

A BIOSYSTEMATIC STUDY OF  
*MICROSERIS* SUBGENUS *MONERMOS*  
(Compositae: Cichorieae)

Submitted for the degree of Doctor of  
Philosophy at the Botany Department,  
Victoria University of Wellington, New  
Zealand.

Barry Victor Sneddon

Nov. 1977

# FRONTISPIECE

Capitula of tetraploid ( $2n = 36$ ) *Microseris scapigera* pop. SK (left), octoploid ( $2n = 72$ ) *M. lanceolata* pop. LF (right) and their hexaploid ( $2n = 54$ ) hybrid, H194 (centre).

(The bracteole tips of the LF capitulum have withered slightly).

Magnification c.  $\times 4$ .



CONTENTS

	<u>Page No.</u>
ABSTRACT	1
INTRODUCTION	2
Chambers' work on subgenus <i>Monermos</i> (1955)	2
Morphology and habitats of subgenus <i>Monermos</i>	3
Early taxonomic history of the species in subgenus <i>Monermos</i>	3
Treatment in Allan's Flora (1961)	4
Species recognised in this study	5
Purpose of present study	5
SECTION I. MORPHOLOGICAL CHARACTERS, SYSTEMATIC TREATMENT, VARIATION	6
Methods	6
Morphological characters	10
Systematic treatment	17
<i>Microseris</i> subgenus <i>Monermos</i>	17
Key to species	19
<i>M. scapigera</i>	20
<i>M. lanceolata</i>	26
Key to infraspecific races	31
Race 1	31
Race 2	38
Race 3	42
Variation	45
Phenotypic plasticity	45
(1) Differences between cultivated and wild plants	45
(2) Aspects of plasticity in cultivation	47
Genetic variation within populations	48
Geographical variation	50
(1) <i>M. scapigera</i>	50
(2) <i>M. lanceolata</i> race 1	55
(3) <i>M. lanceolata</i> race 2	57
(4) <i>M. lanceolata</i> race 3	59
SECTION II. BREEDING SYSTEM	61
Method	61
Results	61
Flowering and pollinating behaviour (general)	61
Self-incompatibility	62
SECTION III. ARTIFICIAL HYBRIDIZATIONS	65
Methods	65
Crosses within subgenus <i>Monermos</i>	68
General results	68
Crossing relationships	70
Intraspecific crosses: <i>M. scapigera</i>	70
Intraspecific crosses: <i>M. lanceolata</i>	71
Interspecific crosses	72
Crosses between subgenera: <i>Monermos</i> x <i>Apargidium</i>	75
Discussion: genetic relationships	76
(1) Intraspecific relationships in subgenus <i>Monermos</i>	76
(2) Interspecific relationships in subgenus <i>Monermos</i>	77
(3) Comparison with crosses within subgenus <i>Microseris</i>	78
(4) Origin of <i>Microseris</i> subgenus <i>Monermos</i>	80
(5) Genome differentiation in subgenus <i>Monermos</i>	81
SUMMARY	83
ACKNOWLEDGMENTS	85

REFERENCES	86
TABLES	90-102
PLATES (following page 102)	

### TABLES

1.	Comparison of <i>Microseris scapigera</i> formae	90
2.	Code to collections kept in cultivation and used in experimental studies	91
3.	Comparison between Walpers' description of <i>Phyllopappus lanceolatus</i> and probable types	92
4.	Comparison between <i>Microseris scapigera</i> and <i>M. lanceolata</i>	93
5.	Comparison of <i>Microseris lanceolata</i> races	94
6.	Measurement averages for reproductive characters	95
7.	Comparison of pollen grains in <i>Microseris</i> subgenus <i>Monermos</i>	96
8A.	Breeding systems in <i>Microseris</i> subgenus <i>Monermos</i>	97
8B.	Self-pollination fruit set	97
9.	Data on germination and pollen fertility of intra- & interspecific F <sub>1</sub> crosses in <i>Microseris</i> subgenus <i>Monermos</i>	98-101
10.	Data on germination and pollen fertility of intra-specific F <sub>2</sub> and intra- & interspecific BC <sub>1</sub> progenies in <i>Microseris</i> subgenus <i>Monermos</i>	101
11A.	Backcross fertility: percentages of good pollen in some backcrossed interspecific hybrids in <i>Microseris</i> subgenus <i>Monermos</i>	102
11B.	Distribution of average pollen fertilities of the backcrosses in Table 11A.	102

