 mm lata, obovata, obtusa, mucronata, trinervia, maxima parte herbacea. Umbellulae 4—5-florae, pedicelli 0.5—1 mm. Petala 0.45—0.55 mm, nervo tenui percursa, lobulo inflexo lato bifido instructa. Antherae 0.3 mm longae, stylopodium 0.4—0.5 mm latum, styli 0.2 mm longi. Fructus 2—2.5 mm longus, rotundato-oblongus, laevis, juga filiformia vel inconspicua.

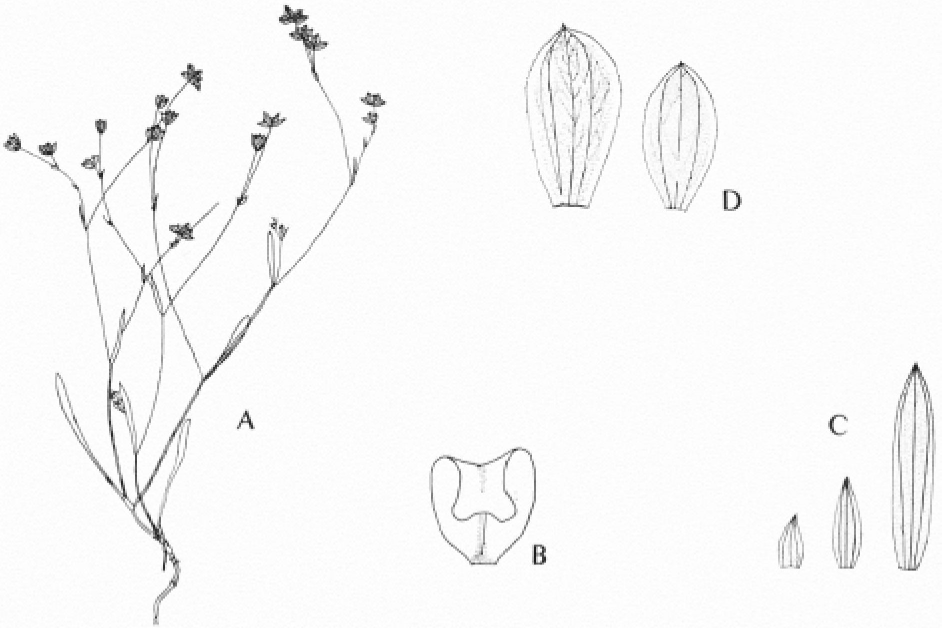

Fig. 3. *Bupleurum davisii* Snog. — A: Habit, ×0.5. — B: Petal, ×24. — C: Bracts, ×6. — D: Bractlets, ×6. — Type collection.

Annual, 10—15 cm high, erect, sparingly pseudodichotomously branched. Cotyledons linear, c. 15 mm long. First leaves petiolated, narrowly elliptical to obovate. Cauline leaves 10—35 mm long, 1.5—3 mm broad, very narrowly obovate, entire, gradually changing from obtuse to acute, most of them with a small whitish mucro, with one strong vein. Upper leaves successively smaller and more oblong. Umbel stalks 10—35 mm. Umbel rays 2—3, 3—15 mm, very unequal, in main umbels shorter than the stalk, angular and often slightly scabrid. Bracts 2, equal to very unequal, or in lateral umbels only 1, 0.5—5 mm long, 0.3—1 mm broad, elliptical to narrowly ovate or ovate, entire or slightly serrate apically, 3-veined. Bractlets 5, 3.5—4 mm long, 1.5—2.0 mm broad, obovate, obtuse with a 0.1—0.2 mm long mucro, entirely or in their major part herbaceous, in fruit ± violet apically, usually with a c. 0.2 mm broad scarious margin, finely scabrid at apical part of margin, veins 3, uniting near the top, veinlets inconspicuous. Well-developed umbellules 4—5-flowered, pedicels 0.5—1 mm. Petals 0.45—0.55 mm, 0.4—0.5 mm broad, with a narrow midrib, smooth and entire, inflexed lobe broad, bifid. Anthers 0.3 mm and equally broad, filaments c. 0.6 mm. Stylopodium 0.45—0.5 mm broad, styles c. 0.2 mm. Fruit 2—2.5 mm long, 0.9—1 mm broad, rounded, smooth, ridges filiform, vittae 6, 2 in commissural surface, 1 in each dorsal field.

The name is formed in honour of the type collector, Dr. P. H. Davis, Editor of the Flora of Turkey, who noted the material as probably belonging to an undescribed species.

B. davisii is known only from the type collection. Probably it is a local endemic, like its closest relatives *B. erubescens* Boiss. and *B. pulchellum* Boiss. & Heldr., both endemics of the Antalya region. *B. davisii* is most easily distinguished from both by its herbaceous bractlets, those of

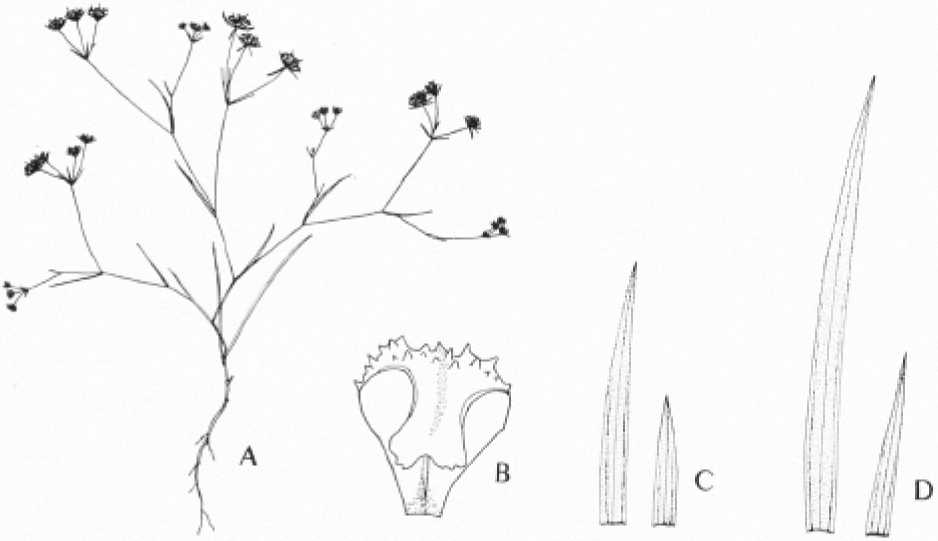

Fig. 4. *Bupleurum turcicum* Snog. — A: Habit, ×0.5. — B: Petal, ×24. — C: Bractlets, ×6. — D: Bracts, ×6. — Zohary et. al. 117731.

the other two species being scarious, semipellucid with more veins and veinlets. This group of endemics seems to be most closely related to *B. Karglii* Vis. and *B. capillare* Boiss. of W. and Central Balkans, but they also show more distant similarities to *B. aleppicum* Boiss. of the Mesopotamian region.

Bupleurum turcicum Snogerup, sp. nov. (Fig. 4)

Typus: Zohary 942 (HUJ holotypus).

Annuum, 5—15 cm altum, pseudodichotome ramosum. Folia anguste linearia. Umbellae normaliter 5—15, 3—4-radiatae, radiis pedunculo brevioribus. Involucri phylla 3—4, 2.5—10 mm longa, anguste ovata, margine subtiliter serrulata, radiis breviora, acutissima. Involucelli phylla illis conformia, 5, 3—8 mm longa. Umbellulae 5—8-florae, pedicelli inaequales, 0.3—2 mm. Petala 0.8—1 mm longa, superne papilloso-exasperata, late cucullata, lobulo inflexo lato bifido instructa. Fructus 3 mm longus, ubique papillis vesiculiformibus majusculis in series longitudinales dispositis obtectus, papillae 0.4—0.65 mm altae, apice non vel parum dilatatae, minute papillulosae.

Annual, 5—15 cm high, sparsely pseudodichotomously branched, usually with 5—15 developed umbels. Cotyledons linear, c. 8 mm long. First leaves imperfectly known, small and soon withering, from a wide sheathy base probably petiolated. Cauline leaves 1—5 (—7) cm, 1—1.5 mm broad, ± linear, with a narrowly acuminate, sharp-pointed apex, often with somewhat convolute margin or ± rolled, slightly scabrid at apical parts of margin and midrib, veins inconspicuous. Umbel stalks up to 35 mm, those of main umbels 10—35 mm. Umbel rays in well developed umbels 3—4, 5—25 mm, in main umbels ± considerably shorter than the stalk. Bracts 3—4, 2.5—10 mm long, 0.4—1 mm broad, thick, ± keeled, sharply acuminate, their margins scabrid apically. Bractlets 5, 3—8 mm long, 0.4—0.8 mm broad, like the bracts. Umbellules 5—8-flowered, pedicels 0.3—2 mm, unequal. Petals 0.8—1 mm, 0.7—0.9 mm broad, from a narrow base broadly obovoidal, broadly cucullate, with pointed, often 0.1—0.2 mm high papillae especi-

Table 1. Differences between *Bupleurum turcicum* and *B. papillosum.*

	B. turcicum	*B. papillosum*
Plant height (cm)	5 —15	10 — 30
Rays of central umbels, length (mm)	5 —25, shorter than stalk	25 —100, longer than stalk
Number of bracts	3 — 4	3
Length of bracts (mm)	2.5—10	5 — 30
Length of bractlets (mm)	3 — 8	3 — 20
Petal size (mm)	0.8— 1.0	1 — 1.2
Anther length (mm)	0.4— 0.5	0.5— 0.6
Fruit size (mm)	3 — 4	2.5— 3
Fruit papillae	0.4— 0.65 mm, micropapillulose, not or slightly expanded	0.6— 1 mm, almost smooth, apically expanded to c. 0.5 mm width

ally at the bend, inflexed lobe broad, markedly bifid. Anthers 0.4—0.5 mm, filaments c. 0.8 mm. Stylopodium cup-formed, 0.8—1.2 mm broad, styles 0.7—0.8 mm, longer than stylopodium radius. The upper margin of the ovarium in flower forming a papillose substylopodium, no longer visible in fruit. Fruit c. 3 mm long, fruit surface densely covered with rows of 0.4—0.65 mm high, hollow, white papillae, papillae not or only slightly expanding apically, 0.25 mm or less broad, especially in their apical part covered with 0.01—0.02 mm high papillulae.

The name is formed from the country name of Turkey, because this species is no doubt restricted to the typical steppe areas of inner Anatolia.

MATERIAL REVISED: B4 Ankara: NE. shore of Tuz Gölü, at northernmost extension, 905 m, Darrah 170 (E). — B4 Ankara: 86 km SW of Sungurlu, 930 m, Zohary et al. 117731 (HUJ). — B5 Nigde: 5 km E Aksaray, 1100 m, Sorger 70-39-9 (Herb. Sorger). — B3 Afyon: 35 km S Cifteler, 1000 m, Sorger 68-48-5 (Herb. Sorger). — C2 Denizli: about 10 km W of Denizli, Zohary 942. Typus (HUJ).

According to collectors' information, *B. turcicum* is a plant of the C. Anatolian steppes and saline areas, and it seems to have a comparatively wide distribution in spite of the fact that it was not collected until 1962. It is no doubt closely related to *B. papillosum* DC. of the Mesopotamian steppes, which it resembles in the fruit ornamentation and the form of the petals as well as in general habit. There are, however, differences in a number of characters, as summarized in Table 1. *B. turcicum* is most easily distinguished from *B. papillosum* by its shorter umbel rays, which are 25 mm or less and shorter than the stalk in the main umbels. In *B. papillosum* the rays of the main umbels are 25—100 mm and longer than the stalk. The fruit papillae in *B. papillosum* are apically expanded to a width of c. 0.5 mm and lack the micro-papillae typical of *B. turcicum.*

Bupleurum orientale Snogerup, sp. nov. (Fig. 5)

Typus: Sintenis 916 p.p. 12.9. 1880 (LD holotypus, Herb. Huber-Morath).

Annuum, 40—70 cm altum. Caulis erectus, a basi ramosus, ramis elongatis, erectopatentibus usque ascendentibus. Folia anguste linearia, integra vel minute serrulata. Umbellae numerosae, variabiliter evolutae, pedunculo usque ad 30 mm longo suffultae, 1—3-radiatae, radiis inaequilongis, in umbellis centralibus 15—25 mm longis. Involucri phylla 3, 1.5—3 mm longa, anguste ovata, integra vel apice minute serrulata, illis involucelli conformia, 5, 1.7—3 mm longa. Umbellulae centrales 5—6-florae, pedicelli valde inaequales, 0.2—2 mm longi. Petala 0.4—0.5 mm, rotundata, superne papillulosa, lobulo inflexi e basi lata

Fig. 5.

angustato instructa. Fructus 1.7—2 mm longus, rotundatus, papillis subcylindricis albicantibus 0.1—0.15 mm altis obtectus, juga filiformia.

Annual, 40—70 cm high, with an erect main stem, much branched from near the base, branches long and slender, erectopatent to ascending. Cotyledons not seen. First leaves imperfectly known, soon withering, probably the first ones short, ± oblong, next ones broad-petiolated with a lanceolate lamina. Cauline leaves 3—10 cm long, 2—3 mm broad, lower ones very narrowly obovate to linear, apiculate, upper ones successively smaller and changing to narrowly lanceolate and narrowly ovate, margin entire or very finely serrulate, veins parallel, midvein strongest, veinlets thin, anastomosing. Umbels numerous, variously developed. Umbel stalks short or up to 30 mm, in terminal umbels 15—30 mm. Umbel rays 1—3, in terminal umbels usually 3, very unequal, 0—25 mm, in terminal umbels the longest 15—25 mm, often slightly scabrid. Bracts 3, 1.5—3 mm long, 0.5—1 mm broad, narrowly ovate, acuminate, entire or very finely scabrid at apical parts of margin and midrib, herbaceous, usually 3-veined. Bractlets in well-developed umbellules 5, equalling the highest flowers or slightly lower, 1.7—3 mm long, 0.5—0.8 mm broad, like the bracts. Well-developed umbellules 5—6-flowered, pedicels very unequal, 0.2—2 mm long. Petals 0.4—0.5 mm long, 0.4—0.55 mm broad, rounded, entire. Midvein dark, narrow, continuing on lobe to its narrowest part, the bend with a ± marked median bulb, inflexed lobe 1/2—4/5 as long as the limb, abruptly narrowing to a breadth of 0.15—0.2 mm, apically truncate but not considerably broader, petal surface with small blunt papillae, especially on the bend, or almost smooth. Anthers 0.30—0.35 mm and about equally broad, filament 0.5—0.6 mm. Stylopodium 0.5—0.65 mm broad, styles c. 0.2 mm, shorter than the stylopodium radius. Ripe mericarp 1.7—2 mm long, c. 0.8 mm broad, rounded, ridges filiform or quite inconspicuous, fruit surface densely covered with 0.1—0.15 mm high, blunt, ± cylindrical, light papillae, commissural surface also slightly papillose, with a narrow furrow.

The name *B. orientale* is chosen because of its distribution along the eastern shores of the Mediterranean, which is also eastern compared to related species of the *B. tenuissimum* group.

MATERIAL REVISED: Turkey: C3 Antalya: Finike, freshwater marsh by sea. Schultz 151 (E). — C5 Seyhan: Karatas area, S of Adana, sand dunes. Findlay 270 (E). — C6 Hatay: Lake of Antiochia, marshes dry in summer. Eig & Zohary, 1931 (HUJ).

Palestine: Jaffa, low ground, 1 m. Meyers & Dinsmore 3441 (LD). — Sharon, Atlith, banks of salt pans. Zohary, Fl. Terr. Isr. Exs. 556 (LD, Herb. Huber-Morath, W).

Cyprus: Salzsteppe bei Larnaka, 12.9 1880. Sintenis 916 p.p. Typus (LD, Herb. Huber-Morath). — Salzsteppe bei Larnaka, 8. 1880. Sintenis 916 p.p. (LD, G). — Distr. Famagusta, in locis salsis inter Prasdio et Konuklia, 1939. Lindberg (LD). — Distr. Famagusta, in campo arenoso juxta mare prope opp. Famagusta, 1939. Lindberg (LD).

According to the above list of localities, *B. orientale* is known from Palestine, Cyprus and S. Anatolia. It could be expected in neighbouring territories and from more localities. It should be pointed out that I have not seen the entire HUJ material of this group.

B. orientale was usually labelled by its collectors under synonyms of *B. euboeum* Beauv. [Syn. *B. gracile* (M.B.) DC. sensu auct. mult. non M.B.] Its fruit, however, is quite different from that of *B. euboeum* and *B. tenuissimum*. In the form of the papillae it forms a transition between the *B. tenuissimum* group and the *B. leucochladum* group of the S. Mesopotamian region. The other species of the *B. tenuissimum* group have ± confluent rugulae instead of papillae.

Fig. 5. — *Bupleurum orientale* Snog. — A: Apical part of specimen, ×0.5. — B: Bract, ×6. — C: Bractlet, ×6. — D: Petal, ×24. — A—C: Sintenis 916, D: Findlay 270.

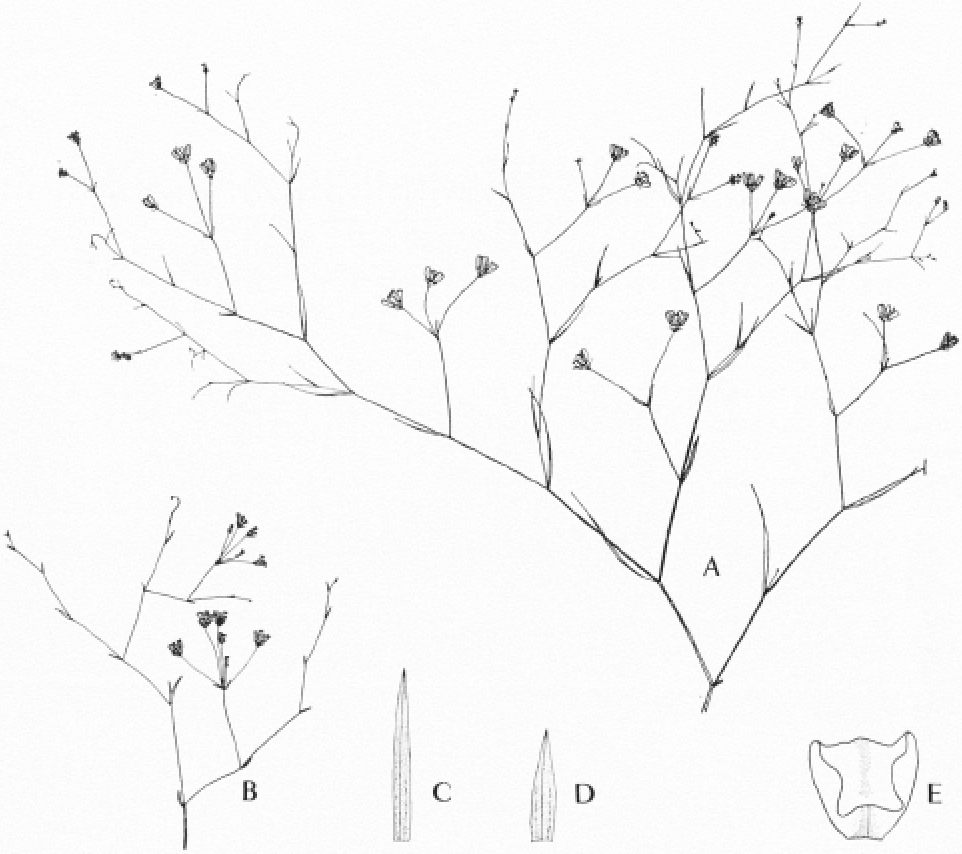

Fig. 6. *Bupleurum eginense* (WOLFF) SNOG. — A: Major part of fruiting inflorescence, ×0.5. — B: Part of inflorescence with central umbel, ×0.5. — C: Bract, ×6. — D: Bractlet, ×6. — E: Petal, ×24. — A, C, and D: HUBER-MORATH 15259, B and E: SINTENIS 2351.

Bupleurum eginense (WOLFF 1910 pro f.) SNOGERUP, stat. nov. (Fig. 6)

B. Koechelii FENZL f. *eginense* WOLFF in ENGL. Pflanzenr. 43 (IV. 228) p. 94 (1910).

Typus: SINTENIS 2351/1890 (G lectotypus, FI, W, E, LD).

Annuum, 20—40 cm altum, a medio pseudodichotome ramosum. Caulis et rami flexuosi. Folia anguste linearia. Umbellae paucae, terminales pedunculo 10—15 mm longo suffultae, 2—6-radiatae, radiis subaequalibus, 10—20 mm longis. Involucri phylla 2—5, 2.5—4 (—7) mm longa, anguste ovata, acuminata, integra, illis involucelli conformia, 5, 1.5—2 mm longa. Petala 0.4—0.6 mm, lobulo inflexo lato bifido instructa. Antherae 0.2—0.3 mm longae, stylopodium 0.55—0.7 mm latum, styli 0.2—0.25 mm longi. Fructus 3.5—4 mm longus, prismaticus, retusus, papillulis c. 0.02 mm altis dense obtectus, juga rugulosa.

Annual, 20—40 cm high, much pseudodichotomously branched in upper part, stem and branches slightly flexuose. Branches next to terminal umbels developed, side umbels preceded by 2—3 reduced ones. Cotyledons not seen. First leaves imperfectly known, small and soon withering, at least some of them petio-

Table 2. Variation in the *Bupleurum koechelii* group.

	B. lycaonicum	*B. koechelii*	*B. eginense*	*B. dichotomum*
Branches below central umbels ..	developed	reduced	developed	developed
Umbel rays, number	4 — 8	4 — 6	2 — 6	2—4 (—5)
Umbel rays, length (mm)	10 —20	5 — 8	10 —20	10 —25
Flowers per umbellule	(4—)5—7	6 — 8	2 — 5	1 — 6
Pedicel length (mm)	0.2 — 2	0.8 — 2.5	0.5 — 2	1 — 3
Petal size (mm)	0.4 — 0.5	0.75— 0.9	0.4 — 0.6	c.0.5
Anther length (mm)	0.2 — 0.25	0.4 — 0.5	0.2 — 0.3	c.0.3
Stylopodium bredth (mm)	0.55— 0.7	1 — 1.2	0.55— 0.7	0.55— 0.65
Style length (mm)	0.2 — 0.3	c.0.4	0.2 — 0.25	0.15— 0.2
Fruit size (mm)	c.3	> 2.5	3.5 — 4	3
Fruit surface	± granulose	± granulose	papillose, ridges rugulose	granulose

lated. Cauline leaves 2—8 cm, 2—3 mm broad, approximately linear, upper ones successively smaller and changing to very narrowly ovate. Stalks of terminal umbels 10—15 mm, their rays 2—6, 10—20 mm, slightly unequal, smooth. Bracts 2—5, 2.5—5 (—7) mm long, 0.3—0.5 (—1) mm broad, narrowly ovate, acuminate, entire, with 1 strong and 2 fainter veins, veinlets inconspicuous. Bractlets 5, 1.5—2.5 mm long, 0.3—0.5 mm broad, like the bracts. Umbellules (1—) 2—5-flowered, pedicels unequal, 0.5—2 mm. Petals 0.4—0.6 mm, inflexed lobe 1/2—2/3 as long as limb, broad, slightly bifid. Anthers 0.2—0.3 mm, filaments c. 0.6 mm. Stylopodium 0.55—0.7 mm wide, styles 0.2—0.25 mm. Fruit 3.5—4 mm long, prismatic, retuse, ridges finely rugulose, fruit surface densely covered by small, c. 0.02 mm high, whitish papillae.

I find it most correct to accept the name given by WOLFF under the rank of forma, but have provided it with a new diagnosis, as the old one could hardly be regarded as correctly describing or distinguishing *B. eginense*.

MATERIAL REVISED: B6 Sivas: Distr. Gürün, Gürün — Pinarbasi, Kalkschutt 11 km W Gülner Gürün, 1740 m, HUBER-MORATH 15259 (Herb. HUB.-MOR.). — B7 Erzincan: Egin, in declivibus saxosis ad Euphratem. SINTENIS 2351/1890. Typus (G, FI, W, E, LD). — C6 Hatay: Amanus Mts., ascent to Achayi Zarkoun from the Karakisieh side, 800—1000 m, pinetum halepense, 1932. EIG & ZOHARY (HUJ).

B. eginense is probably closely related to *B. koechelii* FENZL, *B. lycaonicum* SNOG. and *B. dichotomum* BOISS. It is strictly distinguished by its large, papillose fruit. In the ornamentation of the fruit surface it even approaches the *B. leuchochladum* and *B. tenuissimum* groups. About the *B. koechelii* group see further p. 371 and Table 2.

According to the collectors' information, *B. eginense* is a plant of dry, rocky or stony slopes, flowering during the dry period in June and July.

Bupleurum lycaonicum SNOGERUP, sp. nov. (Fig. 7)

Typus: HUBER-MORATH 8058 (Herb. HUB.-MOR. holotypus, LD).

Annuum, 15—35 cm altum, superne pseudodichotome ramosum. Caulis et rami sub umbellis terminalibus flexuosi. Folia anguste linearia, acuminata, margine integra vel apice tantum scabriuscula. Umbellae paucae, terminales, pedunculo 10—25 mm longo suffultae, 4—8-radiatae, radiis subaequalibus 10—20 mm longis. Involucri phylla 5, 2.5—6 mm longa, anguste ovata, acuminata, integra, illis involucelli conformia, 5, 2—4 mm longa. Umbellae 4—7-florae, pedicelli inaequales, 0.2—1.5 mm longi. Petala 0.35—0.5 mm,

Fig. 7.

integra vel superiore minute papillulosa, lobulo inflexo lato bifido instructa. Antherae 0.2—0.25 mm longae, stylopodium 0.55—0.7 mm latum, styli 0.25 mm longi. Fructus c. 3 mm longus, prismaticus, retusus, minute granuloso-papillosus, juga filiformia.

Annual, 15—35 cm high, in upper part pseudodichotomously branched, stem and branches flexuose below the terminal umbels, branches next to terminal umbel developed, side umbels preceded by 2—4 reduced ones. Cotyledons linear, c. 10 mm. First leaves small, soon withering, from a sheathy base all linear or some inconspicuously petiolated with a long petiole and narrow lamina. Cauline leaves 2—7 cm long, 1—2 mm broad, approximately linear, sharply acuminate, entire or very finely scabrid at apical part of the margin, veins marked, veinlets inconspicuous. Stalks of terminal umbels 10—25 mm, rays 4—8, 10—20 mm, subequal, equalling the stalk or shorter. Bracts 5, 2.5—6 mm long, 0.5—0.7 mm broad, narrowly ovate, acuminate, entire, 3-veined. Bractlets 5, 2—4 mm long, 0.5—0.7 mm broad, like the bracts. Umbellules 4—7-flowered, pedicels unequal, 0.2—1.5 mm. Petals 0.35—0.5 mm high, 0.45—0.5 mm broad, with high margins at the bend, smooth or with small papillae especially at the bend, purplish, inflexed lobe c. 3/4 as long as limb, broad, bifid. Anthers 0.2—0.25 mm, filaments 0.5—0.7 mm. Stylopodium 0.55—0.7 mm broad, styles c. 0.25 mm. Fruit not seen ripe, c. 3 mm, rounded prismatic, retuse, ridges filiform, fruit surface very finely granulose-papillose.

The name *B. lycaonicum* is formed from the old provincial name Lycaonia.