PLATES

1. Reference points for measurements
2. Early illustrations of *M. scapigera* and *M. lanceolata*
3. Lectotype of *Microseris scapigera* (Sol. ex A. Cunn.) Sch.-Bip.
4. Holotype? and isotype? of *Microseris lanceolata* (Walp.) Sch.-Bip.
5. Lectotype and isolectotype? of *Scorzonera* (*Moniermos*) *lawrencii* Hook. f.
6. Specimens of *M. forsteri* var. *subplumosa*, *M. teakleana*, and *M. latifolia*
7. Distribution of *M. scapigera*
8. Distribution of *M. lanceolata* race 1
9. Distribution of *M. lanceolata* races 2 & 3
10. *M. scapigera* formae. Representative herbarium specimens to show habit
11. *M. lanceolata* race 1. Representative herbarium specimens to show habit
12. *M. lanceolata* race 2. Representative herbarium specimens to show habit
13. *M. lanceolata* race 3. Representative herbarium specimens to show habit
14. Roots and stems I. *M. scapigera*
15. Roots and stems II. *M. lanceolata* race 1
16. Roots and stems III. *M. lanceolata* race 2, *M. lanceolata* intraspecific and interspecific hybrids
17. *M. lanceolata*. Adventitious suckers on roots
18. Leaf form I. Silhouettes of leaves from glasshouse-cultivated plants to show seasonal extremes in size
19. Leaf form II. *M. scapigera*
20. Leaf form III. *M. scapigera*
21. Leaf form IV. *M. lanceolata*
22. Leaf form V. *M. scapigera* and *M. lanceolata* - selected intraspecific and interspecific hybrids
23. Leaf form VI. *M. scapigera* and *M. lanceolata* - selected intraspecific and interspecific hybrids
24. Leaf surfaces. *M. lanceolata* and *M. scapigera*
25. Capitula viewed from above. *M. scapigera* and *M. lanceolata*
26. Capitula form I. *M. scapigera*: examples of capitula from glasshouse-cultivated populations, viewed from the side (with florets in nocturnal position).
27. Capitula form II. *M. scapigera*: examples of capitula from glasshouse-cultivated populations, and from wild plant herbarium specimens

28. Capitula form III. *M. lanceolata*: examples of capitula from glasshouse-cultivated populations, viewed from the side (with florets in nocturnal position)
29. Capitula form IV. *M. lanceolata* race 1: examples of pressed capitula from wild plant herbarium specimens
30. Capitula form V. *M. lanceolata* races 1-3: examples of pressed capitula from wild plant herbarium specimens
31. Capitula form VI. *M. lanceolata* race 2: examples of pressed capitula from wild plant herbarium specimens
32. Involucre part form I. *M. scapigera*
33. Involucre part form II. *M. scapigera* and *M. lanceolata*
34. *Microseris* subgenus *Monermos*: trichome types and pappus awn silhouettes
35. Form of achenes and pappus I. *M. scapigera*
36. Form of achenes and pappus II. *M. lanceolata*
37. Achene and pappus member detail
38. Map indicating pappus measurements in *M. scapigera*
39. Map indicating pappus measurements in *M. lanceolata*
40. Achene and pappus variation in *Microseris scapigera* population SF
41. Map indicating average states of 12 reproductive characters in population samples of *M. lanceolata* and *M. scapigera*
42. Chromosomes. *M. scapigera*, *M. lanceolata*, and interspecific hybrids
43. Crossing details
44. Average pollen fertilities in F<sub>1</sub> crosses within *Microseris* subgenus *Monermos*, together with unsuccessful crosses
45. Summary of pollen fertility in F<sub>1</sub> crosses within *Microseris* subgenus *Monermos*
46. Capitula of crosses. SC x SW, SK x SC
47. Capitula of crosses. SK x SG, SM x SC
48. Capitula of crosses. SM x SK, SM x SW
49. Capitula of crosses. SW x SK, F<sub>2</sub>
50. Capitula of crosses. SC x LA, SK x LA
51. Capitula of crosses. SK x LF, LC x SA
52. Capitula of crosses. LE x LB, LE x SD

## ABSTRACT

The taxonomy of *Microseris* subgenus *Monermos* (Hook. f.) Chambers (Compositae: Cichorieae) is investigated. Two species are recognised, namely *M. scapigera* (Sol. ex A. Cunn.) Sch.-Bip. and *M. lanceolata* (Walp.) Sch.-Bip., which are confined to New Zealand and Australia respectively. In *M. scapigera*, taxonomic subdivision was not practicable, the formae of Allan (1961) not being upheld. *Microseris lanceolata* is subdivided into three groups which are described informally as races. The races are viewed as probable subspecies but need further study before this status can be confirmed. The two species are described and illustrated and details are given for each on typification, synonymy, chromosome number, distribution, ecology and geographical variation.

Strong self-incompatibility is prevalent in both *M. scapigera* and *M. lanceolata*. The only exceptions in the populations examined were in *M. scapigera*, in which two populations were only moderately self-incompatible, and another was substantially self-compatible. The last population appeared to have morphological and behavioural adaptations to promote autogamy.

Artificial hybridizations were made within and between the two species. *Microseris scapigera* and *M. lanceolata* were freely or poorly intercrossable according to the populations used, and formed semi-fertile or sterile hybrids. Semi-fertile hybrids were virtually blocked from forming a F<sub>2</sub> generation (fruit set was very low and no fruits germinated) but they could be backcrossed. Fertility in BC<sub>1</sub> hybrids was mostly higher than in the F<sub>1</sub>, but was not restored to normal. *Microseris scapigera* and *M. lanceolata* race 1 appear to have largely homologous chromosomes.

Attempts to cross the species of subgenus *Monermos* with *M. borealis* (subgenus *Apargidium*) were unsuccessful.