MATERIAL REVISED: C4 Konya: Bozkir-Hadim, Gök Cay Tal, 54 km nach Bozkir, 1250 m. HUBER-MORATH 8058. Typus (Herb. HUB.-MOR., LD). — C4 Konya: Karaman — Ermenek, 73 km nach Karaman, 1500 m. HUBER-MORATH 8057 (Herb. HUB.-MOR.). — C4 Konya: 13 km W Konya, bei der Wasserleitung hinter dem Elektrizitätswerk, 1170 m. HUBER-MORATH 8055 (Herb. HUB.-MOR.). — C4 Icel: Mut-Kirobasi, 33 km nach Mut. 1260 m. HUBER-MORATH 9822 (Herb. HUB.-MOR.).

According to the collectors' information, *B. lycaonicum* grows in dry forest and macchia, but also in scree, between 1000 and 1500 m, flowering in June.

B. lycaonicum is no doubt closely related to *B. koechelii* FENZL, to which it was first referred by its collector, but it is still more similar to *B. eginense* (WOLFF) SNOG. The 3 mentioned species and *B. dichotomum* BOISS. from Hatay, NW. Syria form a series of closely related species of restricted distribution. Their morphological relationships are illustrated in Table 2. WOLFF (1910) treated *B. dichotomum* as a variety of *B. trichopodum* BOISS. & SPR., but it seems to have much more in common with the other species mentioned above.

Bupleurum zoharii SNOGERUP, sp. nov. (Fig. 8)

Typus: EIG & ZOHARY 12.8. 1931 (HUJ holotypus).

Annuum (vel bienne). Caulis (25—) 50—70 cm vel altior, a basi ramosus, ramis longis profunde ramulosis, umbellis numerosissimis, vel raro planta minora, apice parce ramosa. Folia anguste linearia. Umbellae pedunculo 5—20 mm longo suffultae, 5—9 (—11)-radiatae, radiis aequalibus vel subaequalibus 3—8 mm longis. Involucri phylla 4—5, 2.5—5 mm longa, radiis breviora, anguste ovata, acutissima, margine scabriuscula, illis involucelli conformia, 5. 2.5—3.5 mm longa. Umbellulae (6—) 9—11-florae, pedicelli 0.9—1.5 mm longi, subaequales. Petala 0.45—0.55 mm, late rotundata, lobulo inflexo lato bifido instructa. Antherae 0.3—0.4 mm, stylopodium 0.6—0.8 mm latum, styli 0.4—0.5 mm longi. Fructus 1.6—2 mm longus, rotundato-prismaticus, glaucescens.

Annual or perhaps biennial, (25—) 50—70 cm and probably higher, often with an up to 5 mm thick, ± woody basal stem part, usually branched from the base, branches long and secondarily branched,

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Fig. 7. *Bupleurum lycaonicum* SNOG. — A: Habit, ×0.5. — B: Bracts, ×6. — C: Bractlets, ×6. — D: Petal, ×24. — A—C: Type collection, D: HUBER-MORATH 9822.

Fig. 8.

umbels numerous. Rarely small specimens only apically branched, with few umbels. Leaves very imperfectly known, usually many basal leaves developed, withering before flowering. Lower leaves probably linear, 1.5—3 mm broad, upper ones successively smaller and those of the ultimate inflorescence parts more like the bracts, leaf margin finely scabrid. Umbel stalks 5—20 mm. Terminal umbels 5—9 (—12)-rayed, rays equal or slightly unequal, 3.5—8 mm, in largest umbels much shorter than the stalk, ± sharply angular. Bracts (4—) 5, 2.5—5 mm long, 0.4—0.8 mm broad, shorter than the rays, narrowly ovate, acuminate with a distinct, pointed tip, scabrid at margin and ventral midrib, only the midrib marked, often two inconspicuous side ribs. Bracteoles 2.5—3.5 mm long, 0.4—0.6 mm broad, like the bracts. Umbellules (6—) 9—11-flowered, pedicels 0.9—1.5 mm. Petals 0.4—0.55 mm, 0.5—0.7 mm broad, rounded, with a wide bend and a broad bulb of the bend and a broad dark midfield, inflexed lobe broad, bifid. Anthers 0.3—0.4 mm, filaments 0.7—0.8 mm. Stylopodium 0.6—0.8 mm broad, styles 0.4—0.5 mm, usually longer than the stylopodium radius. Fruit 1.6—2 mm, 0.55—0.7 mm broad and about equally thick, rounded prismatic, dark brown, glaucous, ridges filiform, commissural surface flat with a narrow furrow, vittae 6, 2 in the commissural side and one in each dorsal field.

The name is formed in honour of one of the type collectors, professor Zohary, who collected much interesting material of annual *Bupleurum* species.

MATERIAL REVISED: C5 Icel/Seyhan: Plain between Mersina and Adana, 12.8. 1931. Eig & Zohary. Typus (HUJ). — C5 Icel: Env. of Mersina, 18.8. 1931. Eig & Zohary (HUJ). — C5 Seyhan: Wegrand 10 km W Zeyhan, 30 m. Huber-Morath 15248 (Herb. Hub.-Mor.). — C6 Seyhan: Near Hasanbeyli, 914—1219 m. Darrah 639 (E). — C6 Hatay: S of Paias (near Alexandretta), 10.8. 1931. Eig & Zohary (HUJ).

B. zoharii occurs in different ± open habitats of the Cilician lowland, such as fields, roadsides and macchias. It is probably most closely related to *B. kurdicum* Boiss., a relatively widespread species of the Mesopotamian area. The easiest distinguishing character is the relative length of the umbel rays, which are markedly unequal and usually much longer in *B. kurdicum*. *B. kurdicum* also has a wider stylopodium (0.5—0.8 mm) and larger fruit (more than 2.5 mm long). Usually it also has longer bracts and bractlets but is less profusely branched and has a smaller number of umbels.

The bases of large *B. zoharii* specimens show a great number of leaf scars and remnants of large leaf bases. Thus, the species has probably often a long period of development as a rosette plant before the large flowering branches are formed. Perhaps that means that it can grow as a winter biennial, but there are no indications that it has perennated through more than one flowering period. Probably the leaves formed during the rosette stage are rather large, but their form and size can not be estimated from the remnants present. Further field observations and collections of young plants are highly desirable.

The collection Huber-Morath 15248 contains only small, normally annual, apically branched specimens, but in floral characters it seems so like the other *B. zoharii* collections that I find it necessary to include it here.

Bupleurum polyactis Post ex Snogerup, sp. nov. (Fig. 9)

Typus: Post 438 (G holotypus).

Annuum, 30—70 cm altum vel altius. Caulis erectus, ramis longis, parce ramulosis. Folia anguste linearia, margine scabriuscula. Umbellae pedunculo 10—45 mm longo suffultae, 6—13-radiatae, terminales 10—13-radiatae, radiis valde inaequalibus 5—22 mm longis, tenuissimis. Involucri phylla 5, 3—7.5 mm longa, anguste ovata, margine scabriuscula,

Fig. 8. *Bupleurum zoharii* Snog. — A: Part of a large specimen, ×0.5. — B: Bracts, ×6. — C: Bractlets, ×6. — D: Petal, ×24. — Material coll. Eig & Zohary 18. 8. 1931.

Fig. 9. *Bupleurum polyactis* POST ex SNOG. — A: One of the largest branches, ×0.5. — B: Bracts, ×6. — C: Bractlets, ×6. — D: Petal, ×24. — Type collection.

acutissima, illis involucelli conformia, 4—5, 2.5—5 mm longa. Umbellulae laterales 10—13-florae, centrales minores, pedicelli 1.2—2 mm longi subaequales. Petala 0.45—0.5 mm, laevia, lobulo inflexo lato bifido instructa. Antherae 0.35 mm, stylopodium 0.6—0.75 mm latum, styli 0.4—0.6 mm longi. Fructus maturus non visus, 1.2 mm vel longior, rotundato-prismaticus, laevis.

Annual, 30—70 cm and probably higher, main stem conspicuous, branches long, moderately branched, branches next to main umbels developed, side umbels preceded by usually 2 reduced ones. Cotyledons not seen. First leaves small, soon withering, probably petiolated. Cauline leaves at least up to 5 cm long and 1.5 mm broad, first ones very narrowly obovoidal, gradually changing to ± linear, very finely scabrid at margin and upper part of ventral midrib, with a pointed tip, uppermost ones narrowly ovate, successively smaller and more like the bracts. Umbel stalk 10—45 mm. Umbel rays 6—13, in main umbels 10—13, 5—22 mm long, very unequal, thin, in main umbels ± considerably shorter than the stalk. Bracts 5, 3—7.5 mm long, 0.4—1.2 mm broad, narrowly ovate, with a long, thin, pointed tip, often ± keeled, with a strong midrib and often 2 weaker lateral ones, marginally scabrid. Bractlets 4—5, 2.5—5 mm long, 0.4—0.6 mm broad, like the bracts. Outer umbellules 10—13-flowered, central ones often reduced, pedicels 1.2—2 mm. Petals 0.45—0.5 mm, 0.6—0.7 mm broad, smooth, midvein broad, dark, inflexed lobe broad, bifid. Anthers c. 0.35 mm, filaments 0.7—0.8 mm. Stylopodium 0.6—0.75 mm broad, styles 0.4—0.6 mm, longer than the stylopodium radius. Ripe fruit not seen, 1.2 mm or probably slightly longer, smooth, ± rounded prismatic, oil ducts 2 in commissural side and 1 in each interjugal side.

The name was proposed by Post in a pencil note to the type collection.

MATERIAL REVISED: C5 Seyhan: Adana to Missis, 2.7. 1906. Post 438. Typus (G). — C4 Icel: 2 km N Mut (Karaman), 290 m. Sorger 66-18-20 & 66-19-30 (Herb. Sorger).

B. polyactis is a plant of the Cilician lowland. It is easily recognised by its many thin and very unequal umbel rays. Its relationships are not quite clear; it has similarities to the *B. koechelii* group on the one hand, but also to *B. zoharii* and *B. kurdicum* on the other.

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Chromosome Numbers in Plants from the Canary Islands

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ABSTRACT

Bramwell, D., Humphries, C. J., Murray, B. G. & Owens, S. J. 1971. Chromosome numbers in plants from the Canary Islands. — Bot. Notiser 124: 376—382.

The chromosome numbers have been determined for twenty seven species of flowering plants from the Canary Islands. Of these, eight species and the genus *Vieraea* Webb were hitherto unknown cytologically. In general our observations agree with those of previous workers, but in *Centaurea arguta* a new count of 2n=31 (30+1) is recorded.

INTRODUCTION

The flora of the Canary Islands comprises some 1750 species of which approximately 450 have been studied cytologically. Particular attention has been paid to the endemic species of which there are about 500, previous workers having determined the chromosome numbers of about half of these. The present contribution deals with 28 species, nine of which have not previously been studied cytologically. Our study tends to confirm earlier reports (Borgen 1970, Larsen 1963) on the low level of polyploidy in the flora since we found only one species to be polyploid.

MATERIALS AND METHODS

Chromosome counts were made from material collected by D. Bramwell in the Canary Islands during the period October 1968 to August 1969, and from spontaneous seed supplied by the Jardín de Aclimatación de Plantas de la Orotava, Tenerife and Oslo Botanic Garden, Norway. Voucher specimens are preserved in the Herbarium of the University of Reading (RNG).

Somatic counts were made from root tips which were pretreated in a saturated solution of paradichlorobenzene for two hours, fixed in acetic alcohol (1 : 3), stained in basic fuchsin and squashed in acetic orcein. Meiosis was studied in pollen mother cells fixed in acetic alcohol and squashed in acetic orcein. The drawings were made with the aid of a Zeiss camera lucida at a magnification of 1600×.

RESULTS

Monocotyledoneae

AMARYLLIDACEAE

Pancratium canariense Ker. Gawl. ex Webb & Berth. — 2n=22 (Fig. 1 A).

Seed collection: Tenerife, Punta de Teno. 7-1969 D. Bramwell.

This endemic geophyte is recorded from the xerophytic zone on each of the Canary Islands. The same number is reported by Borgen (1969) for material from Gran Canaria.

GRAMINEAE

Briza maxima L. — 2n=14 (Fig. 1 D).

Spontaneous seed received from Orotava Botanic Garden, originating from Tenerife, Orotava.

This is a fairly common weed in the Canary Islands. LARSEN (1954) recorded the same number from Canarian material.

Briza media L. — 2n=14 (Fig. 1 C).

Spontaneous seed received from Orotava Botanic Garden, originally from Tenerife, Orotava.

The only record for the occurrence of this species in the Canary Islands is to be found in the Orotava Seed list for 1966—70 and it seems to be a recent introduction. The chromosome number and the morphology of plants raised from seed confirm the material's identity. The same number is widely reported from Europe.

IRIDACEAE

Iris foetidissima L. — 2n=40 (Fig. 1 E).

Seed collection: Tenerife, Icod el Alto. 5-1969 D. BRAMWELL.

This is the first report of the chromosome number of this species based on Canarian material and it agrees with counts made by SIMONET (op. div.) for European material.

LILIACEAE

Androcymbium psammophilum SVENT. (syn. *A. fuerteventurae* KUNKEL & SUNDING) — 2n=18 (Fig. 1 B).

Seed collection: Fuerteventura, Corralejos. 5-1969 D. BRAMWELL.

This is a very rare endemic confined to the sand dunes of the northern region of Fuerteventura. The same chromosome number was reported by BORGEN (1970) under the name *A. fuerteventurae*.

Dicotyledoneae

BORAGINACEAE

Echium giganteum L. *fil.* — 2n=16 (Fig. 1 F).

Seed collection: Tenerife, San Jose. 4-1969 D. BRAMWELL.

This confirms the somatic chromosome number reported by MICHAELIS (1964) and BORGEN (1970). Satellites were observed by us on two chromosomes.

Echium leucophaeum WEBB ex SPRAGUE & HUTCHINSON — 2n=16 (Fig. 1 G).

Seed collection: Tenerife, Valle de San Andrés. 11-1968 D. BRAMWELL.

This species only occurs in the Anaga region of Tenerife and was previously unknown cytologically.

Echium simplex DC. — 2n=16 (Fig. 1 H).

Seed collection: Tenerife, Bajamar. 6-1969 D. BRAMWELL.

E. simplex is a monocarpic rosette plant found only on coastal cliffs between Bajamar and Taganana on the north-east coast of Tenerife. This is the first report of its chromosome number.

Echium strictum L. fil. — 2n=16 (Fig. 1 I).

Seed collection: Tenerife, Cruz de Taganana. 6-1969 D. BRAMWELL.

The same chromosome number is recorded for material from Gran Canaria and Tenerife by BORGEN (1969), LARSEN (1960) and MICHAELIS (1964). This is the most widespread species of the genus in the Canaries.

Echium strictum L. fil. subsp. *exasperatum* (WEBB) BRAMWELL. — n=8 (Fig. 1 J).

Seed collection: Tenerife, Teno. 7-1969 D. BRAMWELL.

This subspecies, known only from the area west of Buenavista on the north coast of Tenerife, has not previously been studied cytologically.

COMPOSITAE

Centaurea arguta NEES — 2n=30+1 (Fig. 1 M).

Seed collection: Tenerife, Montaña de Diego Hernadez. 7-1969 D. BRAMWELL.

LARSEN (1960) and MICHAELIS (1964) report 2n=30 for this species but in our

Fig. 1.

material we have observed in addition a supernumerary chromosome; such supernumerary chromosomes are well known in the genus (Fröst 1954).

Centaurea tagananensis Svent. — 2n=45 (Fig. 1 N).

Seed collection: Tenerife, Roque las Animas, Taganana. 8-1969 D. Bramwell.

This very rare endemic species occurs only on basalt cliffs near Taganana on the north coast of Tenerife. It is a member of the Macaronesian section *Cheirolophus* and the chromosome number 2n=45, though previously recorded in the genus, is new for this section.

Centaurea webbiana Sch. Bip. — 2n=32 (Fig. 1 L).

Spontaneous material received from the Orotava Botanic Garden originating from Tenerife, El Guincho.

This rare endemic species from the north coast of Tenerife is found in the region between Puerto de la Cruz and Icod. It is a member of the section *Cheirolophus* and was previously uninvestigated. The same chromosome number has been recorded in other members of the section, e.g. *C. arbutifolia* Svent. (Borgen 1969).

Argyranthemum foeniculaceum Webb — n=9 (Fig. 2 D).

Spontaneous material received from Orotava Botanic Garden originating from Tamaimo, Tenerife.

This species is found only in the subalpine zone of the south-west region of Tenerife. Our findings confirm previous work by Harling (1951), Larsen (1960) and Borgen (1969).

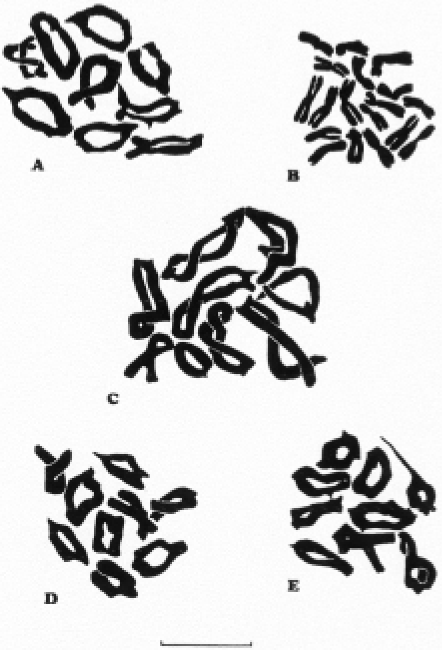

Fig. 2. First meiotic metaphase (A, C—E) and mitotic chromosomes (B) of A: *Argyranthemum grandiflorum*, B: *A. canariense*, C: *A. anethifolium*, D: *A. foeniculaceum*, E: *A. callichrysum* — Scale 1 μ.

Argyranthemum frutescens (L.) Sch. Bip. var. *frutescens* — n=9 (Fig. 3 F).

Spontaneous material from Orotava Botanic Garden originating from San Filipe, Tenerife.

This confirms previous counts of n=9 and 2n=18 by Larsen (1960).

Argyranthemum frutescens (L.) Sch. Bip. var. *crithmifolium* (Link) Pitard — n=9 (Fig. 3 D).

Spontaneous material from Orotava Botanic Garden originating from Sta. Ursula, Tenerife.

Fig. 1. Mitotic chromosomes (A—I, K—N) and first meiotic metaphase (J) of A: *Pancratium canariense*, B: *Androcymbium psammophilum*, C: *Briza media*, D: *B. maxima*, E: *Iris foetidissima*, F: *Echium giganteum*, G: *E. leucophaeum*, H: *E. simplex*, I: *E. strictum*, J: *E. strictum* ssp. *exasperatum*, K: *Sideritis gomerae*, L: *Centaurea webbiana*, M: *C. arguta*, N: *C. tagananensis*. — Scale 1 μ.

Fig. 3. A: Mitotic chromosomes (A) and first meiotic metaphase (B—F) of A: *Argyranthemum haouarytheum*, B: *A. haouarytheum*, C: *Chrysanthemum coronarium*, D: *Argyranthemum frutescens* var. *crithmifolium*, E: *A. frutescens* var. *gracilescens*, F: *A. frutescens* var. *frutescens*. — Scale 1 μ.

Normal meiosis occurred in 90 % of cells examined while the remaining 10 % showed a single quadrivalent and seven bivalents. The quadrivalent appeared as a ring or chain. LARSEN (1960) and BORGEN (1969) report n=9 and 2n=18 for this variety.

Argyranthemum frutescens SCH. BIP. var. *gracilescens* (CHRIST.) HUMPHRIES — n=9 (Fig. 3 E).

Seed collection: Tenerife, Candelaria. 11-1968 D. BRAMWELL.

The only pervious record for this species is a somatic count of 2n=18 by BORGEN (1969).

Argyranthemum anethifolium WEBB — n=9 (Fig. 2 C).

Seed collection: Tenerife, Cañada del Portillo. 10-1968 D. BRAMWELL.

HARLING (1951) and LINDER and LAMBERT (1965) have previously recorded n=9 and LARSEN (1960) and BORGEN (1969, 1970) 2n=18.

Argyranthemum callichrysum (SVENT.) HUMPHRIES — n=9 (Fig. 2 E).

Seed collection: Gomera, Roque de Agando. 6-1969 D. BRAMWELL.

The chromosome number of this rare Gomeran endemic was previously unreported.

Argyranthemum canariense (SCH. BIP.) HUMPHRIES — 2n=18 (Fig. 2 B).

Seed received from Hortus "Llano de la Piedra", Gran Canaria.

LARSEN (1960) and BORGEN (1969) both report 2n=18.

Argyranthemum grandiflorum (WILLD.) HUMPHRIES (syn. *Chrysanthemum coronopifolium* STEUD.) — n=9 (Fig. 2 A).

Seed collection: Tenerife, Buenavista. 6-1969 D. BRAMWELL.

A somatic count of 2n=18 is reported by LARSEN (1960) for *C. coronopifolium*.

Argyranthemum haouarytheum BRAMWELL & HUMPHRIES — 2n=18, n=9 (Fig. 3 B).

Seed collection: La Palma, Casa de la Cumbrecita. 6-1969 D. BRAMWELL.

This species was previously unknown cytologically.

Chrysanthemum coronarium L. — n=9 (Fig. 3 C).

Seed received from Oslo Botanic Garden, Norway; originating from Lanzarote, Arieta.

15 % of cells examined showed a single quadrivalent and seven bivalents.

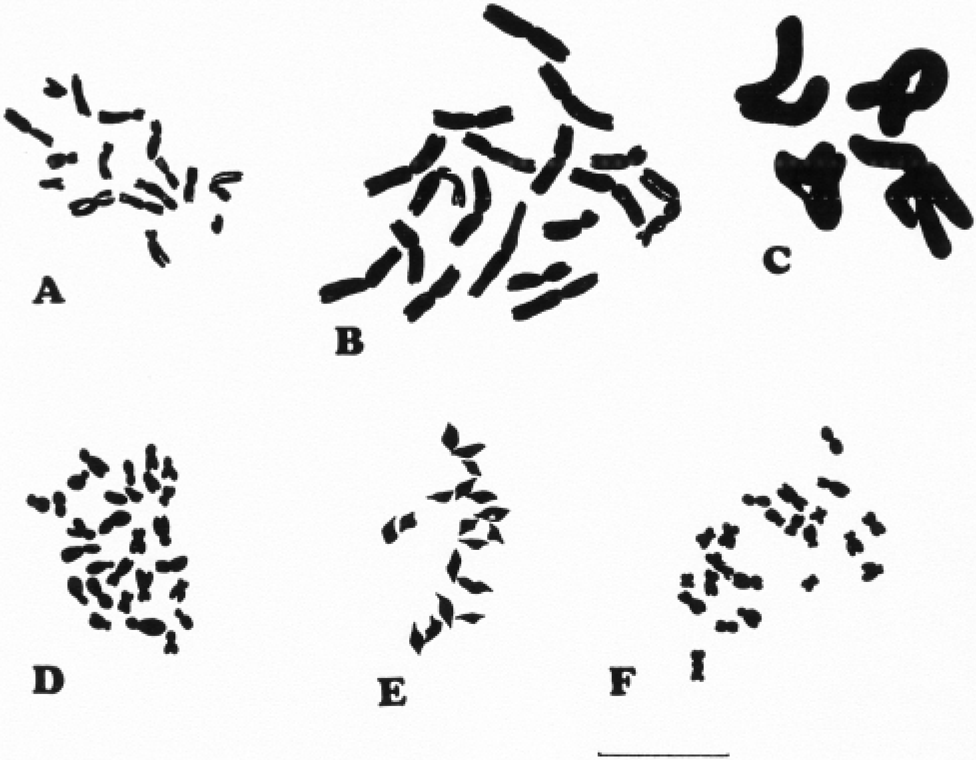

Fig. 4. Mitotic chromosomes (A, B, D, F) and first meiotic metaphase (C, E) of A: *Vieraea laevigata*, B: *Gonospermum gomerae*, C: *Crepis canariensis*, D: *Lotus emeroides*, E: *Ruta oreojasme*, F: *Todaroa aurea*. — Scale 1 μ.

Crepis canariensis (Sch. Bip.) Babc. (syn. *C. lowei* Sch. Bip. var. *canariensis* Sch. Bip.) — n=4 (Fig. 4 C).

Spontaneous material from Orotava Botanic Garden originating from Lanzarote, Famara.

This species is endemic to the eastern Canary Islands and the somatic number 2n=8 has also been recorded by Babcock and Cameron (1934), Babcock and Jenkins (1943) and Borgen (1970).

Gonospermum gomerae Bolle — 2n=18 (Fig. 4 B).

Seed collection: Gomera, Roque Carno, Vallehermoso, 6-1969 D. Bramwell.

This endemic species, of the upper xerophytic zone, has been investigated by Larsen (1963) and Borgen (1969) who report the same number.

Vieraea laevigata Webb — 2n=16 (Fig. 4 A).

Seed collection: Tenerife, Punta de Teno, 7-1969 D. Bramwell.

Vieraea Webb is an endemic, monotypic genus of the tribe Inuleae found only in the north-west region of Tenerife. The genus is related to *Jasonia* and *Pulicaria* and the same chromosome number, 2n=16, is frequent in the latter genus. It is a succulent-leaved shrub which grows as a chasmophyte in crevices on basalt cliffs between 50 and 400 metres. The genus was previously uninvestigated cytologically.

LABIATAE

Sideritis gomerae De Noe — 2n=16 (Fig. 1 K).

Seed collection: Gomera, Bco. la Villa. 6-1969 D. Bramwell.

Of eighteen species of *Sideritis* from the Canary Islands the chromosome number of only one, *S. soluta* Webb 2n=36, (Larsen 1960), is known.

LEGUMINOSAE

Lotus emeroides Murray (syn. *L. borzii* Pitard) — 2n=28 (Fig. 4 D).

Seed collection: Gomera, Cerco de Armas. 6-1969 D. Bramwell.

This confirms previous counts of this Gomeran endemic (Larsen 1958, 1960; Grant 1965; Borgen 1970).

RUTACEAE

Ruta oreojasme Webb — n=18 (Fig. 4 E).

Seed collection: Gran Canaria, Valle de Fataga. 3-1969 D. Bramwell.

Three species of *Ruta* are endemic to the Canary Islands but none of them has previously been investigated cytologically. *Ruta oreojasme* is confined to the island of Gran Canaria, where it occurs as a cliff plant in the dry southern region.

UMBELLIFERAE

Todoroa aurea Parl. — 2n=22 (Fig. 4 F).

Seed collection: Tenerife, Punta de Teno. 4-1969 D. Bramwell.

The same chromosome number is recorded for *T. montana*, the only other Canarian species of this genus (Larsen 1960).

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Chromosome Numbers in the South African Genus Aspalathus L. (Fabaceae)

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ABSTRACT

Dahlgren, R. 1971. Chromosome numbers in the South African genus Aspalathus L. (Fabaceae). — Bot. Notiser 124: 383—398.

Chromosome counts have been made for 149 taxa among 133 species of *Aspalathus* L., which constitutes about half of the total number of species known. The commonest chromosome number in the genus is 2n=18, which was found in all but 17 species. In 15 species the number was found to be 2n=16 or ca. 16 and in 2 species 2n=14. In one species, *A. uniflora*, one of the subspecies proved to have 2n=14 and the other 2n=16; promotion to species rank may be necessary. In a couple of species the chromosome number is probably 2n=20, but no certain counts above 2n=18 were obtained. The number 2n=18 is probably the original one in the genus, and is found also in related genera. The numbers lower than 2n=18 are scattered within *Aspalathus* and species with these numbers have probably evolved along several different lines.

INTRODUCTION

The genus *Aspalathus* L. is endemic in the Cape Province and Natal, South Africa. It has been monographically treated in a number of papers in Opera Botanica and this series.

Chromosome numbers for 61 taxa of *Aspalathus* have been given previously in Dahlgren 1963, 1967 a and b, and 1968 a, b, and c.

In the present survey chromosome numbers are given for 149 taxa (133 species). All chromosome slides of *Aspalathus*, including those studied previously and published in the mentioned works, have been examined in order to obtain as much information as possible on the chromosome numbers in the genus. Some of the previous statements (for *A. abietina*, *capensis* and *nudiflora*) published have been specified or changed here as a result of ampler material.

MATERIAL AND METHODS

The investigations have been made mainly on two series of cultivations, A and D.

Series A was investigated in South Africa between August 1965 and March 1966. It is the largest and consisted of 294 numbered collections of seedlings or young plants selected from plants growing under identifiable adult shrubs of *Aspalathus* species. Plants were only collected when there were no doubts about their connection with the adult specimens, branches of which were usually collected and pressed for use as voucher specimens. The seedlings were dug up carefully together with the soil without serious harm to the root system and put direct into pots. They were taken by van to the nursery of the National Botanic Gardens, Kirstenbosch, were they were placed under the management of competent gardeners.

The plants were individually watered and kept in semi-shade in the open. Repeated control of the absence of weeds was made. Root-tip fixations with Navashin-Karpechenko fixative were carried out in the early morning hours, the young plants having been relatively cool during the night. The tempera-

Table 1. Chromosome numbers in *Aspalathus*. (D. & S. = DAHLGREN & STRID; D. & P. = DAHLGREN & PETERSON). Asterisk indicates illustration, Fig. 1.

Taxon	Voucher	Code no.	Collecting site	2n=	Previous record in DAHLGREN
A. abietina THUNB.	D. & S. 3594	A 117*	Paarl Div.: 6 miles W of French Hoek	14	1968 a p. 185
A. acanthes ECKL. & ZEYH.	D. & S. 4638	A 286	Riversdale Div.: 2 miles SSW of Muis Kraal	18	
A. acanthiloba R. DAHLGR.	D. & S. 3312	A 80	Caledon Div.: Pass to Stenbras Water Works	18	
A. acanthoclada R. DAHLGR.	D. & S. 4950	D 3	Worcester Div.: 3 miles W of Worcester	18	
A. acanthophylla ECKL. & ZEYH.	D. & S. 4246	A 203	Malmesbury Div.: 5—10 miles S of Malmesbury	18	
	D. & S. 4954	D 4	Bellville Div.: Cape Flats 4 miles E of Ascot	18	
A. aciloba R. DAHLGR.	D. & S. 4179	A 188	Bredasdorp Div.: 2 miles NE of Bredasdorp	18—20	1968 a p. 45
A. aculeata THUNB.	D. & S. 3363	A 89*	Paarl Div.: 7 miles ENE of Fisantekraal Stn.	18	
A. acuminata LAM. ssp. *acuminata*	D. & S. 2876	A 39	Mossel Bay Div.: 8 miles NNW of Hartenbosstrand	18	
	—	A 65	Worcester Div.: Du Toit's Kloof	18	1968 a p. 227
	D. & S. 3271	A 77	Clanwilliam Div.: 15 miles S of Clanwilliam	18	
	D. & S. 4310	A 224	Somerset W Div.: 1 mile W of Gordon's Bay	18	
	D. & S. 4463	A 263	Clanwilliam Div.: 4 miles NE of Clanwilliam	18	
	D. & S. 4464	A 264	Clanwilliam Div.: Pakhuis Pass, E of Klein Kliphuis	18	1968 a p. 227
ssp. *pungens* (THUNB.) R. DAHLGR.	D. & S. 3978	A 145	Tulbagh Div.: Near Romans River	18	1968 a p. 233
ssp. *pungens* (THUNB.) R. DAHLGR.	D. & S. 3849	A 131	Clanwilliam Div.: Top of Grey's Pass, E side	18	1968 a p. 229
	D. & S. 4958	D 8	Malmesbury Div.: Mamre Hills W of Papkuilsfontein	18	1968 a p. 229
A. acutiflora R. DAHLGR.	D. & S. 4627	A 284	Riversdale Div.: 3 miles N of Blombos	18	1968 a p. 59
A. albens L.	D. & S. 4331	A 231	Malmesbury Div.: Just E of Mamre	18	1968 a p. 25
	D. & S. 4331	D 11	Malmesbury Div.: Just E of Mamre	18	
A. alopecurus BURCH. ex BENTH.	D. & S. 4663	A 292	Knysna Div.: Hills at Brenton, opposite Knysna	18	
A. alpestris (BENTH.) R. DAHLGR.	D. & S. 4177	A 186	Caledon Div.: 14 miles WNW of Napier	18	1968 c pp. 44—45
	D. & S. 4870	D 12	Uniondale Div.: 10 miles SW of Uniondale	18	
A. angustifolia (LAM.) R. DAHLGR. ssp. *angustifolia*	D. & S. 4219	A 195	Caledon Div.: Base of Pilaarkop, Riversonderend Mts.	18	
	D. & S. 4304	A 220	Swellendam Div.: Near Strawberry Hill Forest Stn.	18	1968 c p. 77
A. araneosa L.	D. & S. 3443	A 101	Paarl Div.: 2 miles E of Suider Paarl	18	
A. arenaria R. DAHLGR.	D. & S. 2324	D 14	Riversdale Div.: 2 miles W of Still Bay Bridge	18	

A. *arenaria* R. Dahlgr.	—	A 282	Riversdale Div.: 3 miles W of Still Bay Bridge	18		
A. *arida* E. Mey. ssp. *arida*	D. & S. 4002	A 151*	Caledon Div.: Villiersdorp region, 1 mile NE of Rusfontein	14		
ssp. *erecta* (E. Mey.) R. Dahlgr.	D. & S. 4455	A 261	Clanwilliam Div.: 8 miles NNW of Clanwilliam	14		
ssp. *procumbens* (E. Mey.) R. Dahlgr.	D. & S. 3444	A 102	Paarl Div.: Bottom of Du Toit's Kloof, W side	14		
	D. & S. 4938	A 248	Caledon Div.: 6 miles SSW of Villersdorp	14		
A. *aristata* Compt.	D. & S. 4439	A 255	Clanwilliam Div.: Top of Cederberg Pass, E of Algeria	16	1968 a	p. 149
A. *aristifolia* R. Dahlgr.	D. & S. 3841	A 128	Clanwilliam Div.: 10 miles N of Citrusdal	18	1968 a	p. 205
A. *aspalathoides* (L.) R. Dahlgr.	—	A 86*	Caledon Div.: NE of Little Hangklip Mt.	16		
	D. & S. 4924	D 16	Bredasdorp Div.: 7 miles WNW of Elim	16		
A. *asparagoides* L. fil. ssp. *asparagoides*	D. & S. 4221	A 198*	Caledon Div.: Base of Pilaarkop, Riversonderend Mts.	18		
A. *astroites* L.	D. & S. 3441	A 99	Cape Peninsula: Spontaneous at Kirstenbosch	18	1968 a	p. 177
A. *barbigera* R. Dahlgr.	D. & S. 4182	A 189	Bredasdorp Div.: 2 miles E of Kathoek	18	1967 a	p. 31
A. *biflora* E. Mey. ssp. *longicarpa* R. Dahlgr.	D. & S. 4662	A 291	Knysna Div.: Brenton, opposite Knysna	18	1968 a	p. 279
A. *bracteata* Thunb.	D. & S. 4397	A 243	Ceres Div.: 2 miles SW of the top of Gydo Pass	18		
A. *calcarata* Harv.	D. & S. 4560	A 274*	Swellendam Div.: Bontbok National Park	16		
A. *caledonensis* R. Dahlgr.	—	A 6	Caledon Div.: Top of Houw Hoek Pass	18		
	D. & S. 4534	D 20	Bredasdorp Div.: S side of Soetanysberg, near top	18		
A. *callosa* L.	D. & S. 3721	A 120	Caledon Div.: N of Hawston	18		
	D. & S. 4035	A 154	Caledon Div.: Betty's Bay	18		
A. *candicans* Ait.	D. & P. 1828	B	Worcester Div.: E of Worcester on road to Robertson	18	1963	p. 232
	D. & S. 4400	D 10	Robertson Div.: 3 miles S of Bonnievale	18		
	D. & S. 4949	D 22	Worcester Div.: SW outskirts of Worcester Town	18		
A. *capensis* (Walp.) R. Dahlgr.	—	B	Kirstenbosch Botanic Gardens, cultivated	18	1963	p. 231
A. *carnosa* Berg.	—	A 25	Cape Peninsula: Red Hill	18		
	D. & S. 3572	A 113	Caledon Div.: 1 mile E of Betty's Bay	18		
	D. & S. 4056	A 158	Cape Peninsula: 1/2 mile NE of Cirkels Vlei	18		
A. *cephalotes* Thunb. ssp. *violacea* R. Dahlgr.	—	B	Cape Peninsula: Signal Hill	18	1963	p. 232
	D. & S. 3313	A 83	Caledon Div.: 2 miles NNE of Cape Hangklip	18		
	D. & S. 3447	A 104	Worcester Div.: Du Toit's Kloof, 1 mile E of tunnel	18		

Taxon	Voucher	Code no.	Collecting site	2n =	Previous record in Dahlgren
A. cephalotes Thunb. ssp. *violacea* R. Dahlgr.	D. & S. 4094	A 164	Stellenbosch Div.: Jonkershoek Valley, central part	18	
A. chenopoda L. ssp. *chenopoda*	—	B	Cape Peninsula: Muizenberg Mt.	18	1963 p. 231
A. chortophila Eckl. & Zeyh. ssp. *kougaënsis* R. Dahlgr.	D. & S. 3025	A 45	Humansdorp Div.: 21 miles E of Joubertina	18	
A. chrysantha R. Dahlgr.	D. & S. 4253	A 206	Piketberg Div.: Near top of Versfeld Pass	16	1968 a p. 129
A. ciliaris L.	D. & S. 2874	A 37	Mossel Bay Div.: 8 miles NNW of Hartenbosstrand	18	
	D. & S. 3315	A 84	Caledon Div.: 2 miles NNE of Cape Hangklip	18	
	D. & S. 4116	A 167	Worcester Div.: E part of Bain's Kloof	18	
	—	D 24	Bredasdorp Div.: N side of Soetanysberg	18	
A. cinerascens E. Mey.	D. & S. 3095	A 52	Albany Div.: 16 miles E of Grahamstown	18	1968 a p. 65
A. compacta R. Dahlgr.	D. & S. 4132	A 176	Ceres Div.: Gydo Pass, upper part	18	1968 c p. 41
A. cordata (L.) R. Dahlgr.	—	A 82	Caledon Div.: 2 miles NNE of Cape Hangklip	18	
	—	D 85	Cape Peninsula: Spontaneous at Kirstenbosch	18	1968 c p. 79
	D. & S. 3439	A 97	Cape Peninsula: Spontaneous at Kirstenbosch	18	1968 c p. 79
	D. & S. 4356	A 236	Somerset W Div.: Top of Sir Lowry's Pass	18	
A. corrudifolia Berg.	D. & S. 3979	A 146	Ceres Div.: S entrance of Mitchell's Pass	18	1968 a p. 217
A. costulata Benth.	D. & S. 4436	A 253*	Clanwilliam Div.: Plain E of Cederberg Pass	16	
A. crenata (L.) R. Dahlgr.	D. & S. 4059	A 160	Cape Peninsula: 1 mile W of Judas' Peak	18	1968 c p. 95
A. cuspidata R. Dahlgr. ssp. *humifusa* R. Dahlgr.	D. & S. 4272	A 212	Clanwilliam Div.: 1 mile W of Algeria Forest Stn.	18	1968 a p. 241
A. cymbiformis DC.	D. & S. 3591	A 114	Stellenbosch Div.: W part of Helshoogte Pass	18	
	D. & S. 3948	A 139	Stellenbosch Div.: 3 miles SSW of Stellenbosch	18	
A. cytisoides Lam.	D. & S. 3570	A 112	Caledon Div.: Viljoen's Pass	18	
A. decora R. Dahlgr.	D. & S. 3262	A 75*	Clanwilliam Div.: Base of Cederberg (Uitkyk) Pass	18	
A. desertorum Bol.	D. & S. 3985	A 148	Ceres Div.: Gydo Pass, upper part	16	
	D. & S. 3993	D 29	Ceres Div.: Gydo Pass, central part	16	
	D. & S. 4125	A 174*	Ceres Div.: Gydo Pass, central part	16	
A. dianthopora Phill.	D. & S. 4478	A 268	Clanwilliam Div.: 2 miles NNE of Pakhuis Village	16	
	D. & S. 4478	D 30*	Clanwilliam Div.: 2 miles NNE of Pakhuis Village	16	
A. diffusa Eckl. & Zeyh.	D. & S. 2291	A 11	Swellendam Div.: Tradu Pass	ca. 18	
A. divaricata Thunb. ssp. *divaricata*	D. & S. 3442	D 33	Cape Peninsula: Kirstenbosch, near Window Stream	18	

A. *divaricata* Thunb. ssp. *divaricata* ..	D. & S. 3857	A 134	Piketberg Div.: Versfeld Pass, upper part	18	
	D. & S. 4357	A 237	Somerset W Div.: Top of Sir Lowry's Pass	18	1968 a p. 263
	D. & S. 4933	D 32	Bellville Div.: 3 miles S of Tigerberg	18	1968 a pp. 260—261
ssp. *horizontalis* R. Dahlgr.	D. & S. 4247	A 204	Malmesbury Div.: 6 miles N of Malmesbury	18	1968 a p. 253
A. *ericifolia* L. ssp. *ericifolia*	D. & S. 3350	A 88	Caledon Div.: 5 miles N of Hawston	18	
	D. & S. 3436	A 95	Caledon Div.: 4 miles ESE of Grabouw	18	
	D. & S. 4044	A 155	Cape Peninsula: 2 miles SE of Simonstown	18	
	D. & S. 4358	A 238	Somerset W Div.: Top of Sir Lowry's Pass	18	
ssp. *minuta* R. Dahlgr.	D. & S. 3117	A 59	Tulbagh Div.: Nieuwe Kloof	18	
	D. & S. 3448	A 105	Worcester Div.: Du Toit's Kloof, 1 mile E of tunnel	18	
	D. & S. 4020	A 153	Paarl Div.: French Hoek Pass, W side	18	
A. *excelsa* R. Dahlgr.	D. & S. 3417	A 93	Caledon Div.: 1 1/2 miles E of Mossel River	18	
	D. & S. 3656	A 119*	Caledon Div.: Mossel River	18	
	—	A 122	Caledon Div.: Hermanus	18	
A. *filicaulis* Eckl. & Zeyh.	D. & S. 4148	A 183*	Ceres Div.: S spur of Skurfdeberg	18	
	D. & S. 4386	A 241	Ceres Div.: S spur of Skurfdeberg	18	
A. *flexuosa* Thunb.	D. & S. 2776	A 31	Malmesbury Div.: The Towers Farm, S of Darling	18	
	D. & S. 3122	A 61	Tulbagh Div.: Near Tulbagh Road (Bergville)	18	
	D. & S. 4349	D 36	Malmesbury Div.: Just outside Malmesbury, NW side	18	
	D. & S. 4399	D 37	Worcester Div.: 4 miles NW of Worcester	18	
A. *florifera* R. Dahlgr.	D. & P. 1339	B	Riversdale Div.: Garcia's Pass, S entrance	18	1963 p. 232
	D. & S. 3106	A 53	George Div.: E of George, bridge at Kaaimans River	18	
A. *forbesii* Harv.	D. & P. 1307	B	Caledon Div.: Betty's Bay, Old Whaling Stn.	18	1963 p. 232
	—	A 8	Caledon Div.: 4 miles S of Stanford	18	
		A 9	Caledon Div.: 4 miles S of Stanford	18	
	D. & S. 3933	D 39	Caledon Div.: E end of Hangklip Mt.	18	
A. *frankenioides* DC.	D. & S. 3086	A 50	Albany Div.: 1 mile W of Coldspring	18	1968 a p. 45
A. *fusca* Thunb.	D. & S. 3727	A 123	Caledon Div.: Paardeberg, 7 miles E of Stanford	18	
A. *galeata* E. Mey.	D. & S. 3850	A 132	Clanwilliam Div.: Top of Grey's Pass, E side	16	
	D. & S. 4449	D 41	Clanwilliam Div.: Near top of Grey's Pass	16	
A. *glabrescens* R. Dahlgr.	D. & S. 2943	A 42	George Div.: N entrance of Outeniqua Pass	18	
A. *globulosa* E. Mey.	D. & S. 3928	A 136	Caledon Div.: 2 1/2 miles W of Betty's Bay	18	
A. *grobleri* R. Dahlgr.	D. & S. 4191	A 191	Bredasdorp Div.: 1 mile W of Potberg Farm	18	
A. *heterophylla* L. fil. ssp. *heterophylla*	D. & S. 3842	A 129	Clanwilliam Div.: 10 miles N of Citrusdal	18	
A. *hirta* E. Mey. ssp. *hirta*	D. & S. 4894	D 45	Riversdale Div.: Just N of Garcia's Pass, Muis Kraal	18	

Taxon	Voucher	Code no.	Collecting site	2n=	Previous record in DAHLGREN
A. hirta E. MEY. ssp. *hirta*	D. & S. 4226	A 201	Swellendam Div.: Storms Vlei Kloof	ca. 18	
	D. & S. 4278	A 215	Clanwilliam Div.: Top of Niewoudt Pass, W of Algeria	ca. 20	
A. hispida THUNB. ssp. *hispida*	—	A 28	Malmesbury Div.: 3 miles S of Darling	18	
	—	A 34	Paarl Div.: 5 miles E of Simondium	18	
	D. & S. 4066	A 162	Cape Peninsula: 1 mile ESE of Scarborough	18	
	D. & S. 4307	A 221	Somerset W Div.: Gordon's Bay	18	
	D. & S. 4320	A 226	Cape Peninsula: 1 mile S of Little Lion's Head	18	
	D. & S. 4334	D 49	Malmesbury Div.: 1/2 mile NW of Mamre	18	
	D. & S. 4348	A 235	Malmesbury Div.: Just NW of Malmesbury	18	
	D. & S. 4433	A 251*	Clanwilliam Div.: Cederberg Tafelberg, S slopes near Sanddrif	18	
	D. & S. 4467	A 267	Clanwilliam Div.: Pakhuis Pass, E of Klein Kliphuis	18	
A. hystrix L. FIL.	—	A 41	George Div.: N entrance of Outeniqua Pass, Muis Kraal	18	
	D. & S. 4650	A 288	Laingsburg Div.: Anysberg, W part, N side	18	
A. incompta THUNB.	D. & S. 4294	A 219	Swellendam Div.: Just W of Storms Vlei	18	1968 a p. 53
A. incurvifolia VOG. ex WALP.	D. & P. 1326	B	Riversdale Div.: 18 miles W of Still Bay	18	1963 p. 232
	D. & S. 4683	D 50	Riversdale Div.: 9 miles W of Albertinia	18	
A. intricata COMPT. ssp. *intricata*	D. & S. 3988	A 150	Ceres Div.: Gydo Pass, upper part	ca. 16	1968 a p. 169
	D. & S. 4131	A	Ceres Div.: Gydo Pass, central part	18	
A. joubertiana ECKL. & ZEYH. ssp. *shawii* (L. BOL.) R. DAHLGR.	D. & S. 4435	A 252	Clanwilliam Div.: High plains E of Cederberg Pass	18	
A. juniperina THUNB. ssp. *juniperina* ..	D. & S. 4167	A 185	Somerset W Div.: W base of mts. between Somerset Sneeuwkop and Landdrostkop	18	1968 a p. 121
A. lanceifolia R. DAHLGR.	D. & S. 4225	A 200	Caledon Div.: Base of Pilaarkop, Riversonderend Mts.	18	1968 c p. 65
A. lanata E. MEY.	D. & S. 4257	A 207	Piketberg Div.: Near Stawelklip, Piketberg Mt.	18	
	D. & S. 4262	A 208	Clanwilliam Div.: Algeria Valley, foot of Cederberg Pass	18	
	D. & S. 4275	A 213	Clanwilliam Div.: 2 miles W of Algeria Forest Stn.	18	1967 b p. 151
A. lanifera R. DAHLGR.	—	A 250	Ceres Div.: Witzenberg Vlakte, W of Slagboom	18	1968 c p. 37
A. laricifolia BERG. ssp. *laricifolia* ..	D. & S. 4010	A 152	Paarl Div.: 1/2 mile N of top of French Hoek Pass	ca. 20	

A. laricifolia BERG. ssp. *laricifolia*	D. & S. 4166	A 184	Somerset W Div.: W base of mts. between Somerset Sneeuwkop and Landdrostkop	18	
A. leucophylla R. DAHLGR. ssp. *leucophylla*	D. & P. 1364	B	Ladismith Div.: Ca. 2 miles N of Ladismith	18	1963 p. 232;
A. linearis (BURM. FIL.) R. DAHLGR. ssp. *latipetala* R. DAHLGR.	D. & S. 4563	A 275	Swellendam Div.: Bontbok National Park	18	1968 b p. 189
ssp. *linearis*	—		Clanwilliam Tea Industry, cultivated, numerous collections, all with	18	1968 b p. 177
A. linguiloba R. DAHLGR.	D. & S. 4055	A 157	Cape Peninsula: 1/2 mile NE of Cirkels Vlei	18	
A. longifolia BENTH.	D. & S. 3972	A 143	Riversdale Div.: 1/2 mile S of Muis Kraal	18	
	D. & S. 4900	D 38	Riversdale Div.: S of Muis Kraal	18	
A. longipes HARV.	D. & S. 3499	A 111	Robertson Div.: Bushmankloof Pass, upper part	18	
	D. & S. 4553	A 273	Swellendam Div.: Bontbok National Park	18	1968 a p. 31
A. macrantha HARV.	—	A	Cape Peninsula: Wynberg Hill	16	1967 b p. 151
	—	D 53	Cape Peninsula: Wynberg Hill	16	
A. macrocarpa ECKL. & ZEYH.	D. & S. 4402	A 245*	Robertson Div.: De Hoop Farm, NE of Robertson	18	
A. marginata HARV.	D. & S. 4213	A 195*	Bredasdorp Div.: Top of hill E of Elim	16	
A. microphylla DC.	—	A 159	Cape Peninsula: 1/2 mile NE of Cirkels Vlei	18	
	D. & S. 4061	A 161	Cape Peninsula: 1 mile W of Judas' Peak	18	
	D. & S. 4566a	A 276	Swellendam Div.: Bontbok National Park	18	1968 a p. 285
A. millefolia R. DAHLGR.	D. & S. 3950	A 140	Swellendam Div.: 4 miles E of Swellendam	18	
A. muraltioides ECKL. & ZEYH.	D. & S. 3825	A 126	Paarl Div.: 3 miles N of Wellington	18	
A. nigra L.	D. & P. 1514	B	Uniondale Div.: 6 miles E of Joubertina	18	1963 p. 232
	D. & S. 4123	A 172	Ceres Div.: Gydo Pass, upper part	18	
	D. & S. 4222	A 199	Caledon Div.: Base of Pilaarkop, Riversonderend Mts.	18	
A. nivea THUNB.	D. & S. 3043	A 46	Humansdorp Div.: 11 miles NNE of Humansdorp	18	
	D. & S. 4815	D 56	Port Elizabeth Div.: Thornhill. 5 miles from Gamtoos River bridge	18	1968 a pp. 76—77
A. nudiflora HARV.	D. & S. 4127	A 175	Ceres Div.: Gydo Pass, central part	18	1968 c p. 105
A. oblongifolia R. DAHLGR.	D. & S. 3939	A 138	Caledon Div.: S part of "Two Sisters" near Little Hangklip	18	
A. obtusifolia R. DAHLGR.	D. & S. 4787	A	Mossel Bay Div.: 9 miles W of Mossel Bay	18	
A. opaca ECKL. & ZEYH. ssp. *opaca*	D. & S. 2993	A 43	Uniondale Div.: Prince Alfred's Pass, central part	18	
A. pachyloba BENTH. ssp. *macroclada* R. DAHLGR.	D. & S. 4228	A 202	Robertson Div.: Bushmankloof Pass	18	
	—	A 246	Robertson Div.: Top of Bushmankloof Pass	18	
A. pallidiflora R. DAHLGR.	D. & S. 2124	A 173	Ceres Div.: Gydo Pass, upper part	16, 18	

Taxon	Voucher	Code no.	Collecting site	2n=	Previous record in DAHLGREN
A. *pallescens* ECKL. & ZEYH.	D. & S. 4188	A 190	Bredasdorp Div.: Ridge 2 miles SW of Ouplaas	18	1967 a p. 31
	D. & S. 4188	D 58	Bredasdorp Div.: Ridge 2 miles SW of Ouplaas	18	
A. *parviflora* BERG.	—	A 32	Malmesbury Div.: 3 miles S of Darling	18	
A. *pedicellata* HARV.	D. & S. 4371	A 249	Ceres Div.: Witzenberg Vlakte, W of Slagboom	16	1968 a p. 141
A. *pedunculata* HOUTT.	D. & S. 2937	A 40	George Div.: 2 miles NNW of Herold	18	1968 a p. 71
A. *perfoliata* (LAM.) R. DAHLGR. ssp. *phillipsii* R. DAHLGR.	D. & S. 4441	D 59	Clanwilliam Div.: Niewoudt Pass, W of Algeria	18	1967 b p. 151
A. *perforata* (THUNB.) R. DAHLGR.	D. & S. 4220	A 197	Caledon Div.: Base of Pilaarkop, Riversonderend Mts.	18	1968 c p. 29
A. *pigmentosa* R. DAHLGR.	D. & S. 3454	A 106	Worcester Div.: E end of Du Toit's Kloof	18	
A. *pinguis* THUNB. ssp. *australis* R. DAHLGR.	D. & S. 3404	A 92	Bredasdorp Div.: Near Elim towards SE	18	
	D. & S. 4923	D 60*	Bredasdorp Div.: 2 miles NE of Bredasdorp	18	
A. *quinquefolia* L. ssp. *acocksii* R. DAHLGR.	D. & S. 4264	A 202	Clanwilliam Div.: E of top of Cederberg Pass	18	
ssp. *virgata* (THUNB.) R. DAHLGR.	D. & S. 4277	A 214	Clanwilliam Div.: Top of Niewoudt Pass, W of Algeria	18	
	D. & S. 4457	D 62*	Clanwilliam Div.: 9 miles N of Citrusdal	18	
	D. & S. 4624	A 283	Riversdale Div.: 5 miles W of Still Bay West	18	
A. *recurva* BENTH.	D. & S. 4309	A 223	Somerset W Div.: 1 mile W of Gordon's Bay	18	
A. *rectistyla* R. DAHLGR.	D. & S. 2505	A	Piketberg Div.: 11 miles NE of Piketberg Town	ca. 18	
A. *retroflexa* L. ssp. *amoena* R. DAHLGR.	D. & S. 3977	A 144	Worcester Div.: 1 mile N of Darling Bridge, Brede River	18	
ssp. *bicolor* (ECKL. & ZEYH.) R. DAHLGR.	—	A 33	Cape Peninsula: Kenilworth Race Cource	18	
	D. & S. 4931	D 64	Bellville Div.: 1 mile W of S end of Tigerberg	18	1968 a pp. 86—87
A. *rigidifolia* R. DAHLGR.	D. & S. 3474	A 108	Montagu Div.: Koghman's Kloof, central part	16	1968 a p. 143
A. *rubiginosa* R. DAHLGR.	D. & S. 3145	A 66	Worcester Div.: Du Toit's Kloof	18	
A. *rugosa* THUNB. ssp. *rugosa*	—	A 13	Worcester Div.: Bain's Kloof, NE parts	18	
	—	A 67*	Worcester Div.: 4 miles W of Rawsonville	18	