## INTRODUCTION

*Microseris* is classified as a member of the Compositae tribe Cichorieae, and is currently placed in subtribe Microseridinae (Stebbins 1953). It is a genus of about 17 species\*.

The most recent monograph on the genus is that of Chambers (1955). Chambers was primarily concerned with reviewing the taxonomy of the annual species of *Microseris* (subgenus *Microseris*) but he also circumscribed the genus and its principal subgeneric taxa. He delimited four subgenera: *Microseris* (annuals), *Scorzonella*, *Apargidium* and *Monermos*† (all perennials). The first three subgenera have an American distribution (Western North America except for one species of subgenus *Microseris*, *M. pymaea*, which occurs in Chile), while the last is confined to Australia and New Zealand. The present study is concerned with an investigation of the Australasian subgenus *Monermos*.

Chambers' work on subgenus *Monermos* (1955).

Chambers recognised one species in Australia and New Zealand, *M. scapigera*, an opinion that has since been followed by the authors of regional floras. In a preliminary study of cytology he found that Australian and New Zealand material examined was tetraploid with 36 chromosomes (of the other subgenera, *Apargidium* and *Scorzonella* have the diploid number 18, while *Microseris* has both tetraploid and diploid species). On the basis of karyotype comparison, together with evidence from external morphology, he suggested a possible amphiploid origin for subgenus *Monermos* from a hybrid between subgenus *Microseris* (section *Microseris*) and subgenus *Apargidium*. Chambers also investigated the breeding system in two collections (one from Australia and one from New Zealand) and found both to be self-incompatible.

---

\* Based on Chambers (1955, 1957) and the present study.

† Originally spelt *Moniermos* but corrected to *Monermos*, see p. 17.

### Morphology and habitats of subgenus *Monermos*.

Plants vary considerably in size. They have a low-growing rosette-leaved habit with highly contracted stems (caudex and branches) and well developed taproots which are tuberous in some plants and non-tuberous in others. Capitula are mostly conspicuous and are borne on long unbranched naked scapes. Members of the subgenus are found in open habitats, commonly in grassland but also in glades in forest, in grassy open woodland, in valley-floor herb communities and on cliffs.

### Early taxonomic history of the species in subgenus *Monermos*.

The first plants were discovered by Sir Joseph Banks and Dr. Daniel Solander at Totaranui (Queen Charlotte Sound) on Captain James Cook's first voyage to New Zealand (1769-1770). Solander prepared a detailed description under the name *Scorzonera scapigera*, and a plant was illustrated by Parkinson (Plate 2 A), but the work was not published\*.

In 1786, George Forster published the name of Solander's species, *Scorzonera scapigera*, but since there was no accompanying description it was invalid. The name was validated by Allan Cunningham in 1838 when he published a short description for *Scorzonera? scapigera*, and designated two syntypes.

In 1840, Wilhelm Walpers published the description of *Phyllopappus lanceolatus*, based on material collected in Australia by Johann Lhotsky.

In 1846, Etienne Raoul mistakenly listed *M. pygmaea* "Hook. et Arn." (= *M. pygmaea* Don) as occurring in New Zealand, and the name appeared subsequently in the synonymies of New Zealand Floras.

---

\* Solander had two manuscripts: his "Slip Catalogue" and the "Primitiae Florae Novae Zealandiae." Page references to *Scorzonera scapigera* in the two MSS are 749-752 and 516-7 respectively. The description is the same in both cases except that the "Slip Catalogue" has an accompanying introductory sentence of 11 words. The original copies of the MSS are lodged at the British Museum of Natural History.

In 1847, Joseph D. Hooker described *Scorzonera lawrencii* from Tasmania and placed it together with *S. scapigera* Forst. in a newly erected subgenus, *Moniermos*. Not long afterwards, in 1852, Hooker submerged both species names under the nomenclaturally superfluous *M. forsteri* Hook. f., and in 1856 he also included *Phyllopappus lanceolatus* under this name.

In 1866, the third volume of George Bentham's *Flora Australiensis* appeared. In this Bentham maintained *M. forsteri* for Australian and New Zealand material and named a variety from Western Australia, var.? *subplumosa*, which was distinguished by "strongly ciliate, almost plumose" pappus bristles.

In a paper also published in 1866, C.H. Schultz-Bipontinus recognised two species in the Australasian region for which he made the combinations *M. scapigera* (Forst. f.) Sch.-Bip. and *M. lanceolatus* (Walpers) Sch.-Bip. *M. forsteri* was reduced to a synonym under *M. scapigera*. He erected a subgenus, *Gelasiopsis*, to incorporate both species and a third, *M. boreale* (= *M. borealis*) from Alaska. Each species was placed in a supraspecific taxon of equal rank (section or series?) viz.: *Podospermopsis* (*M. scapigera*), *Phyllopappus* (*M. lanceolatus*), and *Apargidium* (*M. boreale*).

Subsequent authors mostly treated *Microseris* from Australia and New Zealand as a single species, referring it either to the long-retained *M. forsteri*, or to *M. scapigera*.