A. *rugosa* Thunb. ssp. *rugosa*	D. & S. 3455	A 107	Worcester Div.: E end of Du Toit's Kloof	18		
A. *salteri* L. Bol.	—	D 68	Cape Peninsula: Limestone rocks at Cape Maclear	18		
	D. & S. 4047	A 156	Cape Peninsula: Limestone rocks at Cape Maclear	18		
A. *sanguinea* Thunb. ssp. *sanguinea*	D. & S. 4614	A 280	Riversdale Div.: 10 miles SSE of Riversdale	18		
	D. & S. 4617	A 281	Riversdale Div.: Melkhoutfontein	18		
A. *sericea* Berg. ssp. *sericea*	D. & S. 3935	A 137*	Caledon Div.: 2 miles E of Groot Hangklip Mt.	16		
	—	D 71	Caledon Div.: N of Groot Hangklip Mt.	16		
A. *serpens* R. Dahlgr.	D. & S. 3723	A 121	Caledon Div.: Hermanus	18	1968 a	p. 271
A. *setacea* Eckl. & Zeyh.	D. & S. 3087	A 51	Albany Div.: 1 mile W of Coldspring	18		
A. *spectabilis* R. Dahlgr.	D. & P. 1438	B	Riversdale Div.; Aasvogelberg, resown second generation	18	1963	p. 231
A. *spicata* Thunb. ssp. *cliffortioides* (Bol. in Schltr) R. Dahlgr.	—	A 36	Caledon Div.: Mts. above Genadendal	18		
ssp. *neglecta* (Salter) R. Dahlgr.	D. & P. 1300	B	Somerset W Div.: Sir Lowry's Pass	18	1963	p. 232
	D. & S. 3305	A 81	Somerset W Div.: Above Gordon's Bay	18		
ssp. *spicata*	D. & S. 3117	A 60	Tulbagh Div.: Nieuwe Kloof	18		
	D. & S. 4381	A 240	Ceres Div.: Witzenberg Mts., Old Witzenberg Pass	18		
A. *spinescens* Thunb. ssp. *lepida* (E. Mey.) R. Dahlgr.	—	A 130	Clanwilliam Div.: 10 miles N of Citrusdal	18		
	—	A 216	Clanwilliam Div.: Near Citrusdal	18		
ssp. *spinescens*	D. & S. 4335	A 232	Malmesbury Div.: 1 mile N of Mamre	18		
A. *spinosa* L. ssp. *glauca* (Eckl. & Zeyh.) R. Dahlgr.	D. & S. 4410	A 247	Robertson Div.: 2 miles SE of Langvlei Lime Works	18		
ssp. *spinosa*	D. & S. 3440	A 98	Cape Peninsula: Spontaneous at Kirstenbosch	18		
	D. & S. 4311	A 225	Somerset W Div.: 1 mile W of Gordon's Bay	18		
	D. & S. 4668	A 293	Knysna Div.: Hill at Brenton, opposite Knysna	18		
	D. & S. 4802	D 74*	Albany Div.: 17 miles E of Grahamstown	18		
A. *stenophylla* Eckl. & Zeyh. ssp. *colorata* R. Dahlgr.	D. & S. 4360	A 239	Caledon Div.: 1 1/2 mile SW of Mispath, Elgin area	ca. 16		
A. *steudeliana* Brongn.	D. & S. 4545	A 272	Bredasdorp Div.: NW of Soetendalsvlei	18		
A. *submissa* R. Dahlgr.	D. & S. 2875	A 38	Mossel Bay Div.: 8 miles NNW of Hartenbosstrand	18		
	D. & S. 3373	A 90	Worcester Div.: 5 miles N of Villiersdorp	18		
A. *subulata* Thunb.	D. & S. 3425	A 94	Caledon Div.: 2 miles WNW of Caledon	18		
A. *ternata* (Thunb.) Druce	D. & S. 2769	A 27	Malmesbury Div.: 2 miles S of Mamre	18		

Taxon	Voucher	Code no.	Collecting site	2n =	Previous record in DAHLGREN
A. tridentata L. ssp. *fragilis* R. DAHLGR.	D. & S. 4437	A 254	Clanwilliam Div.: 1 mile E of top of Cederberg Pass	18	
ssp. *rotunda* R. DAHLGR	D. & S. 4293	A 217	Clanwilliam Div.: Top of Grey's Pass, E side	18	
	D. & S. 4459	D 77*	Clanwilliam Div.: 15 miles N of Citrusdal	18	
A. tuberculata VOG.	D. & S. 4394	A 242	Worcester Div.: 5 miles S of Worcester	18	
	D. & S. 4651	A 289	Laingsburg Div.: Anysberg, W part, N slopes	18	
A. tylodes ECKL. & ZEYH.	D. & S. 4095	A 165*	Bellville Div.: 1 1/2 miles E of Killarney	18	
	D. & S. 4324	A 227	Bellville Div.: 1 1/2 miles E of Killarney	18	
A. ulicina ECKL. & ZEYH. ssp. *kardouwensis* R. DAHLGR.	D. & S. 3210	A 71	Piketberg-Clanwilliam Div. border: Kardouw (=Dasklip) Pass	18	
ssp. *ulicina*	D. & S. 4147	A 182	Ceres Div.: Near Slagboom	18	1968 a pp. 198—199
A. uniflora L. ssp. *uniflora*	D. & P. 1738	B	Worcester Div.: Du Toit's Kloof 21 miles W of Worcester	14	1963 p. 232
	D. & S. 3837	A 127*	Tulbagh Div.: S of Tulbagh Road (Bergville) Stn.	14	
	D. & S. 3856	A 133	Piketberg Div.: Versfeld Pass, upper part	14	
ssp. *willdenowiana* (BENTH.) R. DAHLGR.	D. & S. 3142	A 64	Worcester Div.: Du Toit's Kloof, central part	16	
	D. & S. 3952	D 80*	Swellendam Div.: Tradu Pass	16	
	D. & S. 4418	D 81	Caledon Div.: French Hoek Pass, central part	16	1967 b p. 151
A. varians ECKL. & ZEYH. ssp. *varians*	D. & S. 3824	A 125	Paarl Div.: 3 miles N of Wellington	18	
A. villosa THUNB.	D. & S. 4136	A 178*	Ceres Div.: S spur of Skurfdeberg	18	
A. vulnerans THUNB.	D. & S. 2510	A 21	Piketberg Div.: Bottom of Grey's Pass, W side	18	
	D. & S. 4267	A 210	Clanwilliam Div.: Cederberg Pass, E of Algeria	18	1968 a p. 209
	D. & S. 4466	A 266	Clanwilliam Div.: Pakhuis Pass	18	
	D. & S. 4466	D 31	Clanwilliam Div.: Pakhuis Pass	18	
A. vulpina GARAB. ex R. DAHLGR.	D. & S. 3971	A 142*	Riversdale Div.: 1 mile S of Muis Kraal	18	
A. wurmbeana E. MEY.	—	A 256	Clanwilliam Div.: 1 mile E of Kriedouwkrans	18	
	D. & S. 4454	A 260	Clanwilliam Div.: Just E of Citrusdal	18	
A. zeyheri (HARV.) R. DAHLGR.	D. & S. 3110	A 56	Swellendam Div.: 14 miles W of Heidelberg	18	
	D. & S. 3960	A 82	Riversdale Div.: 4 miles WSW of Riversdale	18	
	D. & S. 4613	A 279*	Riversdale Div.: 3 miles SW of Riversdale	18	

ture, however, proved not always to have been low enough to produce a desirable contraction of chromosomes.

By the time of our departure from South Africa in 1966, about 135 species of *Aspalathus* were growing in the nursery gardens at Kirstenbosch. Of these many are extremely rare in nature and had previously been collected only on one or a few isolated occasions.

Series D derives from ca. 90 collections of seeds made in the field during the same period. Voucher specimens were generally collected from the same shrubs. The seeds were sown in the green-houses of the Botanical Gardens, Lund. Root-tip fixation was carried out with Navashin-Karpechenko fixative after cooling over-night at a temperature of +2°—4° C.

Besides, some not numbered seedlings were grown in South Africa. They are marked with A only. Some seed collections, marked with B, were made during a botanical tour in South Africa 1956—57. Plants from these were grown in the green-houses in Lund. Chromosome counts of them are also included here.

All the material was stained in crystal violet. In most cases repeated fixations were carried out, and more than half of the counts were made in more than one slide. There are generally 3 or more counts for each collection.

All voucher specimens are deposited in the Botanical Museum, Lund (LD).

DISCUSSION

It is apparent from the above table, that $2n=18$ is the commonest number in the genus *Aspalathus*, and that in the material studied $2n=16$ is restricted to 15 species, and $2n=14$ to 2 species. Besides, there is one species, *A. uniflora*, in which the numbers $2n=16$ and $2n=14$ were found in each of the two subspecies.

As $2n=18$ is the commonest number in *Aspalathus*. As it is also the number found in species of the related genera *Lebeckia* and *Wiborgia* (DAHLGREN 1967 b) I consider it highly probable that $x=9$ is the primary basic number in these genera. The number $2n=16$ has been found in the only species studied of *Rafnia*, a morphologically somewhat specialized genus. This number would then be secondary.

It can now be of interest to investigate the grouping of the species with $2n=16$ and $2n=14$. Generalizing broadly, they may represent one of the following alternatives, or a combination of these:

1. one or a few natural groups of species in the genus, or
2. several mutually dissimilar groups of species, or finally
3. a number of randomly distributed single species with no apparent connection with one another.

As will be apparent from the following comments, the results mainly support the second alternative.

In regard to the division of the *Aspalathus* species into subgenera and "groups" based on morphological similarity, DAHLGREN (1963) will be followed with some slight modifications.

Although several collections have been studied of some species and subspecies, there is generally only one or a few collections of each. More than one chromosome number was found only in one collection (of *A. pallidiflora* with $2n=16$ and 18). Apart from this species and apart from *A. uniflora*, where the material studied of the two subspecies have different numbers, there is no certain documentation of more than one chromosome number in any of the species. The following discussion should be judged from these premises.

Subgenus **Purpureipetala** (=the Aspalathus nigra group). All of the species studied — *A. forbesii, submissa, nigra, cephalotes,* and *barbigera* — were found to have the number $2n=18$.

Subgenus **Triplobractea** (=the A. triquetra group). Only two collections of *A. galeata* have been cytologically studied. Both were found to have $2n=16$.

Subgenus **Aspalathus.** This subgenus comprises the main part of the genus and contains numerous groups of species. Among them $2n=18$ is most frequently occurring, but 2n=16 has been found in certain species or groups of species.

The number 2n=16 was found in *A. desertorum*, which forms its own group. In the obviously interrelated A. aculeata, A. chenopoda, A. ciliaris, and A. cymbiformis groups — where the ala and carina claws are adherent to the staminal sheath and the bracts are often trifoliolate — all the species studied have the number 2n=18. This also proved to be the case in the more or less similar A. prostrata, A. pallescens, and A. asparagoides groups and also in the smaller-flowered A. parviflora and A. ericifolia groups, the latter having several common species.

A. calcarata is similar to the species of the two latter groups, but has larger fruits, prominently spur-like leaf bases, and different petal shape. The chromosome number was found to be 2n=16.

In the A. pinea group (sensu Dahlgren 1967 a), *A. uniflora* is interesting in that it was found to have two numbers, 2n=16 in 3 samples of ssp. *willdenowiana*, and 2n=14 in 3 samples of ssp. *uniflora*. The two subspecies prove to be rather distinct except for some intermediates in the northernmost parts, and it may be necessary to reconsider using the previous specific rank (i.e. as *A. uniflora* L. and *A. willdenowiana* Benth.). The cytological evidence apparently favours such treatment. The eastern forms of ssp. *willdenowiana*, which unlike the western forms lack yellow pigments in the petals and have a claw-like legume, have the same chromosome number.

A. macrocarpa and *filicaulis*, both with long, many-seeded legumes, were shown to have the number 2n=18 in spite of showing similarities in leaf as well as flower features with *A. uniflora* and *A. macrantha*, the latter having 2n=16 in the material studied.

In the many common species of the A. laricifolia group, 2n=18 is the usual number, but in *A. laricifolia* and *hirta* some slides seem to show a higher number, 2n=ca. 20, although the contraction of chromosomes in these particular cases has not been sufficient to allow a proper count to be made. In the 4 similar species of the A. longifolia group the number was found to be 2n=18.

While among the species with flat, trifoliolate leaves most species proved to have the number 2n=18, i.e. *A. vulpina, caledonensis, oblongifolia, ternata, tridentata, villosa, heterophylla, quinquefolia, rugosa* and *cytisoides*, the species of the A. stenophylla group investigated have the number 2n=16 or ca. 16. Three species of the latter group, *A. aspalathoides, stenophylla* and *marginata*, were studied. These species probably have a common origin.

A. sericea, which has flat leaves, but is widely different from the species of the A. stenophylla group, similarly proved to have 2n=16.

A. decora is similar to *A. macrantha* especially in regard to the vegetative characters, but differs in floral details and has the chromosome number 2n=18. This also applies to all the material taken

Fig. 1. Somatic metaphase plates in *Aspalathus* L. A—P with 2n=18, Q—Y with 2n=16, and Z—Ä with 2n=14. — A: *A. aculeata* (A 89). — B: *A. asparagoides* (A 198). — C: *A. decora* (A 75). — D: *A. excelsa* (A 119). — E: *A. filicaulis* (A 183). — F: *A. hispida* ssp. *hispida* (A 251). — G: *A. macrocarpa* (A 245). — H: *A. pinguis* ssp. *australis* (D 60). — I: *A. quinquefolia* ssp. *virgata* (D 62). — J: *A. rugosa* ssp. *rugosa* (A 67). — K: *A. spinosa* ssp. *spinosa* (D 74). — L: *A. tridentata* ssp. *rotunda* (D 77). — M: *A. tylodes* (A 165). — N: *A. villosa* (A 178). — O: *A. vulpina* (A 142). — P: *A. zeyheri* (A 279). — Q: *A. aspalathoides* (A 86). — R: *A. calcarata* (A 274). — S: *A. costulata* (A 253). — T: *A. desertorum* (A 174). — U: *A. dianthopora* (D 30). — V: *A. marginata* (A 195). — X: *A. sericea* ssp. *sericea* (A 157). — Y: *A. uniflora* ssp. *willdenowiana* (D 80). — Z: *A. abietina* (A 117). — Å: *A. arida* ssp. *arida* (A 151). — Ä: *A. uniflora* ssp. *uniflora* (A 127). — The scale is the same for all plates. Differences in chromosome contraction make comparison between the karyotypes irrelevant.

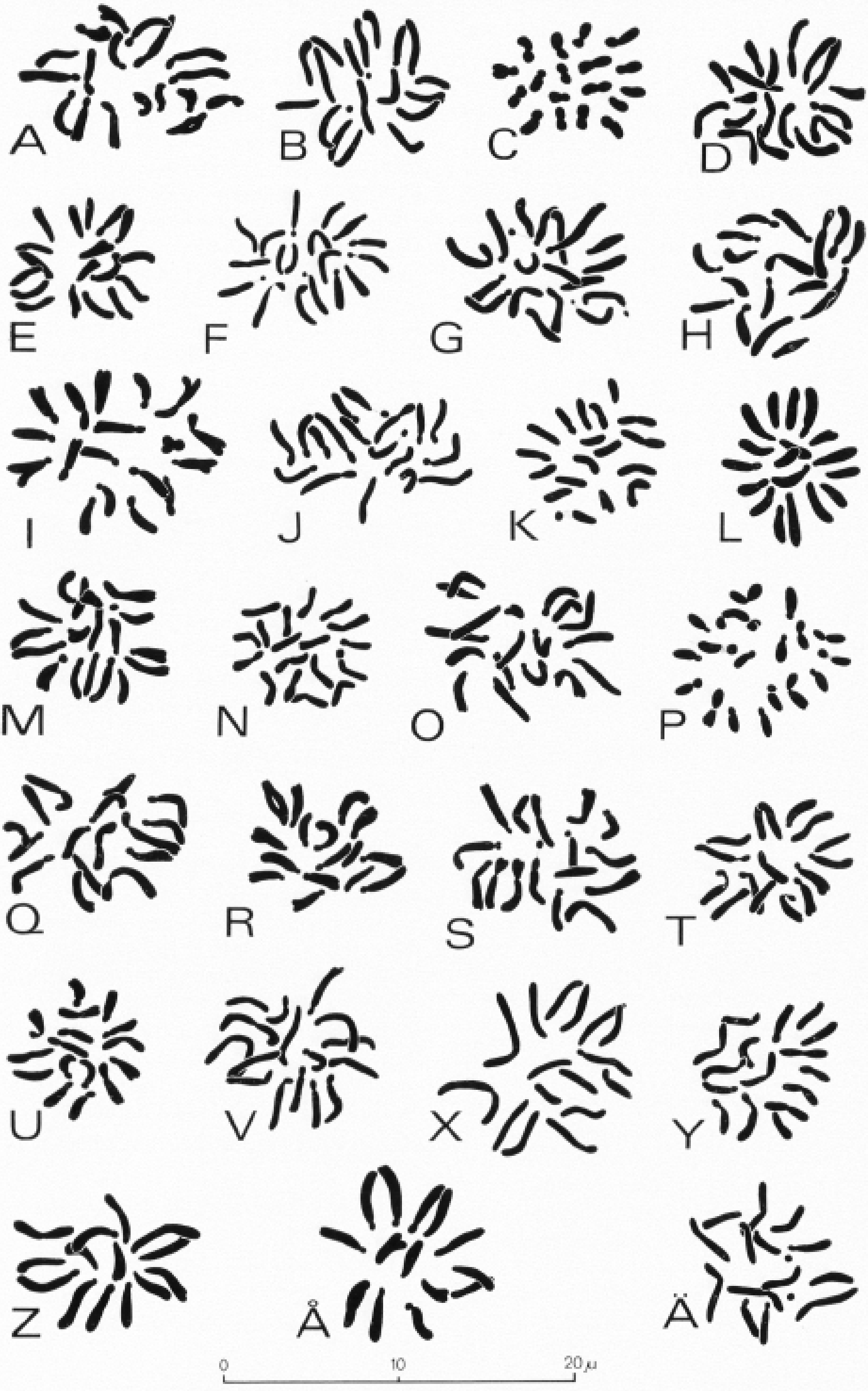

Fig. 1.

from the species of the A. carnosa group, where the bract is united with the pedicel for some distance, as it is in *A. decora*. Within the A. carnosa group, material from *A. capensis, carnosa, excelsa, fusca,* and *subulata* has been studied. Re-examination of ample material taken from *A. capensis* has given the number 2n=18, not 2n=ca. 16 as given in DAHLGREN 1963.

A. callosa and *tylodes,* forming the A. callosa group, both have 2n=18. Unfortunately the A. aciphylla group is not represented in may material. Information concerning chromosome number in this group would be of interest as the species are morphologically similar to the A. carnosa group as well as to the A. arida and A. pachyloba groups.

In *A. arida,* all three subspecies of which are represented in the investigation, the chromosome number is as low as 2n =14. (Certainly there is no close connection between *A. arida* and *A. uniflora* ssp. *uniflora,* which also has 2n=14; the karyotypes are also different.) In material taken from *A. costulata* and *pallidiflora* of the A. pachyloba group, the number found was 2n=16, although in the latter species I have also noted 2n=18. In *A. pachyloba* I found 2n=18. The chromosome number 2n=16 also occurs in *A. dianthopora,* which is similar to *A. arida* as well as to the species of the A. pachyloba group.

In the A. tuberculata, A. candicans, A. pinguis, A. spinosa, A. recurva, A. sanguinea, A. frankenioides, A. acutiflora, and A. nivea groups the chromosome numbers were invariably found to be 2n=18. This was also the case in *A. retroflexa* and *juniperina* of the A. juniperina group, but in *A. chrysantha,* a species endemic on the Piketberg and which resembles forms of *A. juniperina,* the number was unexpectedly found to be 2n=16. This is probably an isolated case of reduction in chromosome number.

In two plants of *A. abietina* studied, the chromosome number found was 2n=14. A previous count on inferior slides, 2n=18 (DAHLGREN 1968 a) has proved to be incorrect. Further studies of this species would be desirable. Possibly the species, which is at present placed next to *A. astroites* (which has 2n=18) in my revision, is more closely allied to the somewhat similar A. arida group.

Of the A. pedicellata group, all species of which have relatively large, somewhat inflated, smooth, and hard legumes, 3 species are included in the present study, all with the chromosome number 2n=16. Here, as in the A. stenophylla group, the species with this low chromosome number have probably evolved along a common line of evolution.

In all the species within the large A. divaricata group that were investigated the chromosome number has invariably been found to be 2n=18. This is also the case with the material taken from the A. bracteata and A. lanata groups and in the groups with flat simple leaves, previously treated as the genus *Borbonia.*

Subgenus **Ecklonella** (=the A. diffusa group). The single species, *A. diffusa,* is represented in the material studied. The chromosome number is approximately 2n =18.

Subgenus **Nortieria** (=the A. linearis group). Numerous plants of cultivated *A. linearis* ssp. *linearis,* the Rooibos tea plant, have been studied. All had 2n=18, as did a collection of *A. linearis* ssp. *latipetala* from the Swellendam Division.

Subgenus **Rafnioides** (=the A. nudiflora group). The single species, *A. nudiflora,* is represented in the investigation. It was shown to have 2n=18, as do most species of the genus. In DAHLGREN 1968 c the number was reported as being 2n=20 due to marked constrictions on a chromosome pair.

Within *Aspalathus* 2n=16 accordingly occurs as follows:

1. in subgenus *Triplobractea* (*A. galeata*)
2. in the A. stenophylla group
3. in *A. sericea*

4. in species of the A. pachyloba group and in *A. dianthopora*

5. in the A. pedicellata group

6. in a number of species with the leaf base prolonged into a spine or spur: *A. desertorum*, *A. calcarata* and *A. uniflora* ssp. *willdenowiana*, and in *A. macrantha*, which is similar to *A. uniflora*. It is doubtful whether these "leaf base spur species" have close evolutionary connection with one another. In other species with leaf base spines, e.g. *A. aculeata*, the chromosome number is 2n=18.

7. in the two isolated cases *A. chrysantha* and *intricata*.

The number 2n=14 occurs in the following:

1. in *A. arida*
2. in *A. abietina*
3. in *A. uniflora* ssp. *uniflora*

Of these species *A. uniflora* doubtless represents a separate line of reduction of chromosome number, whereas there is possibly a closer connection between the former two species.

GENERIC CONSIDERATIONS

Two conspicuous features can be noted in the case of *Aspalathus:*

1. total absence of polyploidy (apart from odd cases of endopolyploidy) as far as hitherto known

2. change in basic number, probably x=9 → x=8 (→ x=7), which has ocurred in several independent groups of species or in individual species.

Within Fabaceae in the narrow sense, polyploidy is rather common, and there is probably no genus of a size comparable to *Aspalathus* (and equally well known) which lacks polyploidy entirely. *Psoralea* (which is possibly heterogeneous) may represent such a case, as the only numbers known are 2n=20 and 22. Similarly *Crotalaria* commonly displays the chromosome number 2n=16, though a few species have 2n=32. In *Cytisus* the polyploid number 2n=48 dominates, and in *Ulex* the polyploidy is even more pronounced.

Aspalathus is not closely related to any of the genera mentioned. In the genera *Lebeckia* and *Wiborgia*, which are among those most closely related to *Aspalathus*, polyploidy has not been found in the (relatively small) material studied.

In spite of the probable absence of polyploidy, different populations of several species exhibit conspicuous differences in floral size — e.g. within *A. quinquefolia*, *acuminata*, *carnosa*, *aciphylla*, and *citrina*. The investigation includes examples of extremes in floral size for several such species.

Variation in the basic number as in *Aspalathus* is common in larger genera in Fabaceae. Thus in *Trifolium* x=5, 6, 7, 8, or 9, x=8 being the commonest number found, in *Medicago* x=7, 8, or 9 similarly with x=8 as the commonest number, and in *Lotus* x=6 and 7, both numbers being frequent.

In the genera of tribus Genisteae (in a wide sense) the chromosome numbers are less well known and the variation in basic number within the genera less pronounced. *Crotalaria* has almost invaribly x=8 and *Genista* x=12 (or 6). *Aspalathus* shows greater variation in basic chromosome number than do most other genera of Genisteae that have so far been cytologically investigated.

ACKNOWLEDGEMENTS

I wish to thank Professor H. B. Rycroft. and his staff at National Botanic Gardens, Kirstenbosch, among others Mr J. Marais and Mr G. Feinauer. It is thanks to their generosity and kind support that this investigation has been possible. During the work in South Africa I was fortunate to receive the Smuts Memorial Fellowship. This was of great help to me and my associate in the field, Dr A. Strid, Lund, whom I wish to thank for help and companionship. Mrs M. Petersson has kindly checked the manuscript.

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Studies in the Aegean Flora XIX

Notes on Alyssum and Some Other Genera of Cruciferae

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ABSTRACT

Persson, J. 1971. Studies in the Aegean flora XIX. Notes on Alyssum and some other genera of Cruciferae. — Bot. Notiser 124: 399—418.

Somatic chromosome numbers of 15 species of Cruciferae from the Aegean region are reported. For eight species the chromosome number have not been previously recorded. One deviates from an earlier record.

New records are: *Alyssum foliosum* Bory & Chaub. 2n=16, *Alyssum fulvescens* Sibth. & Sm. 2n=16, *Alyssum smyrnaeum* Meyer 2n=16, *Alyssum strigosum* Banks & Sol. 2n=16, *Alyssum umbellatum* Desv. 2n=16, *Alyssum siculum* Jord. 2n=48, *Cardamine graeca* L. 2n=18, *Iberis spruneri* Jord. 2n=14, *Ricotia cretica* Boiss. & Heldr. 2n=28.

Variation and taxonomy in some critical groups, especially the *Alyssum minus* complex, and *Aurinia saxatilis* are discussed.

Alyssum siculum Jord. is reestablished. It is a perfectly good species occurring in Sicily, Peloponnisos and Crete.

MATERIAL AND METHODS

The present investigation is based mainly upon material collected in Greece between 1957 and 1970 by the author and colleagues from the Department of Plant Taxonomy, Lund.

Plants were cultivated in greenhouses in the Botanical Garden, Lund. After pretreatment for about 15 hours at 2—4°C, root tips were fixed in the Svalöf modification of Navashin-Karpechenko, cut by means of microtome (sections 12 µ), and stained in crystal violet. The drawings were made with the aid of a camera lucida.

For morphologic analysis material from the following herbaria has been studied (abbreviations according to Lanjouw and Stafleu 1964): E, FI, G, LD, W and WU. I am most indebted to be directors and curators of these institutes.

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

The following abbreviations of collectors names are used: D=P. H. Davis, G—H=E. Gathorne-Hardy, N=B. Nordenstam, P=J. Persson, R=H. Runemark, S=S. Snogerup.

Alyssoides cretica (L.) Medicus

Alyssoides cretica is restricted to Crete and the Aegean islands, as shown in the distribution map in Runemark, Snogerup & Nordenstam (1960). A new locality was found in 1966 on the island of Ofidusa, west of Astipalea (R & P 22769). The species grows on precipices of hard calcareous rocks.

The chromosome number is 2n=16, which has been reported earlier by Contandriopoulos (1970). The chromosomes are rod-shaped with a length of 1.8—2.2µ and a breadth of about 0.4µ (Fig. 3 A).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Dodecanesos. Astipalea, NE of Baia di Caminacia, SW-part of Mt. Cutella (R & N 15289).

— — — S of Baia della Sabbia, 5—150 m s.m. (R & N 15106).

Alyssoides utriculata (L.) Medicus

Alyssoides utriculata is a variable species occurring in Italy, south-eastern Europe, western and northern Turkey.

The chromosome number is 2n=16, and the karyotype closely resembles that of *A. cretica*. This number has previously been reported by Contandriopoulos (1970).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Jugoslavia. Makedonija. The narrow gorge of Vardar, S of Negotino (R & S 21493).

ALYSSUM L.

Alyssum has been delimited in accordance with Dudley in his revision of the *Alyssum* species of the Orient (1964 a, 1964b, 1965a). The species investigated are all annuals, viz., *A. foliosum, A. fulvescens, A. minus, A. smyrnaeum, A. strigosum, A. umbellatum* (all belonging to sect. *Alyssum*), *A. alyssoides* (sect. *Psilonema* [Meyer] Hooker fil.), and lastly, *A. siculum,* which with respect to morphological and cytological characteristics is an intermediate between the sections mentioned.

As far as the investigated species are concerned there is a distinct difference in chromosome shape between the two sections (elliptic chromosomes in *A. alyssoides,* elliptic and rod-shaped in *A. siculum* and rod-shaped in the other species).

A detailed morphological analysis has been carried out as some of the species are difficult to delimit and extremely variable, apparently because of an almost obligate self-pollination, leading to distinguishable populations consisting of one or a few pure lines.

Alyssum foliosum Bory & Chaub.

Alyssum foliosum is a rare, polymorphic species known from about 20 localities in southern Greece, Crete, western Anatolia, Cyprus and some Aegean islands (Fig. 1). Vegetative characters like pubescense and leaf-shape are highly variable. Modificative plasticity is obviously considerable and to this an essential part of the variation can be assigned, but a high variability is shown also in non-modificative characters. In Flora of Turkey 1. Dudley (1965 b) distinguishes two varieties, viz., var. *foliosum* and var. *megalocarpum* Hal.

The given characters are:

Fruits 3—4.5 mm long and wide; racemes condensed, 1—2 cm, 10- or less -fruited .... var. *foliosum*
Fruits 5—7 mm long and wide; racemes elongated, 3—4 cm, more than 10-fruited .... var. *megalocarpum*

Of the mentioned characters, fruit-size on the whole can be relied upon as there is little variation within populations. The length of the racemes and the number of fruits are of limited value as they vary widely and cannot be correlated to fruit-size. In large-fruited populations specimens with only 5—10 fruits can be found together with many-fruited specimens, the variation apparently being due to environmental factors. In the small-fruited form, specimens with up to 20 fruits and rather long racemes occur. Furthermore there does not seem to be any correlation between fruit-size and distribution.

In the limited material available to me at a suitable stage of development, I have found the sepals of var. *megalocarpum* (4 collections) to be early deciduous. In var. *foliosum* I have noted 3 collections with persistent and 4 with deciduous sepals. There is also a considerable variation in size of petals, length and shape of the appendages of the shorter stamens (Fig. 2 A—C), length of styles, etc. This variation between material from different areas cannot be taxonomically evaluated on the limited material as yet available. However, as the species during greenhouse conditions develops more or less cleistog-

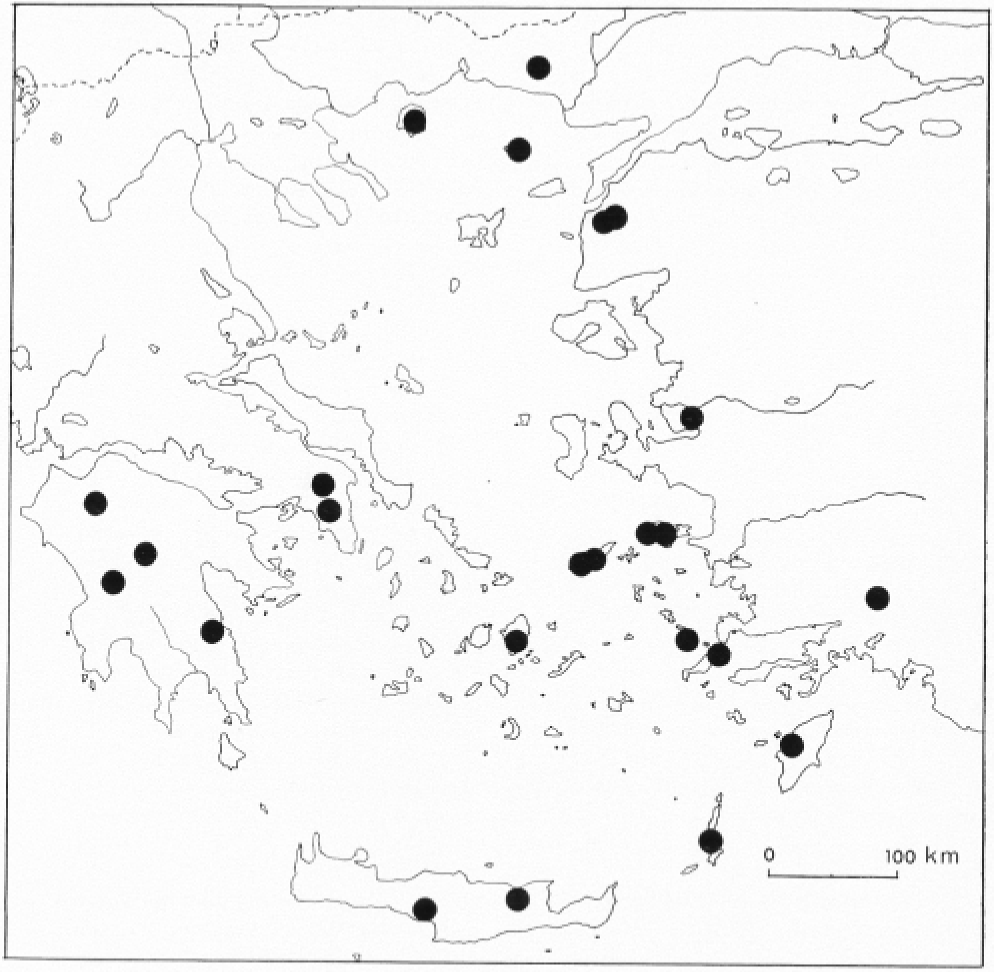


Fig. 1. Distribution of *Alyssum foliosum* according to investigated herbarium material. Outside the map *A. foliosum* is known from Cyprus.

amous flowers, a high rate of self-pollination is probable in nature too. Therefore, the variation pattern found may to a great extent have its origin in local differentiation resulting in populations consisting of pure lines.

The chromosome number is 2n = 16, and the chromosomes are rod-shaped with a length of 1.5—1.8µ and a breadth of 0.3—0.4µ (Fig. 3 B). No earlier records are known to the author.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Samos. Ikaria, 1 km SE of the peak of Mt. Melissa, 700—900 m s.m. (R & S 12637).
— — Samos, 1—3 km W of Marathokampos, 250—350 m s.m. (R & S 19172).

Alyssum fulvescens Sibth. & Sm.

Alyssum fulvescens occurs on the east Aegean islands and in western Anatolia.

A record by Sibthorp from Peloponnisos needs confirmation, as in no other case is the species known to occur west of the phytogeographical borderline between the Cyclades and the east Aegean islands (cf. Rechinger 1949). The east Aegean material is quite homogeneous and belongs to var. *fulvescens* (silicula glabrous).

The chromosome number is 2n=16, and the karyotype is closely similar to that of *A. foliosum* (Fig. 3 C). No previous records are known to the author.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Samos. Samos, 3—4 km W of Marathokampos, 350—450 m s.m. (R & S 19602).
— — — the E-promontory of Mt. Kerki, 600—800 m s.m. (R & S 19306).
— — — the E-promontory of Mt. Kerki, 800—1200 m s.m. (R & S 19370).

The Alyssum minus Complex

In the group of species which has earlier been treated by most botanists as *Alyssum campestre* sensu lato, one of the components is *A. minus* (L.) Rothm. and the rest are *A. strigosum* Banks & Sol. and *A. hirsutum* Bieb.

This group has been extensively investigated by Dudley (1964a). According to him, *A. minus* is distinguished from the other two species in having a monomorphic indumentum of the siliculae consisting of small stellate hairs, while *A. strigosum* and *A. hirsutum* have a dimorphic indumentum consisting of, in addition to stellate hairs, equally bifurcate or, in the latter case, simple sometimes unequally bifurcate hairs. *A. minus* var. *micranthum* (Meyer) Dudley has stellate fruit-hairs with unequal rays, two of which are longer and ascending, thereby appearing furcate. It might therefore be confused with *A. strigosum*. However, other characteristics, such as longer, often hairy style and the, at maturity, horizontal to ascending pedicels of *A. minus* var. *micranthum* can also be used in separating it from *A. strigosum*, which has a glabrous style and divergent-spreading pedicels. Still, on individuals without developed fruits these characters can hardly be observed. In such cases Dudley (1964 a) points to another characteristic of *A. minus*, namely a monomorphic indumentum on the pedicels, but I have found that this is not always true. In my opinion the shape and size of petals and appendages of the shorter stamens are more reliable characters. *A. minus* has petals which are entire to emarginate and gradually attenuate towards the base, and the appendages of the shorter stamens are about half as long as the filaments (Fig. 2 I). The petals of *A. strigosum* ssp. *strigosum* are emarginate and somewhat constricted at the middle, and the appendages are 3/4 to 4/5 as long as the filaments (Fig. 2 G). The third species, *A. hirsutum*, can in a similar (young) stage easily be identified by the presence of a wing-like appendage also on the longer stamens (Fig. 2 H).

Key to the species

1. Fruit indumentum monomorphic, of stellate hairs. Petals 2—3 mm long, gradually attenuate towards the base . . . . *A. minus*
1. Fruit indumentum dimorphic, of tuberculate simple or furcate, and stellate hairs. Petals somewhat constricted at the middle or more than 3 mm long.
2. Tuberculate fruit hairs simple or unequally bifurcate. All filaments with winglike appendages . . . . *A. hirsutum*
2. Tuberculate fruit hairs equally bifurcate. Long filaments wingless.
3. Sepals early deciduous. Bifurcate fruit hairs stiff, 0.4—0.8 mm long. Petals ± constricted at the middle, 2.5—3.5 mm long . . . . *A. strigosum* ssp. *strigosum*
3. Sepals persistent. Bifurcate fruit hairs ± sericeous, 0.8—1.6 mm long. Petals gradually attenuate towards the base, 3.0—4.5 mm long . . . . *A. strigosum* ssp. *cedrorum*

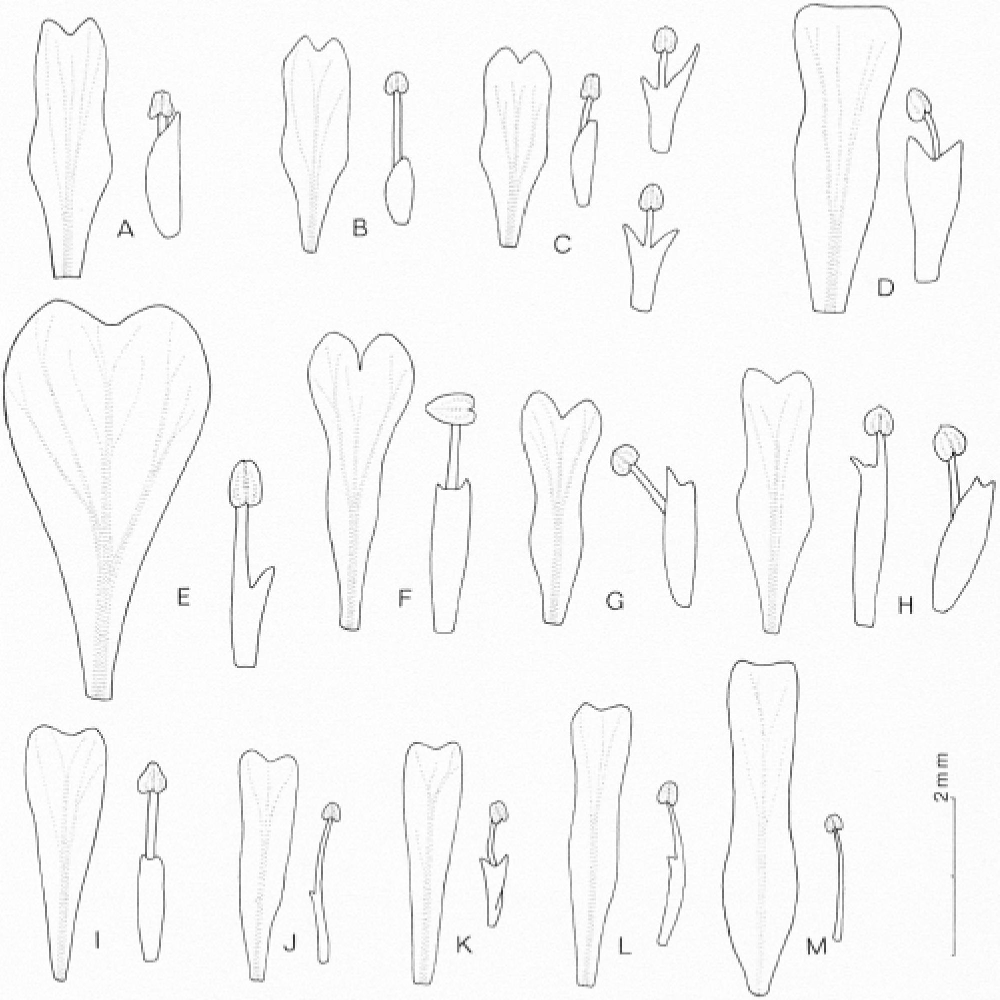


Fig. 2. Petals and short stamens. — A—C: *Alyssum foliosum*. — D: *A. smyrnaeum*. — E: *A. fulvescens*. — F: *A. strigosum* ssp. *cedrorum*, — G: *A. strigosum* ssp. *strigosum*. — H: *A. hirsutum* (also long stamen). — I: *A. minus*. — J—L: *A. siculum*. — M: *A. alyssoides*. — A: Greece, Attica, HELDREICH, 5.4. 1892. — B: Turkey, Menderes Dagh, SINTENIS 223. — C: Greece, Samos, D 1662K. — D: Gr., Naxos, R 374. — E: Gr., Kalimnos, R 19096. — F: Turkey, Mersin, D 26489. — G: Iran, Mazanderan, WENDELBO 253. — H: Turkey, Antalya, D 35262. — I: Portugal, Estremadura, DA CUNHA 1888. — J: Greece, Chelmos, HALACSY, 15.4. 1893. — K: Gr., Erimanthos, cult. P 160—1. — L: Italy, Sicily, ROSS 802. — M: Poland, Bolkenhain, SINTENIS, 28.5. 1876.

Alyssum minus (L.) ROTHM.

Alyssum minus is distributed in southern and eastern Europe, northern Africa and southwestern Asia, often as a weed.

The chromosome number is 2n = 16, agreeing with earlier reports on the chromosome number of *A. campestre* (JARETZKY 1932, MANTON 1932, GARDÉ &

Malheiros-Gardé 1953, Böcher & Larsen 1958). The karyotype is very similar to that of *A. foliosum* (Fig. 3 E).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Cyclades. Paros, 1 km N of the peak of Prof. Elias, 550 m s.m. (R & S 12726).
— — — E of the peak of Prof. Elias, 700 m s.m. (R & S 12378).
— Nom. Samos. Ikaria, 1 km N of Ag. Nikolaos, 50—150 m s.m. (R & S 6190).
— — — Ag. Nikolaos S of Evethelo, 80—120 m s.m. (R & S 6790).
— — Samos, the E-promontory of Mt. Kerki, 800—1200 m s.m. (R & S 19370).
— — — S-precipices of Mt. Kerki, N of Ag. Kiriaki (R & S 19519).
— — — 3—4 km W of Marathokampos, 350—450 m s.m. (R & S 19131).
— Nom. Lasithion (Crete). Sitia, Mt. Spathi, N—NW-slope, 850—1150 m s.m. (R & S 18304).
— — — the slope above Dri, 450—750 m s.m. (R & S 17151).
— — — the valley of Leopetra, 0—150 m s.m. (R & S 19446).
— — — 2 km S of the town of Ag. Nikolaos, 0—20 m s.m. (R & S 17486).

Alyssum smyrnaeum Meyer

Alyssum smyrnaeum occurs on the east Aegean islands, in western Turkey (also the European part) and Galatia, and has recently been collected on Crete by Greuter and the island of Naxos (Cyclades) by Runemark. (coll. nos. R 332, R 374 and R 746 mistaken for *Alyssum foliosum* in Runemark, Snogerup & Nordenstam 1960).

It is probably closely related to *A. fulvescens,* but easily distinguished by its shorter racemes, shorter styles, and by the size and shape of petals and appendages of the shorter stamens (Fig. 2 D, E).

The chromosome number is 2n=16, and the karyotype closely resembles that of *A. foliosum.* No earlier records are known to the author.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Cyclades. Naxos, W-slope of Fanari Oros, 1 km NE of Moni, 700—750 m s.m. (R & S 11947).

Alyssum strigosum Banks & Sol.

Alyssum strigosum is very similar and probably closely related to *A. minus.* It is widely distributed in southern and eastern Europe, northern Africa and the Near East eastwards to Afghanistan. Although occurring in the surrounding areas it seems to be totally lacking in the Cyclades. Dudley (1964a) has distinguished two subspecies, viz., ssp. *strigosum* and ssp. *cedrorum* (Schott & Kotschy) Dudley.

Ssp. *cedrorum* is found mainly in southern Anatolia, extending into northeastern Anatolia and Cyprus (Fig. 4). According to Dudley, "this taxon was originally thought to be a species distinct from *A. strigosum,* but the presence of a large number of intermediate specimens from Anatolia and Cyprus (mostly occurring within the range of ssp. *cedrorum*) indicates that subspecific rank is more appropriate" (Dudley 1964a). Four of the nine collections which Dudley in Flora of Turkey 1 (1965) classified as intermediates have been available to me, and I found all incorrectly determined.

The collections are:

Turkey. Prov. Tunceli. Tunceli to Pülümür, 1000 m s.m. (D 29215).
— Prov. Gaziantep. S of Kizilhisardere, 750 m s.m. (D 28008).
— Prov. Eskisehir. Sivrihisar to Eskisehir, 900 m s.m. (D 36046).
— Prov. Burdur. Yesilova to Denizli, 1100 m s.m. (D 35308).

The two first mentioned collections are quite typical *A. strigosum* ssp. *cedrorum,* and the other two are *A. hirsutum* Bieb.

However, in other material available to me (about 100 collections) a few collections, especially material from Cyprus, appeared to be intermediate between the two taxa, and this fact points to the sub-

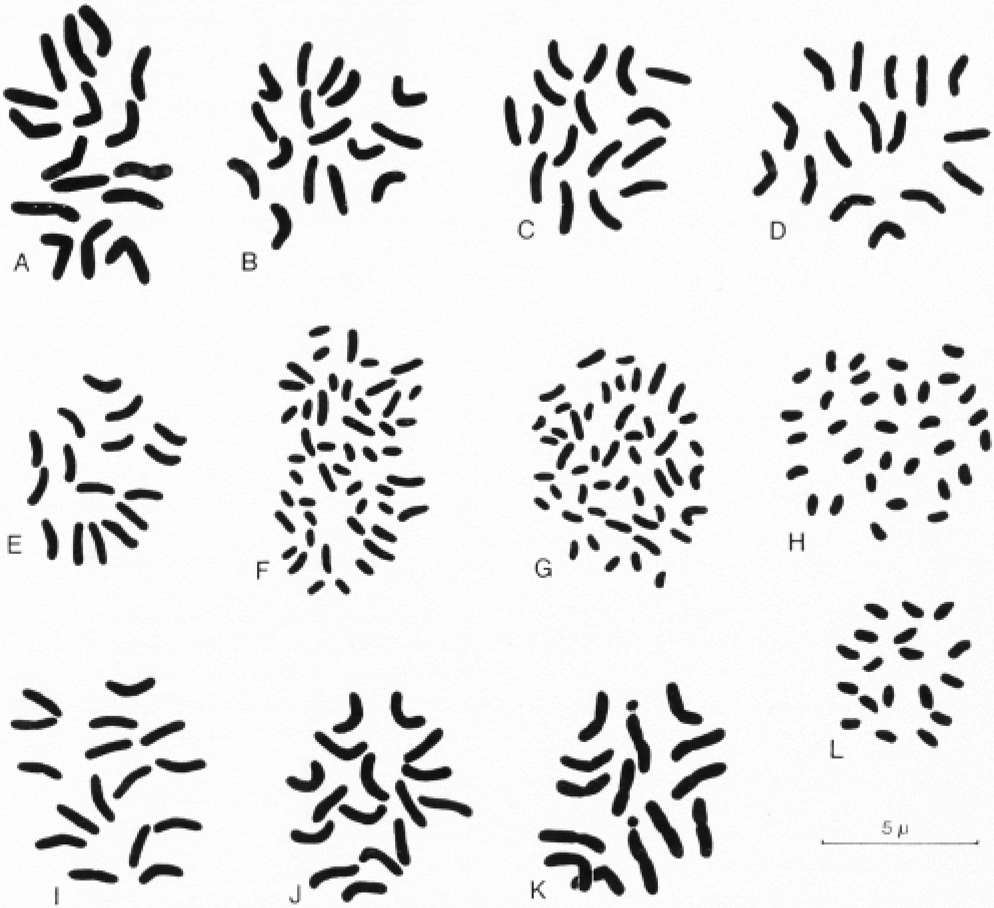


Fig. 3. Somatic metaphases in sections of root tips. — A: *Alyssoides cretica*, 2n=16. — B: *Alyssum foliosum*, 2n=16. — C: *Alyssum fulvescens*, 2n=16. — D: *Alyssum strigosum* ssp. *strigosum*, 2n=16. — E: *Alyssum minus*, 2n=16. — F—G: *Alyssum siculum* 2n=48. — H: *Alyssum alyssoides*, 2n=32. — I: *Alyssum umbellatum*, 2n=16. — J: *Aurinia saxatilis* ssp. *orientalis*, 2n=16. — K: *Iberis spruneri*, 2n=14. — L: *Cardamine graeca*, 2n=18.

specific rank as being the most appropriate (differences between the two subspecies summarized in Table. 1).

There seems to be a very high rate of self-fertilization in this species (full seed-setting on isolated specimens). This may be one of the factors that make intermediate specimens quite rare although the distribution area of ssp. *cedrorum* is completely covered by that of ssp. *strigosum*.

The chromosome number is 2n=16, and the karyotype is very similar to that of *A. foliosum* and *A. minus* (Fig. 3 D).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Ssp. *strigosum*:

Greece. Nom. Dodecanesos. Karpathos, Saria, the valley N of Ormos Armiro (R & S 7656).

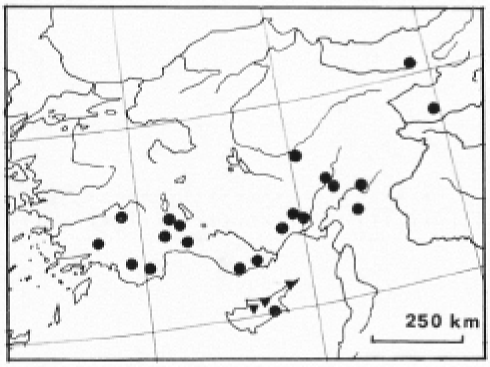


Fig. 4. Distribution of *Alyssum strigosum* ssp. *cedrorum* (dots) and intermediates between *A. strigosum* ssp. *strigosum* and ssp. *cedrorum* (triangles), according to investigated herbarium material.

Ssp. *cedrorum*:

Turkey. Prov. Burdur. Burdur—Anatalya, 5 miles from Bucak, 720 m s.m. (D 35694a).

Alyssum umbellatum Desv.

Alyssum umbellatum is a widespread species in the East Mediterranean area, where it often occurs as a weed.

The chromosome number is 2n=16, and the karyotype is very similar to that of the other investigated species of sect. *Alyssum* (Fig. 3 I). No previous records are known to the author.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Cyclades. Naxos, the slope of Fanari Oros, NE of Moni, 500 m s.m. (R & S 11956).

— — Ios, between Chora and Profitis Elias, 150—300 m s.m. (R 2370).

— Nom. Samos. Ikaria, the pass W of Mt. Melissa, 700—900 m s.m. (R & N 16326).

Alyssum alyssoides (L.) L.

Alyssum alyssoides is distributed throughout most of Europe, northern Africa, Russia and eastwards to India, mostly as an annual weed, and is also naturalized in the United States, Canada and Argentine. It seems to be absent from most of Greece, except the northernmost part of the mainland. Reports from southern Greece probably originate in confusion with *A. siculum* or *A. minus*.

The chromosome number is 2n=32, agreeing with earlier reports (Jaretzky 1928, Manton 1932, Tischler 1934, Böcher & Larsen 1958, Bonnet 1963, Mulligan 1964). The chromosomes are all of about equal size, more or less elliptical and about 0.8µ long and about 0.4µ broad (Fig. 3 H).

The chromosome number 2n=16, given by Contandriopoulos (1970) for *A. alyssoides* var. *depressum* from lowland localities on Attica and Crete, is probably due to confusion with one of the species of sect. *Alyssum*. No Greek collections of *A. alyssoides* var. *depressum* are known to me, and moreover the pollen size of the true var. *depressum* from Hungary and Romania is the same as for var. *alyssoides*, making it plausible that the former, like the latter, is tetraploid (2n=32).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Pieria. Olympos, monastery of Petras, 350—500 m s.m. (R 21374).

Alyssum siculum Jordan

Erect or decumbent annual, 2—5 (—9) cm. Indumentum of adpressed stellate hairs. Leaves obovate to linear-lanceolate. Inflorescence rarely branched. Fruiting raceme short, sometimes nearly subumbellate, 0.5—2 (—3) cm. Pedicels 1.5—3.5 mm, erectopatent. Sepals 2—2.5 mm, falling before ripening of the fruit. Petals pale yellow, ± gradually attenuate towards the base, entire to emarginate, 2—3 mm. Filaments of the shorter stamens in most cases with connate appendages. Nectaries erect, peg-like, c. 0.5 mm. Style 0.5—1 mm, glabrous or with few stellate hairs. Siliculae 3—4×3—4 mm, orbicular, with indumentum of adpressed stellate

Table 1. Differences between the two subspecies of *Alyssum strigosum*.

	ssp. *strigosum*	ssp. *cedrorum*
Size of siliculae (length) (breadth)	3.5—5.0×4.0—6.0 m=4.36 s=±0.45 n=35 m=4.53 s±0.45 n=35	4.0—5.5×4.0—5.5 m=4.66 s=±0.48 n=17 m=4.71 s=±0.47 n=17
Sepals	Early deciduous	Persistent
Petals	Emarginate, more or less constricted at the middle (Fig. 2 G).	Emarginate to biloded, gradually attenuate towards the base or somewhat constricted at the middle (Fig. 2 F).
(length)	2.4—3.3 m=2.84 s=±0.26 n=20	3.2—4.4 m=3.62 s=±0.36 n=11
Style (length)	0.5—1.2 m=0.74 s=±0.16 n=37	0.8—1.4 m=1.03 s=±0.15 n=17
Tuberculate fruithairs (length)	0.4—0.8 m=0.55 s=±0.13 n=37 Hairs stiff.	0.8—1.6 m=1.18 s=±0.22 n=15 Hairs more or less sericeous.