#### Treatment in Allan's Flora (1961).

Allan followed Chambers (1955) in recognising a single species of *Microseris* in Australasia, *M. scapigera*, but he did not make a critical comparison between New Zealand, Australian and Tasmanian forms. In treating variation within New Zealand he described four formae (see Table 1), into which forms could be 'roughly grouped'. Allan noted that there were intermediates between the formae; that the relative

contributions to the polymorphy played by genetic and habitat conditions were not clearly known; and that further study of the distribution and status of the complex was needed.

#### Species recognised in this study.

Australian and New Zealand material was found to differ significantly in cultivation and differences were also apparent in a survey of herbarium specimens collected in nature. Accordingly, two species are recognised in subgenus *Monermos*:

*M. scapigera* (Sol. ex A. Cunn.) Sch.-Bip.

*M. lanceolata* (Walpers) Sch.-Bip.

#### Purpose of present study.

The aims of this study were threefold:

1. To delimit and critically compare *M. scapigera* and *M. lanceolata* and to investigate variation within each species, by examining herbarium material and plants grown in cultivation.
2. To continue the investigation of the breeding system in subgenus *Monermos* begun by Chambers.
3. To carry out a programme of artificial hybridizations within and between the species of subgenus *Monermos*, to determine genetic relationships. A subsidiary aim was to use material of *M. borealis* (subgenus *Apargidium*) which was available to test for intersubgeneric crossability with subgenus *Monermos*.

# SECTION I. MORPHOLOGICAL CHARACTERS, SYSTEMATIC TREATMENT, VARIATION.

## METHODS

**POPULATION SAMPLES.** Live plant studies were limited to the investigation of population samples in cultivation: experiments were not made on populations in nature. One sample was studied from each population and consisted of either transplants or plants raised in cultivation from the seed of wild plants. The original number of plants per sample, which varied from 1-20\*, was augmented in some cases by sexually produced progeny. The collections used in the experimental studies are detailed in Table 2. The population sample (BA) of *M.* (subgenus *Apargidium*) *borealis* (Bong.) Sch.-Bip. was used only in crossing experiments (SECTION III).

**CODING.** Plants collected from each field population for experimental study and all subsequent offspring derived from selfings or intrapopulation crossings were referred to under the one symbol. This consisted of two letters: the first denoting the species (*S* = *scapigera*, *L* = *lanceolata*, *B* = *borealis*), and the second the population (Table 2). Individual plants were identified by numbers placed after the population letter. Code symbols were used in record entries, on seed packets, and in labelling all potted, pressed, and preserved derivatives. Interpopulation crosses (within and between species) are referred to in the text by placing the respective symbols in combination, the maternal parent being first, e.g. SK x LF (SECTION III).

---

\* Plants per sample († denotes progeny also produced): SA = 18†; SB = 3; SC = 12†; SD = 16†; SE = 10†; SF = 15; SG = 12†; SH = 12; SI = 3; SJ = 13; SK = 11†; SL = 2; SM = 6†; SN = 16; SO = 14; SP = 12†; SQ = 4; SR = 6†; SS = 6; ST = 3; SU = 6; SV = 6; SW = 2†; SX = 12; LA = 20; LB = 3; LC = 20; LD = 1; LE = 1; LF = 1; BA = 6.

CULTIVATION. Plants were cultivated in unheated glasshouses and outdoors in sawdust plunge beds. Most plants were grown in a soil mixture consisting of soil:peat:sand:fertiliser ('nitrophoska' or 'magamp') in a ratio of 3:2:1:trace. Some were grown in either peat:perlite:shingle (c. 3:1:1), or fine sand (both with fertiliser). Plastic or clay pots of various sizes (10 to 30 cm in height) were used, depending on the size of the plant. All population samples were propagated by cloning. Clones were derived from either independent rooted branches (tuberous and non-tuberous populations), or adventitious suckers on roots (populations LC, LD, LE & LF). Large numbers of suckers were obtained from roots laid on the soil surface (Plate 17). Plants cultivated in glasshouses for measuring were repotted annually (prior to the flowering season) in fresh soil mixture, to promote optimum growth.

DESCRIPTIONS. Descriptions of taxa are based primarily on wild plants as represented by herbarium specimens. Specimens from all the main Australasian herbaria have been studied, as well as the collections of Kew, the British Museum, Paris Museum, and the Universities of Kiel (West Germany) and Lyon (France). Descriptions of all but one taxon (*M. lanceolata* race 3) also incorporate measurements from cultivated plants, distinguished by {} brackets. These measurements refer to extremes beyond the observed range in wild plants (delimited by () brackets), and to floret characters not readily observable in herbarium material. The description of subgenus *Monermos* includes characters common to all its members and such characters are not repeated in the descriptions of subsidiary taxa. Intraspecific taxa in *M. lanceolata* are described informally as races.

TERMINOLOGY. The terms used for the shapes of involucre parts and paleas are those adopted by the Systematics Association Committee for Descriptive Biological Terminology (Taxon 11: 145-56 and Chart 1, 1962). The outer and inner series of involucre parts are referred to as bracteoles and phyllaries respectively, following the terminology of Allan (1961) and Curtis (1963). Terms classifying the length of bristles (spiculae) on pappus awns and paleas are based on Chambers' illustration (1955, fig. 2), with the addition of subplumose (= barbellate) for longer bristles. The terms are standardised as follows: minutely denticulate = 0.008-0.02 mm; minutely spiculate = 0.02-0.08 mm; spiculate = 0.08-0.14 mm; barbellulate = 0.14-0.20 mm; subplumose = 0.2-0.6 mm. Other terms not explained in the text follow definitions in Stearn (1973), Allan (1961) or Jackson (1928).

MEASUREMENTS. All measurements, unless stated otherwise, were made on mature material, fresh, liquid-preserved or pressed. The points from which less obvious measurements were made are illustrated in Plate 1. For uniformity, only outer phyllaries and corollas were measured. In descriptions, phyllary measurements from flowering and fruiting heads were not separated as the difference in size was usually small. Averages in cultivated material were based mostly on 28-30 measurements for bracteole, phyllary, corolla and anther characters (Table 6), and mostly on 25-50 measurements for all other characters (Table 6, Plate 38). The measurements in Table 6 were made from all available plants in each population sample so that averages would be representative of the sample as a whole. (However, the averages have limited value for direct comparison since some samples were derived from a single plant (populations LD, LE & LF), some from a few, and others from many). Averages for the fruits of *M. lanceolata* (Plate 39) were based on 3-12 measurements (mostly from one plant) in herbarium specimens, and 50 measurements (from more than one plant) in populations LA, LB, & LC (circles G, M & H respectively, in

race 1). Pollen diameters in Table 7 were measured at a magnification of 400, at which the smallest measurable distance (one eyepiece micrometer division) was 2.37  $\mu\text{m}$ .

**CITATION OF SPECIMENS.** The type of the species and the types of synonyms are cited in full in paragraphs following the description. Type duplicates and syntypes have only their location indicated in these paragraphs, and are cited fully under 'representative specimens' or in captions to illustrations. Specimens cited under 'representative specimens' have been selected to exemplify the geographic distribution and morphological range of each taxon. The format for specimen citation is as follows: locality, altitude, collector and collector's number (both italicised), date, Herbarium abbreviation (with the herbarium sheet number given only when there is no collector's number), and an abbreviation in parentheses for the reproductive condition of the specimen (fl. = flowering; fr. = fruiting; st. = sterile). Herbarium abbreviations follow Holmgren and Keuken (1974). For uniformity the months of all dates are given in Roman numerals, and distances and altitudes originally in imperial measures have had metric equivalents included.

**DISTRIBUTION AND ECOLOGY.** The geographic range of the taxa in subgenus *Monermos* is shown in distribution maps. The maps are based solely on herbarium specimen records. All traceable localities are indicated by symbols providing they are more than 5 km apart in New Zealand and 6 or 12 km apart (depending on map scale) in Australia. Ecological data have been derived from herbarium specimen labels and from the literature.

**CHROMOSOMES.** Chromosome counts were made from squashes of root tip cells (somatic chromosomes) and pollen mother cells (meiotic chromosomes). Root tips were pre-treated in 0.5% colchicine for two hours, fixed in 3:1 absolute ethyl alcohol:glacial acetic acid for 18 hours, hydrolysed in 1N HCl at 60° C for 10 minutes, and stained in leuco-basic-fuchsin

(Feulgen's stain). Capitulum buds were fixed in 3:1 absolute ethyl alcohol:glacial acetic acid for 24 hours, then stained in alcoholic HCl-carmines (Snow 1963).

PHOTOGRAPHS. Macrophotographs were taken using an Asahi Pentax 35 mm camera body with one of the following lenses: macrotakumar 50 mm f/4, bellows-takumar 100 mm f/4, or (in Plates 24, 35 & 36) a Nikon macro-nikkor 120 mm f/6.3. Photomicrographs were taken on a Zeiss photomicroscope III. The films used were Ilford Pan F and Agfa IF (macrophotographs), and Agfa L Agepe FF (photomicrographs).

#### MORPHOLOGICAL CHARACTERS

ROOTS. Taxonomically useful root characters are compared in Tables 4 & 5.

Roots in the subgenus *Monermos* are characteristically fleshy. They are cream coloured at first but eventually form a pale brown or rusty brown periderm. In both *M. scapigera* and *M. lanceolata* the primary root may be the strongest root or secondary roots developed from the base of the stem may be larger (Plates 14 B, 15 F). The main roots sometimes produce strong laterals (rare in *M. lanceolata* race 1) or become fastigiately branched at their ends.

Roots in the subgenus are described herein as either tuberous or non-tuberous. The two types differ both in shape and behaviour. Tuberous roots only occur in *M. lanceolata* race 1. They possess a short proximal swollen portion (tuber) which tapers sharply distally. Non-tuberous roots are elongate, and taper gradually from near insertion or are cylindrical for much of their length. Tuberous roots are specialised as water and carbohydrate storage organs. They reach maximum size when about one year old, then become markedly and progressively more shrivelled in their second year as the stored contents are used up (Plate 15 A-E). Non-

tuberous roots have a less significant storage function. The larger ones live for approximately two years and undergo little or no shrivelling after the removal of stored foods (Plate 14 D).