Measures in mm. m=mean, s=standard deviation, n=number of individuals examined.

hairs, valves equally inflated with flattened margins. Seeds 1.4—1.9 mm, narrowly winged. — Pollen-size 26—30µ. — Chromosome number 2n=48. — Flowering period: May—June.

NEOTYPE: Italy. Sicily. In arenosis montosis. Madonie. IV—VI 1913. H. Ross Herbarium Siculum No. 802, in Herb. Bot. Lund (LD).

LOCALITY LIST:

Italy. Sicily. Palermo alla Pizzuta, V 1879, Gandoger 1302 (LY). — It. Sicily. Montium Madoniarum praesertim in Pizzo Antenna, 1700—1930 m s.m. 21.7. 1874. Gabriel Strobl (BM). — It. Sicily. In arenosis montosis. Madonie. IV—VI 1913, H. Ross Herbarium Siculum 802 (LD). — Greece. Crete. Mt. Psiloriti, Hochebene Nidha, 28.V. 1904, Dörfler 774a (W). — Gr. Akhaia. Aroania, 3.5 km SSW of Zarouchla, 1700—1800 m s.m. 2.8. 1968, P 1756 (LD). — Gr. Akh. Panachaikon, 3 km E of Pournarokastron, 1300—1500 m s.m. 5.6. 1969, P 2305 (LD). — Gr. Akh. Erimanthos, 1.5 km E of Kalentsion, 1400 m s.m. 4.6. 1969, P 2176 (LD). — Gr. Akh. Erimanthos, 3 km E of Kalentsion, 1700—1875 m s.m., cult., P 160 (LD). — Gr. Argolis. Oligyrtos, 2.5 km E of Kandihla, 1500—1625 m s.m. 9.7. 1968, P 931 (LD). — Gr. Arkadia. Chelmos, 1500 m s.m. 20.6. 1893, Halácsy (LD, W). — Gr. Ark. Mainalon, 4 km NW of Kardaras, 1600—1650 m s.m. 31.5, 1969, P 2078 (LD). — Gr. Ark. Mainalon, 3 km NW of Kardaras, 1600—1700 m s.m. 3.7. 1968, P 598 (LD). — Gr. Ark. Mainalon, 5 km NW of Kardaras, 1630—1680 m s.m. 2.9. 1970, P 4110 (LD). — Gr. Ark. Parnon, Megala Tourla, 3.5. km W of Kastanitsa. 1500—1550 m s.m. 6.9. 1970, P 4192 (LD). — Gr. Elis. Astra, 2 km NW of Lambia, 1450—1550 m s.m. 24.7. 1968, P 1220 (LD). — Gr. Korinthia. Kyllene, 3 km NW of Bousion, 1600—1700 m s.m. 14.7. 1968, P 1096 (LD). — Gr. Kor. Livadaki, 2.5 km ESE of Zarouchla, 1800 m s.m., cult., P 162 (LD). — Gr. Laconia. Parnon, 4 km WNW of Kosmas, 1550—1600 m s.m. 26.6. 1968, P 264 (LD). — Gr. Lac. Parnon, 6.5 km NE of Vamvakou, 1770—1934 m s.m. 6.7. 1968, P 852 (LD). — Gr. Beotia. Parnassos. 10 km N of Arachova, 1500 m s.m. 25.7. 1971, P (LD). — Gr. Evritania. Kauki, 17 km NW of Karpenision, 1600 m s.m. 28.5. 1971, P (LD). — Gr. Phocis. 10 km N of Amfissa, 1000 m s.m, 23.5. 1971, P (LD). — Gr. Ph. Lidorikiou, 10 km SE of Lidorikion. 1500—1600 m s.m. 25.5. 1971, P (LD).

Alyssum siculum was described by Alexis Jordan (1864) using spontaneous material from Sicily in addition to progeny cultivated in France. This taxon has been neglected by most botanists or treated as a synonym for *Alyssum alyssoides* (L.) L.

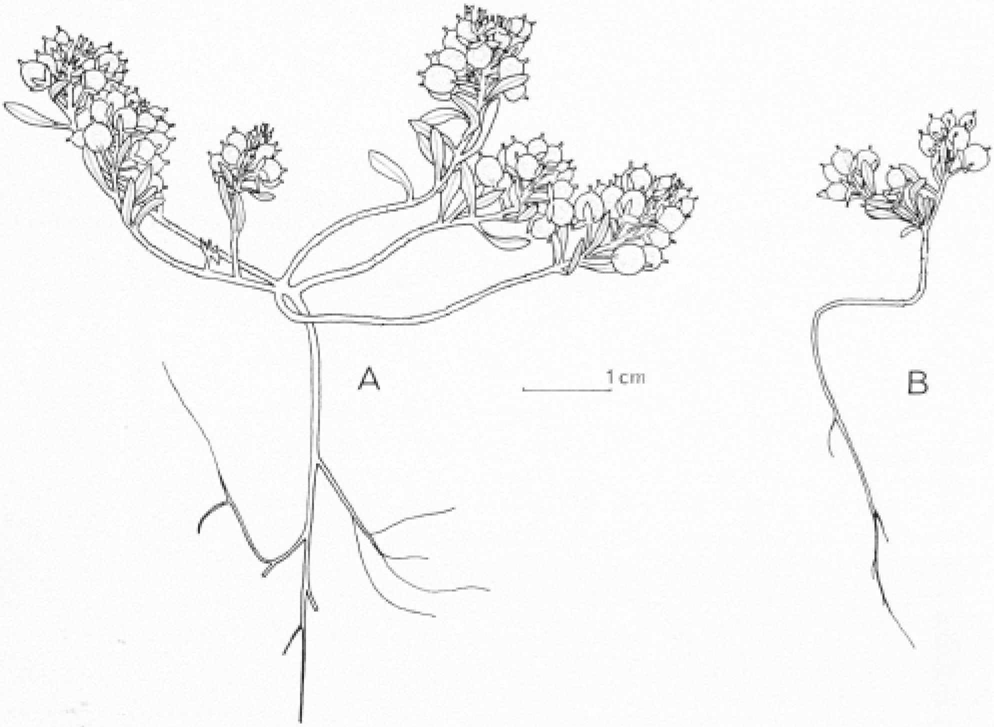


Fig. 5. Habit of *Alyssum siculum* Jord. — A: Greece, Mainalon, P 2078. — B: Gr., Parnon, P 852.

During my investigations of the mountain flora of Peloponnisos a small species of *Alyssum,* superficially similar to a dwarf *A. alyssoides* was found on most of the mountains (Fig. 5). The plant had already been collected by Halácsy on the mountain Chelmos on Peloponnisos in 1893. Due to its dwarf habit and the contracted fruiting raceme he described it as *A. calycinum* L. var. *pumilum* Halácsy (1894). However, in my opinion all characters are well in accordance with the original description of *A. siculum* by Jordan (original material or other specimens from Jordan's herbaria inquired for unsuccessfully in LY, P, K, BM). This fact, together with the occurence of other collections from Sicily (cf. locality list) which in all characters (viz., short racemes, small petals, appendages on the filaments of the shorter stamens, pollen size etc.) is very similar to the Greek material, strongly indicates that *A. calycinum* var. *pumilum* is conspecific with Jordan's taxon.

Concerning *A. alyssoides,* this taxon seems to be totally lacking on Sicily. Furthermore, the chromosome number of *A. siculum* is 2n = 48, whilst *A. alyssoides* has 2n = 32. The former species nearly always has a more or less well developed appendage on the filaments of the shorter stamens, whilst the latter always has slender, unappendaged filaments. This character is of great interest as it is a key-character for the two sections *Psilonema* (C. A. Meyer) Hook. (filaments slender, wingless, edentate and unappendaged) and *Alyssum* (filaments stouter, winged and/or dentate, and/or appendaged). *A. siculum* is obviously intermediate between the two

Table 2. Comparison between *Alyssum alyssoides*, *A. siculum* and *A. minus* in some characters.

	A. alyssoides	*A. siculum*	*A. minus*
Sepals	persistent	deciduous after some time	early deciduous
Petals	somewhat constricted below limb (Fig. 2 M), 3—5 mm	± gradually attenuate towards the base (Fig. 2 J—L), 2—3 mm	gradually attenuate towards the base (Fig. 2 I), 2—3.5 mm
Filaments of short stamens	without appendages (Fig. 2 M)	with or without appendages (Fig. 2 J—L)	with appendages (Fig. 2 I)
Nectaries	peg-like 0.6—1.0 mm	peg-like 0.3—0.6 mm	triangular 0.1 mm
Style	0.3—0.6 mm	0.5—1.0 mm	0.7—1.4 mm
Pollen-size	21.7—24.1μ	26.2—30.5μ	26.4—30.6μ
2n	32	48	16

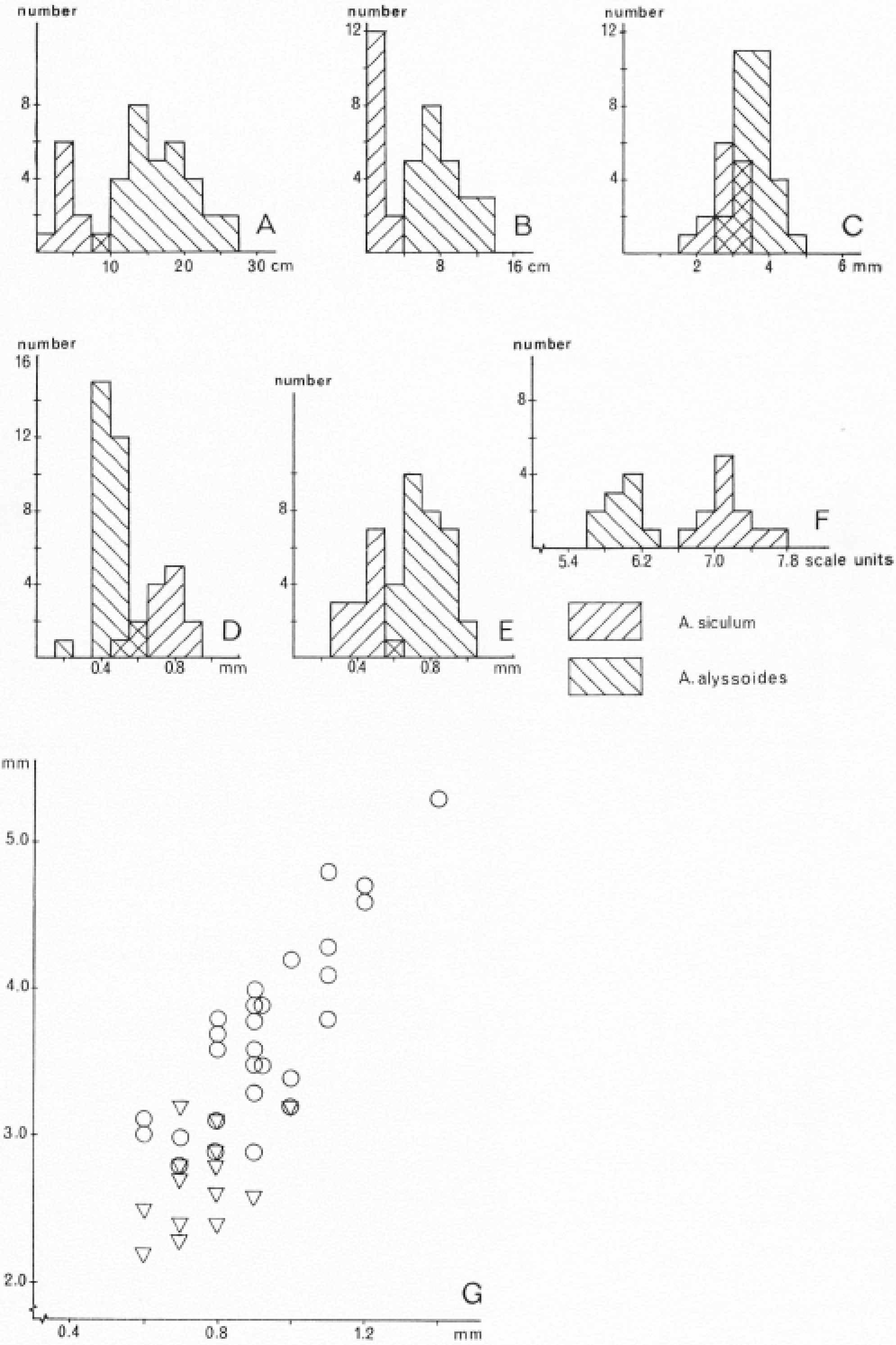
sections in this respect. In most other characters except habit it is intermediate between the tetraploid *A. alyssoides* of sect. *Psilonema* and the diploid *A. minus* of sect. *Alyssum*, both annuals (Table 2). Diagrams, showing the variation in total plant height, raceme length, pedicel length, length of nectaries, length of style, size of petals and pollen-grains of *A. siculum* and *A. alyssoides*, respectively, are given in Fig. 6. It seems quite probable that the hexaploid *A. siculum* is an allopolyploid between two species from the different sections.

In his revision of the *Alyssum* of sect. *Meniocus* and sect. *Psilonema* DUDLEY (1965) considers *Alyssum calycinum* L. var. *pumilum* HAL. to be conspecific with *Alyssum alyssoides* (L.) L. var. *depressum* (SCHUR) DUDLEY, an assumption with which I cannot agree. *Alyssum alyssoides* var. *depressum* is in my opinion only a phenotypically stable dwarf-form of *A. alyssoides* occurring on some mountains in Hungary and Romania. This is supported by similarities in floral characters and pollen size.

CYTOLOGY: While *A. alyssoides* has 32 small, more or less elliptical chromosomes (Fig. 3 H), and *A. minus* (Fig. 3 E) (and other investigated species of sect. *Alyssum*) 16 rod-shaped chromosomes of about twice the size, *A. siculum* has 48 chromosomes of varying size: c. 16 longer, rod-shaped and the rest more or less elliptical (Fig. 3 F, G). Thus, both number and morphology of the chromosomes support the theory of the latter being an allopolyploid between species from the two sections.

DISTRIBUTION AND ECOLOGY: *A. siculum* is distributed on mountains of Sicily, southern Greece and Crete (Fig. 7). On Peloponnisos it occurs on dry slopes and deserted fields on most of the mountains, mostly at altitudes from 1500 to 1800 m s.m.

VARIATION: *A. siculum* is probably to a great extent self-pollinating. The populations are rather homogeneous but variation between populations is pronounced, especially in size and shape of the appendages of the shorter stamens. In populations from Mt. Chelmos, no or only an extremely minute appendage can be found, but on all the other mountains of Peloponnisos the filament of the shorter stamens has an appendage varying from a little tooth (mt. Kyllene) to a well developed wing (Mt. Erimanthos) (Fig. 2 J—K).


number
8
4
A
10
20
30 cm
number
12
8
4
B
8
16 cm
number
12
8
4
C
2
4
6 mm
number
16
12
8
4
D
0.4
0.8
mm
number
8
4
E
0.4
0.8
mm
number
8
4
F
5.4
6.2
7.0
7.8 scale units
A. siculum
A. alyssoides
mm
5.0
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2.0
G
0.4
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1.2
mm

Fig. 6.

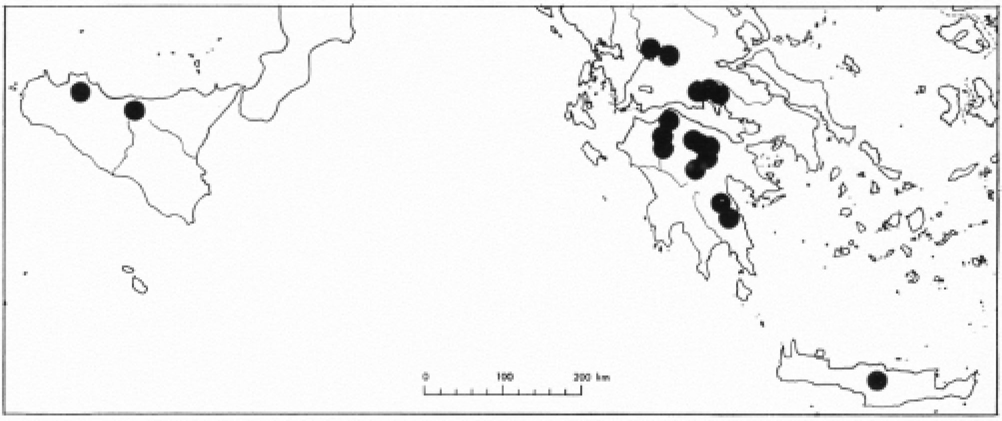

Fig. 7. The known distribution of *Alyssum siculum*.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Akhaia. Erimanthos, 3 km E of Kalentsion, 1700—1875 m s.m. (cult. P 160).
— — Chelmos, 3.5 km SSW of Zarouchla, 1700—1800 m s.m. (P 1756).
— Nom. Korinthia. Livadaki, 2.5 km ESE of Zarouchla, 1800 m s.m. (cult. P 162).
— — Kyllene, 3 km NW of Bousion, 1600—1700 m s.m. (P 1096).
— Nom. Argolis. Oligyrtos, Skiadis, 2.5 km E of Kandhila, 1500—1625 m s.m. (P 931).
— Nom. Arcadia. Mainalon, 3 km NW of Kardaras, 1600—1700 m s.m. (P 598).
— — Parnon, Megala Tourla, 6.5 km NE of Vamvakou, 1700—1934 m s.m. (P 852).

Aurinia saxatilis (L.) Desv.

Aurinia saxatilis is a strongly polymorphic species. Size, shape and pubescence of the leaves, size and shape of the siliculae, length of styles, pedicels etc. vary considerable. Due to this great variation, the taxon has often been divided into different species and subspecies. In his treatment of *Aurinia*, Dudley (1964 c) has distinguished three subspecies, viz., ssp. *saxatilis*, ssp. *orientalis* (Ard.) Dudley and ssp. *megalocarpa* (Hausskn.) Dudley. I agree with the division into three subspecies but cannot confirm the measurements which Dudley gives as a basis for separating ssp. *megalocarpa* from ssp. *orientalis* (not even on material examined by himself), nor the distribution he gives for these two subspecies. For comparision the measurements of several morphological characters according to Dudley (A) and the present author (B) are given in Table 3 (all measurements in mm).

It seems quite obvious that Dudley has overestimated the differences in length of pedicels and size of petals of the two subspecies. It is true that the mean values of ssp. *megalocarpa* are higher than those of ssp. *orientalis,* but the degree of overlapping is too high to give these characters the value of key-characters.

Fig. 6. Comparision between *Alyssum alyssoides* and *A. siculum*. — A: Total plant height. — B: Fruiting raceme length. — C: Pedicel length. — D: Style length. — E: Length of nectaries. — F: Size of pollen (breadth). One scale unit = 3.88 μ. — G: Length (vertical axis) and breadth (horizontal axis) of petals. — *A. alyssoides* (rings), *A. siculum* (triangles). Every measurement represents one individual.

Table 3. Comparison between *Au. saxatilis* ssp. *orientalis* and ssp. *megalocarpa* (cf. text, p. 411).

Ssp. *orientalis*

	A	B
siliculae	3.5—6×4—7	3.5—5.5×3.5—6.0
pedicels	4—10	5—10
styles	1—1.5	0.6—1.4
petals	3—4 (—4.5)×1.5—2	3.5—5.0×1.5—3.0
wing of seeds	0.4—0.5	0.3—0.7

Ssp. *megalocarpa*

	A	B
siliculae	6—12×8—15	6.0—9.0×6.5—10.0
pedicels	(7) 10—20	7—13
styles	(1.5) 2—2.5	1.1—2.5
petals	(4.5) 6—7×(2)2.5—3.5	4.0—6.0×2.5—3.2
wing of seeds	(0.5) 0.7—1	0.7—1.1

KEY TO THE SUBSPECIES:

1\. Siliculae elliptical or obovate, 3.5—5 (—6)×2.5—4 (—5) mm, always longer than broad, obtuse or acute. Style 0.3—0.8 mm. Seed-wing 0.3—0.5 mm. Margins of rosette leaves entire, sinuate or sparsely dentate (never pinnatifid) .... ssp. *saxatilis*

1\. Siliculae orbicular or oblate, 3.5—9×3.5—10 mm. usually wider than long, emarginate or truncate. Style 0.6—2.5 mm. Seed-wing 0.3—1.1 mm. Margins of rosette leaves sometimes entire but mostly dentate or pinnatifid

2\. Siliculae 3.5—5.5×3.5—6.0 mm. Style 0.6—1.4 mm. Seed-wing 0.3—0.7 mm .... ssp. *orientalis*

2\. Siliculae 6—9×6.5—10 mm. Style 1.1—2.5 mm. Seed-wing 0.7—1.1 mm. .... ssp. *megalocarpa*

SSP. SAXATILIS

Distribution and habitat: Widespread on calcareous substrates in central and south-eastern Europe, extending eastwards to Ukraine (Fig. 8).

SSP. ORIENTALIS

Distribution and habitat: Chasmophyte on calcareous substrates in the Balkans and western part of Anatolia, extending northwards into Bulgaria and Romania (Fig. 8). Specimens intermediate in morphology between ssp. *saxatilis* and ssp. *orientalis* are found in the area where the two subspecies overlap (in the northern Balkans). The occurrence of intermediates indicate that subspecific rank will be most appropriate.

Au. saxatilis ssp. *orientalis* has been reported to occur in Dalmatia and Istria (cf., e.g. HAYEK 1924), but this is questionable. My opinion is that there has ben a confusion between *Aurinia leucadaea* (GUSS.) KOCH and *Au. saxatilis*. At least the specimens available to me (8 collections) from Dalmatia and Istria have appeared to belong to *Au. leucadaea*, although determined as *Au. saxatilis* by the collectors. *Au. leucadaea* is strongly polymorphic, and some specimens can be rather similar to *Au. saxatilis*, but the occurrence of 4—6 ovules in each loculus and the inflated siliculae of the former makes identification rather easy (*Au. saxatilis* has only 2 ovules in each loculus and almost flat siliculae).

SSP. MEGALOCARPA

Distribution and habitat: Chasmophyte on calcareous substrates in the Aegean, the west coast of Anatolia and southern Italy (Fig. 9).

The distribution in the Aegean indicates that ssp. *megalocarpa* can be reffered to a relic group of chasmophytic plants which have found refuges on maritime cliffs. Great similarities in distribution in this area are shown by the *Dianthus arboreus* complex, *Senecio bicolor* (Willd.) Tod. (belonging to the *Senecio cineraria* complex) and *Helichrysum orientale* (L.) DC.

Taking the distribution in southern Italy also into consideration, it is obvious that ssp. *megalocarpa* is a contribution to a group of Aegean chasmophytes with west or central Mediterranean affinities. Other species belonging to this group are *Anthyllis aegea* Turr. versus *Anthyllis barba-jovis* Boiss., *Silene fruticosa* L., *Cephalaria squamiflora* (Sieber) Greuter, the complexes of *Brassica cretica* Lam. s.l. and *Scabiosa cretica* L. s.l. (cf. Davis 1953).

The present distribution of ssp. *megalocarpa* gives reason to surmise a wider distribution in earlier times, also comprising the coastal regions of western Turkey, the Peloponnisos and the Ionian islands. Due to large-scale introgression with ssp. *orientalis*, ssp. *megalocarpa* has disappeared from these regions, surviving only on the isolated Aegean islands and in southern Italy. This is supported by the great variability shown in the populations from, for instance, the Ionian islands, consisting of both large- and small-fruited specimens and all kinds of intermediates, whereas the more isolated populations of ssp. *megalocarpa* and the inland populations of ssp. *orientalis* both show a low degree of variability (Fig. 10).

The chromosome number is $2n=16$ (Fig. 3 J), and the chromosomes are rod-shaped with a length of 1.6—1.9µ and a breadth of 0.3—0.4µ (similar to the investigated material of *Alyssum* sect. *Alyssum*). The material examined for chromosome number belongs to all three subspecies, which in this respect showed no differrences. The same chromosome number has been reported by Jaretzky (1932), Manton (1932), Laibach (1907), Bakšay in Löve & Löve (1961), Bonnet (1963) and Contandriopoulos (1970).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Ssp. *saxatilis*:

Czechoslovakia. Moravia meridionalis colles Pavlovske kopce, 400—500 m s.m. (cult. P 86).

Ssp. *orientalis*:

Jugoslavia. Macedonija. Negotin, Demir Kapu, (R & S 21484).
Greece. Nom. Larisa. 5 km SW of Farsala, (R & S 21905).
— Nom. Phocis. 5 km N of Itea, 20 m s.m. (R & S 21216).
— Nom. Korinthia. Akrokorinth, 300—400 m s.m. (R & S 20359).
Turkey. Prov. Denizli. Denizli—Acipayama, 25 km from D., 860 m s.m. (D 35340).

Ssp. *megalocarpa*:

Greece. Nom. Piraeus. Kithira, W of Diakostis, 50 m s.m. (R & S 20827).
— — Kithira, the cliffs of the old fort at Chora Kithira (R & S 20809).
— — Kithira, E-exposed cliffs S of Diakostis (R & S 20845).
— Nom. Cyclades. Amorgos, cliffs S of the village of Langada (S 20242).
— — Amorgos, Krikelas, S-precipice, 500 m s.m. (R & S 12259).
— — Anafi, Kalamos, 0—400 m s.m. (R & N 14856).
— Nom. Chios. Chios, behind Vrontados (G—H 474).
— Nom. Samos. Samos, mt. Kerki, 400—800 m s.m. (R & S 19602).
— Nom. Dodecanesos. Cos, small gorge about 3 miles beyond Pili on Kardamena road, 250—300 m s.m. (G—H 404).

Intermediates Between ssp. *orientalis* and ssp. *megalocarpa*:

Greece. Nom. Laconia. E-exposed cliffs facing the sea SW of Gerolimni, 0—50 m s.m. (R & S 20690).
— — Narrow valley 3 km NNW of the village of Kampos (N of Neapolis) (R & S 20777).

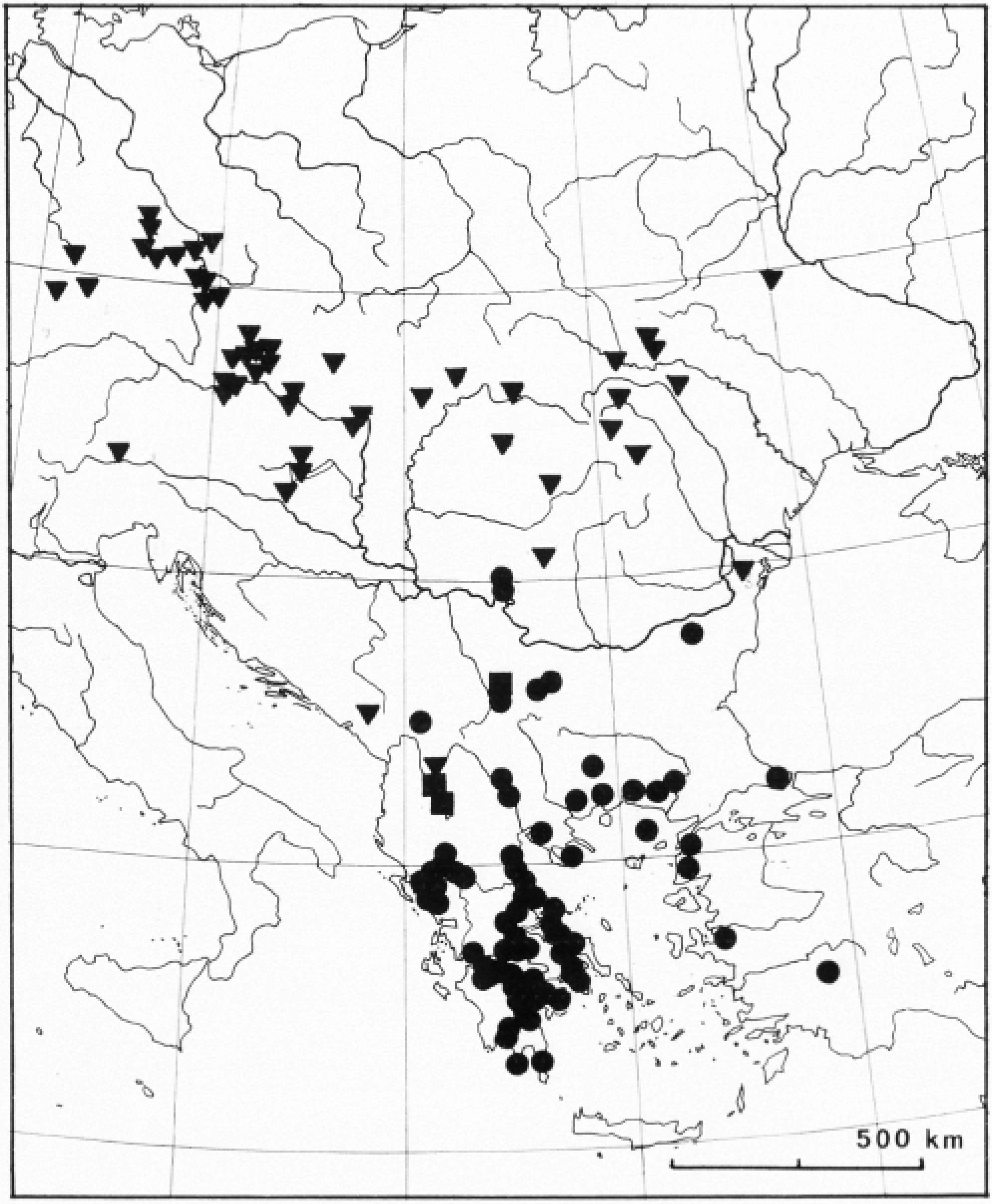

Fig. 8. The distribution of *Aurinia saxatilis* ssp. *saxatilis* (triangles), ssp. *orientalis* (dots) and intermediates (squares).

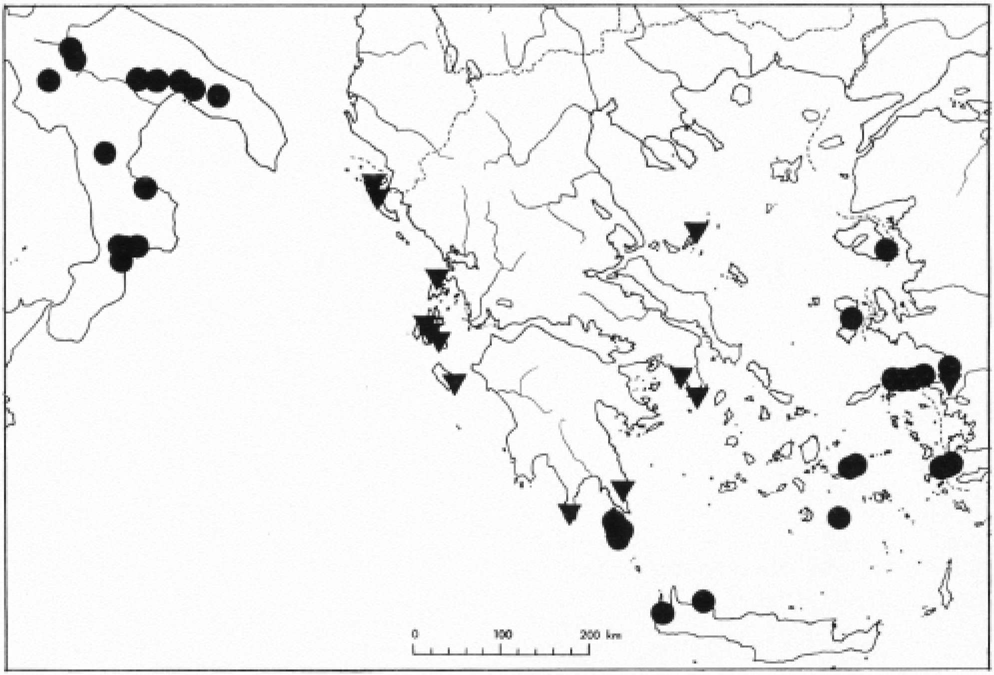

Fig. 9. The distribution of *Aurinia saxatilis* ssp. *megalocarpa* (dots) and intermediates between ssp. *megalocarpa* and ssp. *orientalis* (triangles).

— Nom. Cephalonis. Kephallinia, W of Poros (S 23780).

— — Kephallinia, 0.5—2 km S of Assos, 10—200 m s.m. (S 23654).

Cardamine graeca L.

Cardamine graeca is distributed in southern Europe from Corsica and eastwards, north-western Africa, Caucasia, Crimea, Turkey, Lebanon and northern Iran.

The chromosome number is 2n=18, indicating the basic number x=9, not previously reported within the genus (Fig. 3 L). MANTON (1932) reported the chromosome number 2n=16 for *Cardamine graeca*. The chromosomes are all of about equal size, elliptical, about 0.8μ long and 0.4μ broad.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Samos. Samos, the SW-side of mt. Kerki, 400—800 m s.m. (R & S 19663).

— — Samos, S of Vurliotes. N-exposed cliffs of Ag. Elias, 400—900 m s.m. (R & S 19914).

— Nom. Lasithion (Crete). Sitia, the NW-side of mt. Spathi, 700—800 m s.m. (R & S 18390).

— — Sitia, the NW-side of mt. Spathi, 850—1150 m s.m. (R & S 18376).

Cardamine hirsuta L.

Cardamine hirsuta is widespread in Europe and also occurs as a weed in most parts of the world.

The chromosome number is 2n=16 agreeing with earlier reports (MANTON 1932, TISCHLER 1934, BANACH in SKALIŃSKA 1950, BANACH-POGAN 1955, LÖVE & LÖVE 1956, LÖVKVIST 1956, 1957, PRITCHARD 1957, LARSEN 1960, MULLIGAN 1965, GADELLA & KLIPHUIS 1966).

The karyotype is, except for the different basic number, similar to that of *C. graeca*.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Cyclades. Naxos, 2 km E of Mytria (R 520).
— — Naxos, 3 km S of Komiaki, 650 m s.m. (R 687).
— — Naxos, 2 km SSW of Filoti, 300—350 m s.m. (R 910).
— Nom. Samos. Samos, the valley of Leka, 200—400 m s.m. (R & S 18917).
— — Samos, the E-part of Mt. Kerki, 800—1200 m s.m. (R & S 19354).

Iberis spruneri JORD.

In the Balkan peninsula as well as in Anatolia a number of annual or biennial montane and alpine species of *Iberis* occur. The taxonomy of this group is badly in need of revision (cf. HEDGE 1965 in Flora of Turkey 1, and MEIKLE 1954). One of the components is *Iberis spruneri* distributed in southern Greece and western Anatolia. Material from Samos, in accordance with HEDGE (l.c.) determined as *I. spruneri*, has been cytologically investigated.

The chromosome number is 2n=14 (Fig. 3 K), and the chromosomes are rod-shaped, 2.0—2.5μ long and about 0.4μ broad, with one pair of satellites. In Flora Europaea 1 (1964) this taxon has, by PINTO DA SILVA and AMARAL FRANCO, been included in *I. prutii* TINEO, which was recorded to have 2n=22 by MANTON (1932).

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Samos. Samos, S-slopes of Mt. Kerki, 400—800 m s.m. (R & S 19585).
— — Samos, 1—3 km W of Marathokampos, 250—350 m s.m. (R & S 19203).

Ricotia cretica BOISS. & HELDR.

The genus *Ricotia* L. has been monographed by BURTT (1951). It consists of 9 annual and perennial species occurring from Crete to Iraq and Transcaucasia. *Ricotia cretica* is an annual herb growing in screes in western and the extreme east of Crete.

The chromosome number is 2n=28, and the chromosome are all of about equal size, elliptical, 0.8μ long and 0.4μ broad.

The same number was reported for *R. lunaria* DC. by MANTON (1932), indicating the basic number x=7 in agreement with basic number of the other genera of subtribus Lunariinae.

CYTOLOGICALLY INVESTIGATED MATERIAL:

Greece. Nom. Lasithion (Crete). Sitia, between Achladia and Paraspori, 200 m s.m. (R & S 18533).
— — Sitia, SW of Leopetra, 0—300 m s.m. (R & S 18472).
— — Sitia, Achladia, 200—325 m s.m. (R & S 17855).

Fig. 10. Fruits of *Aurinia saxatilis*. — A—B: ssp. *saxatilis*. — C—D: intermediates between ssp. *saxatilis* and ssp. *orientalis*. — E—L: ssp. *orientalis*. — M—Q: intermediates between ssp. *orientalis* and ssp. *megalocarpa*. — R—Ö: ssp. *megalocarpa*.

A: Czechoslovakia, Bratislava, LABRANSKY, 23.5. 1884. — B: Hungary, Budaörs, STEINITZ, 29.5. 1881. — C—D: Jugoslavia, Pirot, RECHINGER 16036. — E: Romania, Varciorova, DEGEN 3268. — F: Bulgaria, Mezdra, HRUBY 2192. — G: Jugoslavia, Negotino, R 21485. — H: Ju., Gjefgjeli, RECHINGER 1525. — I: Greece, Alexandroupolis, RECHINGER 6048. — J: Gr., Lithochorion, SINTENIS 1156. — K: Gr., Acropolis, SINTENIS 15. — L: Turkey, Izmir, BALANSA, 1854. — M: Greece, Kephallinia, S 23610. — N: Gr., Kephallinia, S 23780. — O: Gr., Kerkyra, S 27841. — P: Gr., Kerkyra, S 23551. — Q: Gr., Kerkyra, S 23856. — R: Turkey, Ephesos, BORNMÜLLER 9083. — S: Greece, Chios, G—H 474. — T: Gr., Samos, R & S 19724. — U: Gr., Kos, RECHINGER 7981. — V: Gr., Amorgos, R & S 20242. — X: Gr., Anafi, R & N 14856. — Y: Gr., Crete, Kidonia, GREUTER S 3301. — Z: Gr., Kithira, S 20809. — Å: Italy, Campania, PHILIPPIS, 10.6. 1948. — Ä: It., Calabria, 4.5. 1872. — Ö. It., Basilicata, FIORI, 7.6. 1913.

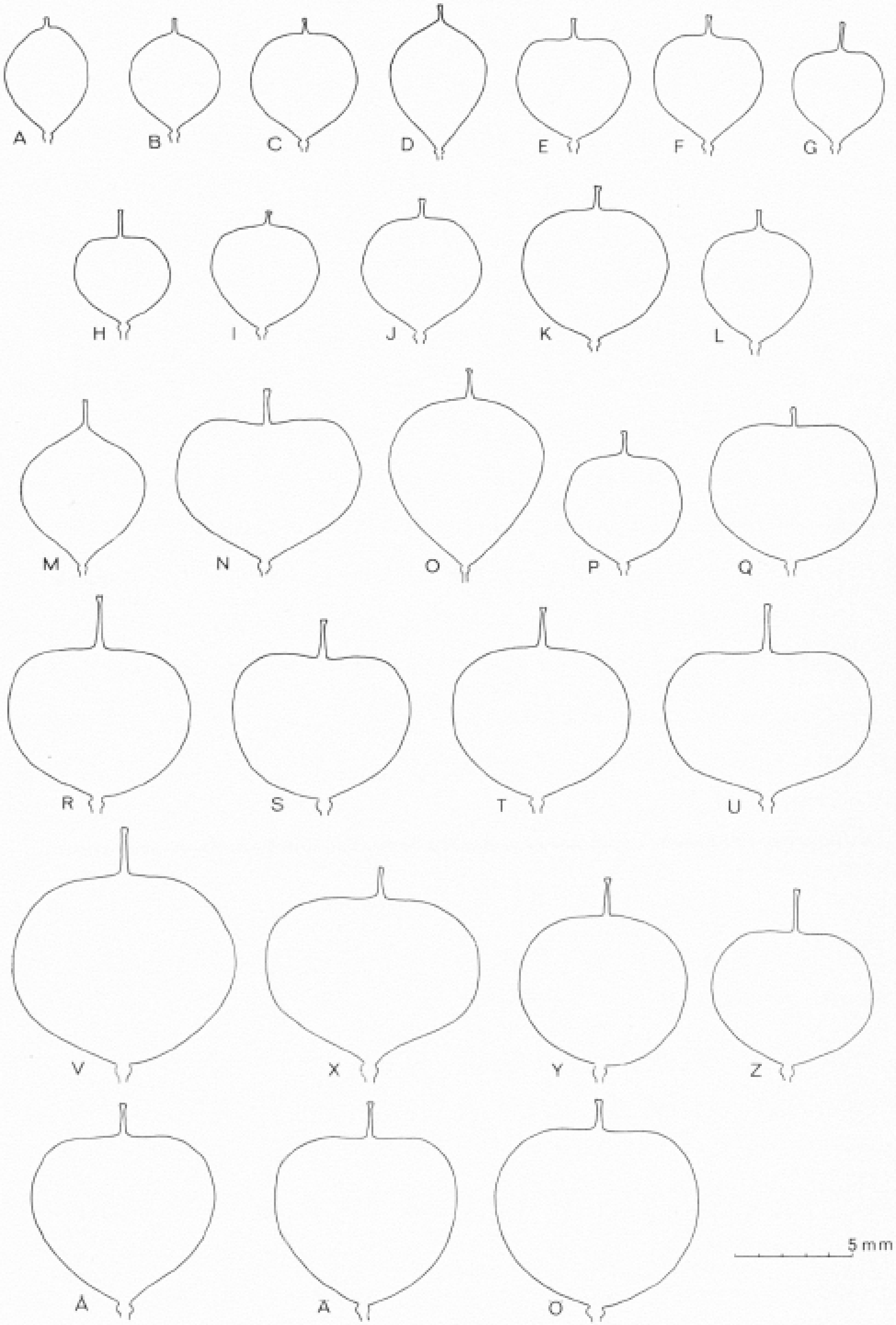

Fig. 10.

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Göte Turesson In Memoriam

GÖTE WILHELM TURESSON was born in Malmö in 1892 and went to school at first in Malmö and later on in the neighbouring town of Lund. As a schoolboy he was quite intelligent but rather obstinate and oppositional which led to conflicts with his teachers. Finally, when he had reached the age of 20, he stated with dismay that the Swedish school system was no good. Consequently, he emigrated to the United States, where he was received by his aunt who lived in Spokane, Washington, not far from Seattle.

After a year of hard struggle with various incidental employments in order to save money for his future activity TURESSON matriculated at the State University of Washington in Seattle. Especially when considering his previous school problems in Sweden, his career at the American university was surprisingly rapid and successful. In 1914 he became a bachelor of science and one year later he acquired the master of science degree. He also got appointments as assistant, at first at the Department of Systematical Botany of the University, and later on at the Department of Physiological Botany.

In order to understand how this rapid development could be possible, it is necessary to realize that the childhood of young GÖTE was not only characterized by his oppositional tendencies but also by early positive influences of decisive importance. His father, JÖNS TURESSON, was a school-master with strong biological interests. Even before the age of ten, GÖTE made excursions with his father, collecting plants as well as butterflies, and quite early it was considered self-evident that GÖTE should become a botanist.

In 1915 he returned from America to Sweden, and in 1916 he matriculated at the University of Lund where he became a licentiate of botany in 1921. In the following year he defended his doctor's thesis and became a docent of botany. Before that he had temperary employments as assistant at the University institutes of Systematical as well as Physiological Botany and also at the Institute of Genetics.

While still a schoolboy GÖTE TURESSON published three small botanical articles, but his real scientific production was commenced in the United States with one ecological and one mycological paper. Another paper was a rather comprehensive plant-biological work, mainly concerning "skunk cabbage" (*Lysichiton camtschatcense*) and its role in the plant communities of bogs.

After his return to Sweden TURESSON at first continued his mycological work and wrote a comprehensive paper on the fungus flora in the intestinal tract of animals and humans. He also demonstrated that certain diseases in honey bees are caused by toxic substances produced by mould fungi. TURESSON wrote a series of articles on bee diseases and became a well-known and often consulted bee-doctor.

By and by, however, this field of work had to give place to more central research projects with flowering plants. As early as in 1917 the genecological main line of his research work may be discerned in a paper on plagiotropism in sea shore plants. TURESSON discovered that prostrate plant-forms comprised hereditary *prostrata*-forms as well as purely environmental modifications and that these two categories may be represented even within the same Linnean species.

1922 is an important year in TURESSON's scientific production. In this year his doctoral thesis, "The genotypical response of the plant species to the habitat", was published and also two interesting forerunners. The first one deals with the development of the new science of plant sociology. In contrast to leading plant sociologists TURESSON realized that plant species are by no means uniform but are composed of races with different ecology. In the second forerunner-article TURESSON reported that the plant species are composed of different ecological units with different appearance and physiological properties. These so-called ecotypes are genotypically adapted to different habitats or climatic areas.

In the doctoral thesis all the empirical data, obtained from a large number of plant species, were accounted for. Living plants of these species had been collected from different habitats and were then cultivated and analysed in a garden belonging to the Institute of Genetics of the University of Lund.

TURESSON realized that he had opened up a new and essential field of research, and in 1923 he published a declaration of program under the title "The scope and import of genecology". In this declaration he stressed that, so far, ecological research had been carried out without realization of the fact that there is a hereditary differentiation within species. Hence, the work initiated concerning the subdivision of species into genotypically different edaphic and climatic types represented a new phase in ecological research.

In numerous papers, approximately up to the middle of the nineteen thirties, TURESSON presented the results of his large research program. This work was carried through with a remarkable strength and energy with regard to the collection of the large material as well as its detailed analysis in the experimental garden. Special attention was also devoted to the occurrence of characteristic physiological differences between the ecotypes — a work in part carried out at research institutes in Munich and Vienna.

The collection trips were at first limited to the province of Scania, South Sweden, but were by and by extended to all Sweden, and then to other countries and continents, including Siberia, United States and Canada.

In 1934 TURESSON — as the sole European — was invited to attend the annual meeting of the Carnegie Institution of Washington which was this year held in Palo Alto, California. The specific research department of the Carnegie Institution located at Palo Alto was devoted to genecology, and the leader of this research group was the Danish-born biologist JENS CLAUSEN. His research program was very much in line with TURESSON's pioneer work and also included cytotaxonomy and experimental taxonomy.

Among the numerous publications following TURESSON's journeys and expeditions a paper from 1925, "The plant species in relation to habitat and climate", is of special importance because it stresses the occurrence of parallel ecotypes in different species (e.g. oecotypus *campestris, arenarius, salinus, subalpinus, alpinus* etc.). Another paper, from 1930, "The selective effect of climate upon the plant species", contains other essential results concerning characteristic features in the genecological differentiation between widely separated flora regions (atlantic versus continental, northern versus southern regions etc.).

Besides the central concept ecotype, TURESSON also introduced several other terms which chiefly concern the delimitation of different kinds of species from each other. In this connection he criticized the tendency of contemporary plant taxonomists to describe all plant forms that can be distinguished morphologically and are truebreeding as separate species. Especially among apomicts these criteria may lead to absurdities. TURESSON, instead, proposed and defined the concept agamospecies which corresponds to natural species among plants with sexual reproduction.

For GÖTE TURESSON the time from 1922 to 1927, when he was a docent of botany

Fig. 1. Göte Turesson together with a student on an excursion to W. Jutland in September, 1970. Photo: Mats Gustafsson.

at the Lund University, was a very intensive and productive period that also involved personal happiness. In 1922 he married Benedicte Lehmann, and in 1924 their son Per Jöran was born. In 1927 Turesson left Lund and took up a position as chief plant breeder at the Weibullsholm Plant Breeding Institute in Landskrona. His breeding work with oats, rye and potatoes lasted four years but was abruptly terminated in 1931, when Turesson and three of his colleagues decided to leave their positions on account of a disagreement with the administrative leaders of Weibullsholm. Turesson then returned to the University of Lund where he got a position as "research docent". His new period of basic research work in genecology was, however, soon disturbed by a long and complicated period of competition for the chair of systematic botany in Lund. He was not appointed to this position but in 1935 he became professor of systematical botany and genetics at the Agricultural College of Sweden in Uppsala.

During the first years in Uppsala Turesson was much burdened by administrative duties — especially the construction and equipment of an institute and the selection of suitable co-workers. He was also much engaged in the establishment of a new genecological garden.

Concerning TURESSON's research work during the Uppsala period the following main features may be mentioned. In the nineteen forties he and his co-workers produced a series of polyploids in various cultivated plants. The best results were represented by tetraploid strains of red clover and alsike clover. Especially the latter one deserves attention since it probably represents the very first case of an experimentally induced autotetraploid of real economical importance.

Investigations on various apomicts had been started by TURESSON during his period in Lund. The first papers of this kind concerned *Festuca ovina*, which comprises sexual races as well as more or less obligately viviparous forms. In this material an autotetraploid series of chromosome numbers was detected, ranging from diploidy to hexaploidy. TURESSON was also interested in the occurrence of apomictic microspecies in *Alchemilla*, and in papers during the period 1943 to 1958 he demonstrated that these microspecies are heterogenous and comprise many different biotypes. Another apomictic complex, investigated by TURESSON and his wife, is the collective species *Hieracium pilosella*. This complex comprises sexual as well as more or less aposporous types with chromosome numbers ranging from 18 to 63.

GÖTE TURESSON's last years in Uppsala were in several respects very burdening, and hence it was with relief that he reached the pension age in 1959. He was then happy to return to Lund and lived there in 12 additional years. Though TURESSON had not any more the great scientific force of his early manhood a favourable effect of the return to his native province became obvious. Among other things this new flourishing led to the comprehensive investigation of the *Hieracium pilosella* group.

Even as late as in the autumn of 1970 TURESSON, together with some young botanists from Lund, made a collection trip to Jutland and had once more the pleasure of strolling around in the natural vegetation, making observations and collections. On account of a serious liver disease his strength was, however, clearly reduced and on the 30th of December, 1970, GÖTE TURESSON died quietly in his home. During his last illness he was quite aware that his time would soon be up but he met the unavoidable without fear and with a scientific mind. He realized that life and death are only different aspects of the same basic biological phenomenon — a phenomenon that man shares with all other organisms in this world.

GÖTE TURESSON was a very dynamic person whose manifestations of power and drastic mode of expression were sometimes very striking. With advancing age, his personality became progressively milder, and to his close friends it had all the time been clear that he possessed gentle and charming strings on which, however, he did not like to play in his earlier days. During his golden age he used his oppositional mind and his great intellectual force for clearing new scientific paths, and, indeed, this led to results of fundamental importance.

ARNE MÜNTZING

PUBLICATIONS BY GÖTE TURESSON

(List prepared by Mrs. MADELEINE GUSTAFSSON)

1909 En jätteask i Skåne. — Fauna och Flora, p. 99.

1910 Tjänstgör morkullan under sin flyttning såsom Goodyera repens fröspridare? Genmäle. — Ibid., p. 40—41.

1912 Några adventivväxter från Skåne. — Svensk Bot. Tidskr. 6: 95—96.

1914 Slope exposure as a factor in the distribution of Pseudotsuga taxifolia in arid parts of Washington. — Bull. Torrey Bot. Club 41: 337—345.

1915 Penicillium avellaneum, a new ascus-producing species. — Mycologia 7(5): 284—287 (together with C. Thom).

1916 Lysichiton camtschatcense (L.) Schott, and its behavior in sphagnum bogs. — Amer. Journ. Bot. 3: 189—209.

1916 The presence and significance of moulds in the alimentary canal of man and higher animals. — Svensk Bot. Tidskr. 10: 1—27.

1917 The toxicity of moulds to the honeybee, and the cause of bee-paralysis. — Ibid. 11: 16—38.

1917 Om orsaken till binas s.k. Majsjuka. — Bitidningen (Jan.), p. 11—14.

1917 Mykologiska Notiser. I. Ett fall av Aspergillusmykos hos bin. — Bot. Notiser, p. 269—271.

1917 Om plagiotropi hos strandväxter. — Ibid. p. 273—296.

1918 Binas sjukdomar. — in A. Holm, Handbok i biskötsel, Ed. 2. p. 189—210.

1918 Om långväga växttransport genom fåglar. — Bot. Notiser, p. 248.

1919 The cause of plagiotropy in maritime shore plants. — Contributions from the Plant Ecology Station, Hallands Väderö, No. 1. — Lunds Univ, Årsskr. N.F. Avd. 2, 16(2): 1—32.

1919 Grupp- och artbegränsning inom släktet Atriplex. — Bot. Notiser, p. 41—47.

1919 Om utbredningen och bekämpande av Nosemasjukan. — Bitidningen 18(7—8): 145—147.

1920 Mykologiska Notiser. II. Fusarium viticola Thüm. infecting peas. — Bot. Notiser, p. 113—125.

1921 Om olika slag av utsot hos bin. — Bitidningen (Nov.), p. 233—234.

1922 Bisjukdomar under år 1921. — Ibid. (Febr.), p. 24—26.

1922 Till frågan om bipestsjukdomarnas bekämpande. — Ibid. (Oct.), p. 251—255.

1922 Växtsamhällslärans utveckling. — Bot. Notiser, p. 49—68.

1922 The species and the variety as ecological units. — Hereditas 3: 100—113.

1922 The genotypical response of the plant species to the habitat. — Ibid. 3: 211—350.

1922 Über den Zusammenhang zwischen Oxydationsenzymen und Keimfähigkeit in verschiedenen Samenarten. — Bot. Notiser. p. 323—335.

1923 The scope and import of genecology. — Hereditas 4: 171—176.

1924 Bisjukdomarnas uppträdande i vårt land och åtgärder för deras bekämpande. — K. Landtbruksakad. Handl. Tidskr., p. 1—15 (together with K. E. Sandberg and S. M. Tullberg).

1925 The plant species in relation to habitat and climate. — Hereditas 6: 147—236.

1925 Studies in the genus Atriplex I. — Lunds Univ. Årsskr. N.F. Avd. 2, 21(4): 1—15.

1926 Die Bedeutung der Rassenökologie für die Systematik und Geographie der Pflanzen. — Feddes Repert. Spec. Nov. Regni Veg. Beiheft 41: 15—37.

1926 Habitat and genotypic changes. A reply — Hereditas 8: 157—160.

1926 Experimentell eller beskrivande växtsystematik? Ett inlägg. — 13 pp. Lund.

1926 Studien über Festuca ovina L. I. — Hereditas 8: 161—206.

1927 Contributions to the genecology of glacial relics. — Ibid. 9: 81—101.

1927 Untersuchungen über Grenzplasmolyse- und Saugkraftwerte in verschiedenen Ökotypen derselben Art. — Jahrb. Wiss. Bot. 66(4): 723—747.

1927—1931 A number of brief reports about breeding results at Weibullsholm Plant Breeding Institute, Landskrona. — Weibulls Årsbok (together with H. Ericson).