In the wild, tuberous roots tend to be produced in regular seasonal succession, one new root per plant each growing season. Non-tuberous roots on the other hand tend to be produced more frequently, often several per plant each year. In tuberous plants, seasonal root growth together with shrivelling behaviour make it possible to estimate the approximate age of the plant up to about five years. Thus old plants usually have a cluster of tubers comprising the swollen current tuber, the shrivelled one from the previous season, and the much-shrunken empty shells of those from still earlier seasons. In non-tuberous plants age cannot be determined in this way.

Tuberous roots appear to be similar in seasonal growth and behaviour to roots in subgenus *Scorzonella* as described by Chambers (1955, p.213).

Adventitious suckers occur on roots of *M. lanceolata* (only on non-tuberous roots) but are apparently absent from *M. scapigera*. The suckers are produced abundantly in cultivation (Plates 16 A & E, 17) but are probably uncommon in nature since none have been found on herbarium specimens. Adventitious suckers on roots are known to occur in other genera of the Cichorieae e.g. *Crepis* (Babcock 1947, p.217) and *Taraxacum* (Clapham et al 1962, p.929) but as far as the author is aware they have not been reported before in *Microseris*.

STEMS. Caudex and branch length in the subgenus ranges from less than 5 mm to (rarely) 80 mm. The length varies in both species though *M. lanceolata* has a shorter range (maximum c. 20 mm) than *M. scapigera*.

Apical growth of the caudex ceases with the formation of a terminal inflorescence. This is followed by the production of a variable number (up to c. 20) of reproductive branches, each consisting of 0-2 basal leaves and a terminal scape.

The growth of vegetative axillary buds on the caudex usually follows flowering, but sometimes precedes it. In cultivated plants the number of branches produced per season varies in both species from one (sympodial branching, e.g. Plates 14 G, 16 C) to many (e.g. Plates 14 B & D, 15 H). Branching frequency is sometimes increased in cultivation, especially in *M. lanceolata* race 1.

Vegetative branches eventually develop one or more adventitious roots. The age at which branches first produce roots varies from young (few leaved) to mature (multi-leaved) in both species. The earliest root growth occurs in *M. lanceolata* race 1 in which a root is associated with each branch from the bud stage. Rooted branches may remain connected to the caudex for one or more years (Plates 14 E, 16 C & D) but finally become independent plants through death and disintegration of caudical and/or proximal branch tissue (Plate 14 I). In *M. lanceolata* race 1, under cultivation, branches often become independent at a very early age (Plate 15 C).

LEAVES. The two species cannot be separated reliably on leaf shape, lobing or size. Leaves are subject to marked environmental modification (see on). However, leaf blade surface markings and marginal pubescence appear relatively stable and hence taxonomically useful (Table 4, Plate 24). Surface markings, especially raised abaxial veins, have two limitations as characters: firstly, they are only exhibited on broader laminae (not visible on narrow-linear and filiform blades); and secondly, they are essentially fresh-plant characters which tend to be lost in pressing, although rugulose surfaces are sometimes preserved on herbarium specimens.

In *M. scapigera*, leaves of plants from coastal stations are subfleshy, whereas those of inland plants are more membranous. It is not known whether *M. lanceolata* also has subfleshy leaves in maritime localities.

The leaves of *M. lanceolata* race 1 tend to die back to ground level after flowering (a phenomenon associated with seasonal drought). Evidence for this comes from herbarium specimens of wild plants, and from plants grown in cultivation. Herbarium specimens of mature fruiting age (early to mid summer collections) frequently had withered leaves that would have been either dead or dying when collected. Such specimens, though only comprising a small proportion of all specimens seen (the majority of which were collected at an earlier flowering stage), were geographically separated (SA, Victoria, N.S.W.) indicating that leaf die-back occurs over much of the area of the race. A number of herbarium specimen labels had the comment "annual", perhaps alluding to die-back behaviour. Material grown in cultivation exhibited die-back in two out of three populations, LA & LC but not LB. Both the former populations could be maintained in the leafy state through summer if kept well watered. Apparently, populations (and individuals within populations) have different thresholds at which water stress causes die-back.

SCAPES. Scapes that terminate vegetative stem axes, particularly the caudex, tend to be slightly larger and bear larger capitula than those produced on short axillary reproductive shoots. Scapes usually reached near-maximum length at anthesis (the length in Table 6) but in a few populations elongation continued until fruiting maturity. The most marked increase occurred in population SW of *M. scapigera*, which had mean scape lengths of 29 and 51 cm at anthesis and fruiting respectively.

CAPITULA. Taxonomically useful capitulum characters are included in Tables 4 & 5.

The involucre is typically biseriate, with a "calyx-like" outer series of small scales (bracteoles) and an inner series of larger, more elongate nearly equal scales (phyllaries). The bracteoles are usually unequal, with members of a series increasing progressively in size from outside inwards. The innermost (largest) bracteole is generally markedly shorter than the phyllaries but occasionally reaches  $2/3 - 3/4$  phyllary length. Phyllaries may elongate slightly between anthesis and fruiting. Such elongation is apparently much less than occurs in subgenus *Microseris* (Chambers 1955, p. 218).