1928 Castration experiments in Hieracium umbellatum L. and Leontodon autumnalis L. — Svensk Bot. Tidskr. 22: 256—260.

1928 Erbliche Transpirationsdifferenzen zwischen Ökotypen derselben Pflanzenart. — Hereditas 11: 193—206.

1929 Zur Natur und Begrenzung der Arteinheiten. — Ibid. 12: 323—334.

1929 Ecotypical selection in Siberian Dactylis glomerata L. — Ibid. 12: 335—351.

1930 Studien über Festuca ovina L. II. Chromosomenzahl und Viviparie. — Ibid. 13: 177—184.

1930 The selective effect of climate upon the plant species. — Ibid. 14: 99—152.

1930 Zur Frage nach der Spontanität von Betonica officinalis L. in Schweden. — Bot. Notiser, p. 495—506.

1930 Genecological units and their classificatory value. — Svensk Bot. Tidskr. 24: 511—518.

1931 Studien über Festuca ovina L. III. Weitere Beiträge zur Kenntnis der Chromosomenzahlen viviparer Formen — Hereditas 15: 13—16.

1931 Über verschiedene Chromosomenzahlen in Allium schoenoprasum L. — Bot. Notiser, p. 15—20.

1931 Field studies and experimental methods in taxonomy. — Hereditas 15: 1—12 (together with A. Müntzing and O. Tedin).

1931 The geographical distribution of the alpine ecotype of some Eurasiatic plants. — Ibid. 15: 329—346.

1932 Trapa natans L. im Altai-Gebiet. — Bot. Notiser, p. 177—190.

1932 Die Genenzentrumtheori und das Entwicklungszentrum der Pflanzenart. — Ibid. 2(6): 1—11.

1932 Die Pflanzenart als Klimaindikator. — K. Fysiogr. Sällsk. Lund Förh. 2(4): 1—35.

1933 Zur Rassenökologie von Adonis vernalis L. — Bot. Notiser, p. 293—304.

1933 Bemötande av några punkter i professor N. Heribert Nilssons "Sic et non." — 9 pp. Lund.

1933 Professuren i systematisk botanik vid Lunds universitet. Ett inlägg. — 25 pp. Lund.

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Botanical Literature

C. T. INGOLD: **Fungal Spores. Their Liberation and Dispersal.** — Clarendon Press: Oxford University Press 1971. 302 pp, 199 figs. Price £ 4,00.

For many problems concerning fungi the interest is concentrated on their spores. As fungi are enormously rich in species and the adaptations for effective reproduction are countless, the knowledge of spores, their structure and behaviour is an extremely wide domain. The English mycologist, professor C. T. INGOLD has studied the subject intensely for some fourty years and is since long the great authority of the branch. His books "Dispersal in Fungi" and "Spore Liberation" reached a wider circle of readers than only mycologists by profession, and became appreciated and much used textbooks i.a. for university students of botany. Instead of new editions of these books he has now published a larger one, which in several respects is an enlargement and continuation of the earlier works. Even if this new publication is larger, it has the same character of a popular book in the best sense of the word, where the scientific material is presented in a very readable and varied form. Even the choice of chapter titles tells of a wish to tickle the reader's curiosity, e.g. chapter 8 "Gasteromycetes, or Nature tries Again" and chapter 9 "Blow-off, Splash-off, and Shake-off".

From the index it is apparent that the author, when ordering the material, in the choice between a taxonomical arrangement and a disposition from pure biological principles (concerning ecology, dispersal technics a.s.o.), has tried both. Hence he has achieved the possibility to show that within one and the same taxonomical group there are adaptations in several different directions but also that similar adaptations may be found within groups that for good reasons are regarded as very distantly related. To quote an example, the Mucoraceae have got a chapter of their own. Among them dispersal mechanisms of different kinds are encountered. Airborn, dry spores are the most common type of diaspores, but in many cases there is secreted together with the spores a sticky liquid as an adaptation to epizootic dispersal. Water-born spores occur in Mucoraceae and at last there are some well-known cases of explosive ejection of sporangia (*Pilobolus*) or conidia (*Entomophthora*).

The spore dispersal in Basidiomycetes is as a rule uniformly based on copious production of air-born spores. One group among them, however, takes up a special position, viz. Gasteromycetes, to which INGOLD devotes a chapter of their own. Among them a long series of adaptations can be found. The majority of them have air-born spores, and different methods for the liberation of the spores are encountered. The dispersal by means of flies in Phallaceae is striking and well-known. The same is true of the formation and active dispersal of the peridiols in Nidulariaceae. Still more effective active ejection of the spore mass has developed in the genus *Sphaerobolus*. Among Gasteromycetes there is even a case of dispersal by water which seems very strange in this group, which in its entirety appears to be adapted to dry climates. The reason why among Gasteromycetes, so many different ways of dispersal can be found is with certainity that the group is not a natural taxon but delimited through characteristics which are correlated to the adaptations. The dispersal mechanisms have evidently developed within different groups of Basidiomycetes and the development has in many cases reached so far that the starting point has become obscure. Like many other mycologists, INGOLD adheres to the idea that Gasteromycetes is a polyphyletic group with several roots among Hymenomycetes, above all Agaricales. Attempts made to arrange systems for fungi based on natural relationships meet with very great difficulties. Adaptations to parasitic or saprophytic way of living have among fungi, as well as among many other groups of organisms, caused strong reductions of vegetative organs. In reproduction fargoing adaptations have taken place, with augmented efficiency as a result, e.g. in the formation of spores and their liberation. Embryonal stages, which could have given clues to the pathways of evolution, lack in fungi. As no information can be expected from fossils, it is clear that a system, which is natural throughout, is something that mycologists dare have very little hope about. To be able to evaluate available facts, good knowledge of the function of the structures is necessary for the taxonomists. For them INGOLD's work is of outstanding importance. There are still, however, structures and qualities in spores which are little known as to their function, e.g. surface structures, or chemical characteristics like the amyloid reaction.

The chapter on the spores in air arises interest and is much to the fore. Spores form an important ingredient in the contents of particles in the air. By means of different tools they can be captured from air currents. Dispersal over very long distances is no doubt possible for many groups of fungi with resistant spores, e.g. many types of *Fungi imperfecti*, Mucoraceae, Gasteromycetes, Uredineae, Ustilagineae.

"Fungal Spores" is not only a very instructive book, it is besides very readable and entertaining and well worth a studium by all who have a deeper interest in biology. It is certainly not an exhaustive reference work as the space of it is limited, but it gives not least through its ample bibliography guidance to further studies in the speciality. The numerous illustrations are very well done and in most cases original.

JOHN ERIKSSON

JACOT GUILLARMOD, AMY: Flora of Lesotho (Basutoland). — Verlag von J. Cramer, Lehre. 1971. (Flora et Vegetatio Mundi III). 474 pp., cloth-bound. DM. 150.—

The check list of plants from Lesotho by Mrs. JACOT GUILLARMOD of Grahamstown, South Africa, has finally appeared, viz. as third volume of the series, 'Flora et Vegetatio Mundi', published by Cramer. It is a fine volume, containing much useful information on a very interesting corner of Southern Africa, but no illustrations. This small country, which was known as Basutoland under British rule until it gained independence in 1966, is largely mountainous and includes the highest mountain of Southern Africa (Thabana Ntlenyana, 3480 m s.m.). The eastern boundary follows the summit of the Drakensberg range, which is phytogeographically significant as part of an important pathway for north- and southward migrations and as a refugium and evolutionary centre for various plant groups. Hence, the knowledge of flora and vegetation of this region is essential to an understanding of South African phytogeography.

The present work aims at providing as complete as possible a check list of plants found within the present boundaries of Lesotho. The only previous work covering roughly the same region is PHILLIPS' 'Flora of the Leribe Plateau and Environs', published in 1917 and now naturally largely outdated. The present list includes 1537 species of flowering plants. The list of thallophytes is very preliminary and will certainly stimulate further collecting. In addition to the accepted Latin names, frequently used synonyms are cited. All collections known are enumerated, with indication of their location. Also, the South African distribution outside Lesotho is often stated. The author has taken much time and trouble to trace all important collections available in South African as well as European herbaria. Foremost among earlier collectors was Mrs. A. Dieterlen, who as the wife of a French missionary spent about forty years in the country around the turn of the century. Her specimens are preserved in Strasbourg, Paris, Pretoria, Cape Town, and various other herbaria, and they formed the basis of Phillips' work (see above). In addition, the author herself has during many years of exploration assembled the most important collection of Lesotho plants, numbering between three and four thousand specimens.

Naturally, the check list will continuously require amendments and additions due to taxonomic progress and further collecting. It must be remembered, that roads in Lesotho are scarce and mainly concentrated to the lowlands in the west. Much of the interior is accessible only by long and tiresome travels on horseback, as the reviewer knows from personal experience in 1963 (not 1965 as stated on p. 64).

Taxonomic literature is well covered up to 1968, when the manuscript seems to have been finished. One omission was incidentally spotted, viz. *Senecio ulopterus* Thellung, which was described on a collection from Basutoland. Since the manuscript left the author's hand, numerous taxonomic changes have been brought forward, including the description of several new species. Also, some genera can now be excluded, viz. *Hertia* (the collection cited belongs to *Euryops montanus*), *Petalactella* (sunk in *Ifloga*), *Metzlera* (species transferred to *Lobelia*), and *Schizocarpus* (included, albeit hesitatingly, in *Scilla*). Furthermore, *Spaeralcea* should be substituted by *Anisodontea*, and *Danthonia* should be replaced by two new genera, *Karroochloa* and *Merxmuellera*.

The check list makes up about half of the volume. The rest contains, inter alia, biographical notes on collectors, a brief statistical analysis of the flora, a Sotho glossary, vernacular names and a chapter on native uses of plants. And especially the introductory chapters on history, topography, climate, land usage, and ecology provide fine reading and an excellent introduction to the natural history of Lesotho.

Pressure from population and cattle is severely affecting the land, causing soil erosion and threatening the natural water supplies. Erosion has already for decades been a serious problem in the country, and although some steps have been taken to prevent further damage (like compulsory contour ploughing), much remains to be done in the field of nature conservation. Whole plant communities as well as individual species are in danger of extinction. The author's statement that *Aloe polyphylla* is the only endemic species of Lesotho is almost certainly an understatement. The reviewer can immediately add *Euryops inops*, and others will probably come to light.

The need for ecological surveys as a basis for better land usage and meaningful conservation is rightly stressed by the author. With her own pioneer work on the flora and vegetation of Lesotho she has laid the necessary foundation for future study and provided a useful source of information for all interested in the natural setting and conditions of Basotho life.

Bertil Nordenstam

Rechinger, K. H.: Flora Iranica. Fasc. 58—89 (1969—71). — Akademische Druck- u. Verlagsanstalt, Graz, Austria.

The steady progress of 'Flora Iranica' is one of the delectations of contemporary botany. Several of the some thirty fascicles under review are quite small (Lentibulariaceae, Sparganiaceae, Celastraceae, Amaryllidaceae, Typhaceae, etc.), while others contain more capacious contributions (Valerianaceae, Salicaceae, Capparidaceae, Geraniaceae, Crassulaceae, Asclepiadaceae, Juncaceae, Alliaceae, and Fagaceae). Finally there are two massive volumes, viz. Rosaceae I and Gramineae.

As it happens, few large genera with significant endemism in the area are represented this time, *Allium* being the most notable exception. Instead, the degree of endemism is very low in most larger genera involved, like *Bromus* (44 species: 4 endemic), *Poa* (40: 3), *Stipa* (39: 5), *Geranium* (35: 1), *Juncus* (28: 1), *Salix* (27: 2), and *Valerianella* (24: 0). Somewhat higher proportions are found in *Agropyron* (61: 13), *Alchemilla* (32: 15), and *Potentilla* (51: 19). *Allium*, however, presents a different picture. It is the largest and phytogeographically most important genus in this set of the flora. The author is P. WENDELBO, who treats the Alliaceae as distinct from the Liliaceae. Of the 139 *Allium* species so far known from the area, no less than 64 are endemic there, and this number may be expected to increase with more extensive collecting. Obviously this genus (which comprises about 600 species in all) has important centres within the area, especially in the steppe regions of Central and East Afghanistan together with adjacent parts of West Pakistan and in West and South Iran. The taxa in the former centre seem to have mainly Central Asiatic affinities, and those of the latter areas show largely Mediterranean connections.

Apropos family taxonomy it may be noted, that Paeoniaceae is treated as distinct from Ranunculaceae, but *Neurada* is kept in the Rosaceae and *Biebersteinia* in the Geraniaceae.

Eight authors contribute to the Rosaceae volume, which covers 32 genera. Only *Rosa* has been left out, in prospect of some future fascicle labelled Rosaceae II. It might have been advisable to administrate *Cotoneaster* likewise. The envisaged revision was not delivered in time, and a substitute was compiled from literature and insufficient material at hand. The result is a very preliminary treatment (comprising 25 species). *Crataegus*, too, is somewhat provisionally treated. A narrow species concept has been adopted, and 21 species are recorded from the area. The *Rubi* of the area likewise pose serious taxonomic problems awaiting a satisfactory solution. *Potentilla* comprises 51 species, when some insufficiently known species are excluded. The majority of the 12 endemic species belong to sect. *Persicae*.

In the Prunoideae, *Prunus* itself is taken in a narrow sense, and *Armeniaca*, *Persica*, *Amygdalus*, *Cerasus*, *Padus*, and *Laurocerasus* are accordingly treated as separate genera. From a phytogeographical point of view *Amygdalus* is of special interest, showing a pronounced centre in the Iranian highlands. About half the genus, or 21 species, occur in the 'Flora Iranica' area, and 12 of these are endemic.

The grass volume (by N. L. BOR) is the hitherto largest single contribution in the series. It contains 573 text pages, concluded by 72 plates of masterly drawings (60 of which have earlier been published in 'Flora of Iraq'). There are 772 grass species belonging to 156 genera. The degree of endemism is remarkably low (in comparison to, e.g., South Africa), and not a single genus is endemic to the area. MELDERIS has contributed substantially to the treatment of tribus Triticeae, and it is interesting to note, that he no longer favours a splitting of *Agropyron* into small, "Nevskian" units, like *Elytrigia*, *Roegneria*, etc. *Agropyron* s.lat. is maintained as distinct from *Elymus*, however, in spite of the occurrence within the area of ×*Agroelymus* and *E. Trinii* MELD., a species formerly referred to *Agropyron* on account of the solitary spikelets.

As usual, the general distribution outside the area is indicated for species and lower categories. Trifling inexactitudes and errors here — like the citation of

Potentilla gelida from Scandinavia — shall not belittle the value of this additional information.

The grass drawings have already been mentioned, and there are many other commendable illustrations. The exquisite colour photographs of live *Allium* inflorescences are beyond praise, and the analytical drawings accompanying the same genus are most useful. Photographs of herbarium specimens are in the reviewer's opinion generally inferior to drawings, but they can be quite adequate for trees (in this case Anacardiaceae, Fagaceae, Aceraceae), but less so for herbs like *Potentilla, Geranium* and the Crassulaceae.

Interspersed in the text occur, as before, very initiated commentaries on taxonomic and nomenclatural matters. E.g., in connection with *Festuca*, Dr. BOR has sensible things to say about the wealth of infraspecific names and categories. Faced with 519 subordinate taxa under *Festuca ovina*, among which *F. ovina* ssp. *eu-ovina* var. *vulgaris* subvar. *niphobia* f. *crassior* is just one albeit horrifying example, the author makes a strong plea for a simplified and more rational nomenclature.

BERTIL NORDENSTAM

Plant Life of South-West Asia. Edited by P. H. DAVIS, P. C. HARPER, & I. C. HEDGE. Published by the Botanical Society of Edinburgh, 1971, at the University Press, Aberdeen. x + 335 pp.

Since World War II plant taxonomists at Edinburgh have directed much attention to the flora of south-west Asia. The "Flora of Turkey" under publication is a well known result of these activities. Another is the present volume, being a record of the papers presented at a symposium held in June, 1970, in connection with the Tercentenary celebrations of the Royal Botanic Garden, Edinburgh.

The symposium was attended by 72 participants from about 18 countries. The volume contains 21 papers, supplemented by discussions and concluding editorial comments. The geographical delimitation is less narrow than implied by the title. Areas treated include Greece, especially the Aegean, and the West Himalayas, and some papers have a still broader outlook. There is also a wide coverage as to subject. Although phytogeography and biosystematics are the major themes, items like the origin of crop plants and problems of plant conservation are also discussed. Thought-provoking issues include the concept of 'reproductive drift' advanced by RUNEMARK, the 'Anatolian Diagonal' recognized by Edinburgh workers on the flora and phytogeography of Turkey, an astute comparison of the five 'Mediterranean' floras of the world (RAVEN), and an adroit outline of the evolution in South-West Asian Rubiaceae (EHRENDORFER). It is impossible here to review or even mention all papers — they are all worth reading, many aptly illustrated, and some contain very stimulating reflections on topics of considerable general or special interest.

BERTIL NORDENSTAM

SAVAGE, JAY M.: Evolution, 2nd ed. Modern Biology Series. — Holt, Rinehart and Winston, London 1971. 152 pp., 46 figures.

The first edition of Evolution by SAVAGE appeared in 1963. The second edition has been substantially revised and the chapters dealing with The Genetic Basis of Evolution, Genetic Drift, and The Rise of Man have been rewritten. The eleven chapters of the book are divided into three parts: Introduction, The Fundamental Evolutionary Process, and Evolutionary Divergence.

The book provides a good introduction to evolution, especially in the chapters dealing with Probability and Genetics, Population Genetics, The Role of Natural Selection, and Evolution above the Species Level.

Much emphasis is placed on the process of genetic drift as a major factor in evolution. On p. 113 the author speaks of drift in asexual organisms. However, it is debatable whether or not the term "drift" is the correct one for establishment of random mutations in asexual groups of organisms.

On p. 100 the author uses the term "chromosomal incompatibility" to explain the sterility of the F_1 offspring when two particular species of *Rana* are crossed. This term seems too limited; the more general "genetic incompatibility" would be preferable.

The symbol N, used by the author to represent the basic number of chromosomes in organisms, is not the one most commonly used in modern European literature. The symbol x has long been used for the basic number, and there is certainly an urgent need for uniformity. Furthermore, the author has used N for different purposes on different occasions. For instance, in Fig. 2—1 and Fig. 2—2 he uses N first for the basic number of chromosomes: here N=2, which is the same as the haploid number of chromosomes in this particular case. In the same figures he then uses N for replicated chromosomes: in this case N=4. That is, he does not distinguish between chromosomes and chromatids. This must be regarded as a serious disadvantage in an elementary textbook of evolution where ordinary cell division should be clearly presented.

On p. 24 the author says that chromosomes presumably contain one long DNA molecule. In fact, chromosomes contain a fairly large number of DNA molecules, at least in organisms above the level of Bacterium. Each organism seems to have a characteristic number of DNA molecules in its chromosomes.

The examples are with very few exceptions taken from zoology, a disadvantage for students mainly interested in plants and plant evolution, eventhough the main processes of evolution are similar in all organisms. Furthermore, most examples have understandably been taken from organisms indigenous to America, a fact that reduces the value of the book to European students not familiar with these organisms.

Provided due consideration is given to these objections the book can be recommended for use by students at university level.

BENGT BENTZER

CULBERSON, CHICITA F.: Chemical and botanical guide to lichen products. — The University of North Carolina Press. Chapel Hill 1969. XI+628 pp. Price $ 12.50 (cloth).

— : Supplement to "Chemical and botanical guide to lichen products." — The Bryologist 73: 2. 1970. 200 pp. Price $ 4.00.

It is a wellknown fact that lichens often produce chemical compounds which are not present in other groups. Some of them have been of economic importance since ancient times, e.g., the manna lichen, *Lecanora esculenta,* the litmus lichens, *Rocella* spp., and various species known as dye lichens. Several of these were described in a classical treatise by WESTRING, "Svenska lafvarnas färghistoria" (Colour history of the Swedish lichens) (1805—1809). Towards the turn of the past century many lichen compounds had been isolated, named and often provided with summaric chemical formulae. This knowledge was summarized in a classical work by ZOPF, "Die Flechtenstoffe" (1907), which described the chemical properties of more than two hundred compounds.

In the 1930's the Japanese botanist and chemist ASAHINA developed a new technique to identify the major lichen metabolites by microchrystallizations. A long series of papers by him and his students brought accelerated progress toward the elucidation of the structural formulae of lichen compounds. Old and new information was presented by ASAHINA and SHIBATA, "Chemistry of lichen substances" (1954), another milestone in the history of lichen chemistry.

The last two decades have seen several new methods, e.g., paper chromatography, thin-layer chromatography and gas chromatography, which have vastly increased our knowledge of the structure of previously unidentified lichen compounds. Dr. CHICITA CULBERSON (Dept. of Botany, Duke University, Durham, N. Carolina, U.S.A.) has summed up all information available at present in a magnificent volume. It is needless to state that this is a standard work indispensible to all serious lichenologists.

An introductory chapter "Lichen and fungal products" brilliantly summarizes the pathways of lichen chemistry including what is known of the biogenesis of lichen substances. The chapter "Chemical guide to lichen products" lists some 300 substances and their occurrence in species of lichens and fungi. Chemical and physical data are presented in a lucid way. A brief chapter "Chemical summary of the genera" reveals several correlations between occurrence of lichen substances and the traditional lichen systematics at generic or family level, but the many problems arising in this field are not discussed in detail.

The last and most comprehensive chapter is called "Botanical guide to lichen products". It lists c. 2000 lichen species which have been recorded in literature (prior to 1968) as containing "lichen substances". In several species only one substance is known, whereas some well investigated lichens, e.g., *Cetraria islandica*, *Cladonia rangiferina* and *Peltigera canina*, have been reported to contain some 15—25 different substances or elements. The name list includes a considerable number of synonyms with references to accepted names, a fact which will make the volume still more useful to the lichen taxonomist. To the merits of this book should be added the exhaustive lists of literature references at the end of each chapter.

Since NYLANDER (1867) introduced potassium hydroxide and calcium hypochlorite as colour tests to distinguish between related lichen species, most lichenologists have found these "chemical characters" to be a useful aid in taxonomy, moreover as they are often combined with morphological differences. In the 1930's ASAHINA introduced paraphenylenediamine for the same purpose. For some decades there was an inflation of "chemical species" often without any correlation to morphology. Somewhat analogous ideas have been met with in cytotaxonomy, where some authors have regarded any difference in chromosome number as sufficient for distinguishing a species. In both cases a natural reaction has followed against too narrow a species concept.

CULBERSON has presented a wealth of clear and critical information on lichen substances, but she has wisely left the interpretation of species and other taxa to the taxonomists.

The rapid progress in lichen chemistry is illustrated by the fact that a supplement containing a large amount of additional information (up till 1968 or 1969) has been issued soon after the publication of the main work. We may hope that Dr. CULBERSON will continue this exellent way of surveying and presenting new material to the benefit of chemists as well as taxonomists.

OVE ALMBORN

HALE, M. E.: The Lichens. — Pictured Key Nature Series "How to know . . .". W. C. Brown Co., Dubuque (Iowa) 1969. 266 pp., 428 illustrations (black-and-white). Price $ 3.00 (spiral-bound), $ 3.75 (cloth).

Dr. MASON E. HALE (Dept. of Botany, Smithsonian Institution, Washington D.C., U.S.A.) is known not only as a skilful monographer of the lichen genus *Par-*

melia (cf. review in Bot. Notiser 1966 p. 471, and article in present fascicle) but also as the author of excellent semipopular works on lichens, "Lichen Handbook" (1961) and "Biology of Lichens" (1967). These were reviewed in Bot. Notiser 1963 p. 110 and 1968 p. 136, respectively. The "Lichen Handbook" contained a fairly brief chapter on the lichen flora of North America (N. of Mexico). This flora has now been enlarged to an attractive booklet presenting a major part of macrolichens known from this area.

The 27 introductory pages give brief information on morphology, terminology, chemical tests, "how to collect and study lichens", uses of lichens, and a condensed bibliography. The bulk of the work consists of dichotomous keys to some 350 species of the more common larger lichens of North America. In addition, some 225 rarer species are discussed briefly under the major species of the key. Every major species has got an illustration (either a photograph or a drawing) in the text and a distribution map at a very reduced scale. Most of the illustrations, especially some photographs, are outstanding, whereas a few others are somewhat vague and give little help for identification. It should be admitted that most lichens are very difficult objects for the black-and-white photographer.

The choice has been restricted to foliose, fruticose and some squamulose lichens. Some species of *Lecanora, Rinodina* and *Placopsis* with more or less distinctly lobed margins have been included in the key, whereas the true crustose lichens which form the major part of the lichen flora are omitted. Some genera, e.g., *Collema, Ramalina* and *Usnea,* whose taxonomy is still uncertain, have been summarized rather broadly. Dr. HALE has accepted part of the many new genera established (or reestablished) in recent time, e.g., *Dirinaria, Platismatia, Cetrelia, Hypogymnia* and *Pseudevernia.* Others have been rejected, e.g., *Heterodermia, Pycnothelia, Lasallia* (and other segregates from *Umbilicaria* s.lat.).

The only taxonomic unit dealt with is the species. No subspecific taxa have been recognized. It is a wellknown fact, also to the trained lichenologist, that several lichen "species" are difficult to delimit as they show transitions to other species. Dr. HALE's treatment of some cases of this kind reflects the varying species concept met with in lichen taxonomy. *Peltigera praetextata* is recorded as a species but with the remark "Less common than *P. canina* and intergrading with it." Under *Usnea dasypoga* there is mentioned an "obvious intergradation with *U. ceratina* and other isidiate-sorediate species". The two chemotypes of *Thamnolia vermicularis* are listed as species but (correctly, in the reviewer's opinion) characterized as "chemical variants".

A student of European lichens will find much useful information in this well-organized volume. He should remember, however, that perhaps half of the number of species recorded by Dr. HALE from N. America do not occur in Europe, whereas a corresponding number of macrolichens fairly common in Europe are not found in N. America.

OVE ALMBORN

OPERA BOTANICA

Vol. 1. N. Hylander, I. Jørstad and J. A. Nannfeldt: Enumeratio Uredinearum Scandinavicarum. 1953. 102 pp. — H. Horn af Rantzien: Middle Triassic Charophyta of South Sweden. 1954. 83 pp. — H. Hjelmqvist: Die älteste Geschichte der Kulturpflanzen in Schweden. 1955. 186 pp. — Price Sw. Kr. 30 (15).

Vol. 2. H. Runemark: Studies in Rhizocarpon. I. Taxonomy of the Yellow Species in Europe. 1956. 152 pp. — H. Runemark: Studies in Rhizocarpon. II. Distribution and Ecology of the Yellow Species in Europe. 1956. 150 pp. — G. Knaben: On the Evolution of the Radicatum-Group of the Scapiflora Papavers as Studied in 70 and 56 Chromosome Species. A. Cytotaxonomical Aspects. 1959. 76 pp. — Price Sw. Kr. 30 (15).

Vol. 3. A. Gustavsson: Studies in Nordic Peronosporas. I. Taxonomic Revision. 1959. 271 pp. — A. Gustavsson: Studies in Nordic Peronosporas. II. General Account. 1959. 61 pp. — G. Knaben: On the Evolution of the Radicatum-Group of the Scapiflora Papavers as Studied in 70 and 56 Chromosome Species. B. Experimental Studies. 1959. 96 pp. — Price Sw. Kr. 30 (15).

Vol. 4. R. Dahlgren: Revision of the Genus Aspalathus. I. The Species with Flat Leaflets. 1960. 393 pp. — Price Sw. Kr. 30 (15).

Vol. 5. Á. Löve and D. Löve: Chromosome Numbers of Central and Northwest European Plant Species. 1961. 581 pp. — Price Sw. Kr. 40 (20), bound Sw. Kr. 48 (28).

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