FRUITS. Fruits in the subgenus are not greatly modified by the environment and hence provide reliable taxonomic characters.

*M. lanceolata* exhibits a wider range of achene and pappus variation than *M. scapigera* (Table 4).

The achenes of a head usually differ slightly in length and curvature: outer ones tend to be longer and more curved than inner ones. The difference in length has a maximum of about 2 mm, in the long achenes of *M. lanceolata* race 1.

The pappus ranges from paleaceous to capillary in both *M. lanceolata* and *M. scapigera*. The capillary states of both species closely resemble that of *M. borealis* (subgenus *Apargidium*). In paleaceous members the distinction between distal awn and proximal palea is obvious. Capillary members also have a distinct proximal region (here referred to as the capillary base) which, unlike the awn, is flattened in all but the narrowest members, and largely smooth (spiculae if present mostly confined to margins). The members of paleaceous pappuses are usually uniform in length and palea size. The members of capillary pappuses on the other hand are sometimes more variable: both in overall length

(between 1/3 and, rarely, 2/3 of the members may be shorter and weaker than the others); and in the character of the bases (capillary and slightly paleaceous bases occurring together).

**PUBESCENCE.** The indumentum in the subgenus consists of unicellular and multicellular (uniseriate) trichomes. A selection of these is illustrated in Plate 34 Fig. 1.

Both species in the subgenus possess the multicellular trichomes that characterise the genus as delimited by Chambers (1955, p. 214): furfuraceous trichomes which occur on leaf blades, scapes and involucre; and black villous and tomentose non-glandular hairs on the involucre. Transitional types between furfuraceous and villous trichomes also occur on the involucre. Villous trichomes (colourless or brownish) are also found on the corolla, and sometimes on achenes and at the base of petioles and scapes. Other trichomes in the subgenus are strigulose (unicellular) and scaberulous (unicellular ?) types, which both occur on achenes.

Indumentum density varies in *M. lanceolata* and *M. scapigera* and nearly glabrous plants are common in both species. The most pubescent leaves have a mealy white appearance on both surfaces, but only when young: leaves (and scapes) are largely glabrescent. On almost glabrous plants furfuraceous trichomes can always be found on young scapes beneath the capitulum bud, and tomentose-villous ones are usually (if sparsely) present on inner phyllaries.

The following pairs of indumentum characters are the most useful taxonomically: (1) Leaf margins either have furfuraceous pubescence (just visible in Plate 24 B) or are glabrous. (2) Outer phyllaries either have black-tomentose pubescence over the whole dorsal surface (Plate 28 E-G) or confined (if present) to the tip region. (3) Achenes either have strigulose trichomes (Plate 37 E) or not (glabrous or with other trichome types only). *M. scapigera* has only the second character in each pair, while *M. lanceolata* has both.

ANTHOCYANIN PIGMENTATION. Red-purple pigmentation occurs frequently in the subgenus and is very variable in distribution and intensity. Plants may lack anthocyanin altogether, or show it in one or more parts. Pigmentation occurs mainly in the following sites: petiole (less commonly on the leaf blade); base and apex of scape; involucre; back of corolla; achene (*M. lanceolata* only). Pigmentation on the involucre varies widely: it may be restricted to the bracteoles or to the phyllaries or occur on both. Pigment may be present as blotches at the tips of involucral parts or as narrow to broad stripes along the midribs. Sometimes all green areas of the involucre are tinged or more strongly stained with anthocyanin.

CHROMOSOME NUMBERS. Chambers (1955, p.248) counted the chromosomes in three collections of subgenus *Monermos* and found them all to be tetraploid with 36 chromosomes. Two of his collections were from New Zealand (= *M. scapigera*), while the third came from Mt. Stirling in the Australian Alps (= *M. lanceolata*, possibly race 2).

Of four populations (SK, LB, LE & LF) counted by the writer (Plate 42) three were also tetraploid and one (LF) an octoploid with 72 chromosomes. Another two populations (SA and LC) can be inferred as tetraploids from the meiotic chromosome number of their hybrid (LC x SA)  $n = 18$  (Plate 42 F).

## SYSTEMATIC TREATMENT

*MICROSERIS* subgenus *MONERMOS* (Hook. f.) Chambers corr. Sneddon\*

*Phyllopappus* Walp. Linnaea 14: 507. 1840. Type: *P. lanceolatus* Walp.

*Scorzonera* subgen. *Moniermos* Hook. f. Lond. Journ. Bot. 6: 124. 1847.

Type: *S. lawrencii* Hook. f., a heterotypic synonym of *Microseris lanceolata* (Walp.) Sch.-Bip.

*Microseris* subgen. *Gelasiopsis* Sch.-Bip.† Pollichia 22-24: 309. 1866, as "*Microseris* VIII. *Gelasiopsis*", p.p. Lectotype: *Scorzonera scapigera* Sol. ex A. Cunn.

DIAGNOSIS: This subgenus differs from subgenus *Microseris* in its perennial habit, from subgenus *Apargidium* in its non-rhizomatous caudex, and from subgenus *Scorzonella* in its unbranched and ebracteate inflorescences.

EXPANDED DESCRIPTION: *Plant*— herbaceous perennial. Caudex short, vertical, internodes suppressed, covered with brown bases of old leaves, us. sparingly branched but sts multicipital, with one or more fleshy, short tuberous or elongate non-tuberous roots. *Leaves*— basal, sts brown woolly at base, glabrous or furfuraceous on blade, green or often tinged with reddish-purple toward the base, linear (sts filiform) to lanceolate or obovate-spathulate, acute to obtuse or apiculate, entire to toothed and/or lobed (the lobing to deeply pinnatifid), tapering into

---

\* The original spelling of *Moniermos* contains an apparently erroneous connecting vowel (i) which is here treated as an orthographic error under the Code (Stafleu et al, 1972, p. 63). Hooker (1852, 1856) subsequently amended the spelling (without comment) to *Monermos* (in synonymy), and later authors have followed either spelling or *Monermios* as mis-quoted by Bentham (1866). The name seems likely to have been based on the Greek compound word *monerma* (μόνος, single, and ἔρμα, prop, support) and possibly refers to the palea. *Monerma* is also a generic name (Gramineae).

† Schultz-Bipontinus (loc. cit.) denoted his primary infrageneric epithets with Roman numerals and did not specify their rank. Chambers (1955, p. 275), points out why they can be regarded as subgenera.

a ± winged petiole with a broader ± clasping base; lobes narrow-triangular to linear or filiform, straight or falcate, entire or occ. toothed. *Inflorescence*— 1 to many unbranched naked scapes terminating the caudex and its branches. Scapes us. longer (up to c. 2x) than the leaves, erect or ascending from a straight or geniculate base, stout or slender, fistular, ribbed, sts brown woolly at base, us. furfuraceous above especially under the head, green or tinged with reddish-purple, straw-coloured at maturity. *Capitula*— 8- to {98} -flowered, head nodding in bud, erect or semi-nodding while fruits are maturing, erect with the involucre reflexed and the fruits forming a dandelion-like ball at maturity. Involucre somewhat fleshy, green, often striped with reddish-purple, parts ± equally divided between 2 series: outer series (bracteoles) us. calyculate, unequal, the longest ±  $\frac{1}{2}$  as long as inner series, broadly elliptic, oblong or narrowly to very broadly ovate-triangular, obtuse to acute or acuminate, obtusely keeled, glabrous or pubescent on back and/or margin; inner series (phyllaries) nearly equal, us. narrowly -elliptic or -ovate, obtuse or acute, obtusely keeled to nearly plane, margin membranous, occ. furfuraceous without, us. black-tomentose especially on backs and tips of innermost phyllaries, rarely glabrous. Receptacle alveolate, alveolae 5-angled, glabrous or margin black-ciliate. *Florets*— corollas yellow to gold-yellow, often striped with red-purple dorsally, varying from slightly longer to c. twice as long as the phyllaries at anthesis; corolla tube  $\frac{1}{3}$ - $\frac{1}{2}$  as long as ligule, ± villous below and about the throat; anthers yellow; pollen yellow or orange, echinolophate, 3- to (rarely) 6-pored; style branches yellow, obtuse. *Fruits*— achenes essentially monomorphic, not beaked, straight or slightly curved, terete or subterete, the lower portion constricted above a white calloused base, the upper portion truncate or ± constricted below the summit; us. 10-ribbed, ribs equal or 3-5 slightly stronger, all narrow, flattened to rounded or acute,

glabrous or scaberulous along midline of all or stronger ribs, sts with scattered villous hairs or (in *M. lanceolata*) all ribs  $\pm$  strigulose. Embryo filling to (in *M. lanceolata*) 3/4-filling achene, the upper portion of the fruit then vacant. Pappus members 8-66, white-silvery to stramineous or sordid, fragile or persistent, paleaceous below or some or all members essentially capillary throughout; base of capillary members  $\pm$  flattened, consisting mainly of midrib or wing-edged, the margins almost smooth in narrower members to minutely denticulate; palea narrow (length:width = c. 3:1 to 30:1), scarious to somewhat cartilaginous, plane to slightly channelled, consisting of an inconspicuous  $\pm$  diffuse brownish to pale-translucent midrib tapering from below and merging laterally into wings, each wing tapering gradually or abruptly above into the awn or sts extending as a short tooth beyond the insertion of the awn; margins of the palea minutely denticulate to spiculate and  $\pm$  lacerate; dorsal surface smooth to minutely denticulate; awns  $\pm$  slender, minutely spiculate to barbellulate or subplumose.

#### KEY TO SPECIES

Plants with non-tuberous roots; leaves not furfuraceous on blade margin; achenes mostly 4.5-7 mm long; pappus us. <10 mm long, often minutely paleaceous (palea up to 4 {-4.3} mm long) or if capillary then <40 members; distribution New Zealand..... *M. scapigera*

Plants with tuberous or non-tuberous roots; leaves often furfuraceous on blade margin; achenes mostly 6-10 mm long; pappus us. >10 mm long,  $\pm$  distinctly paleaceous (palea us. >4 mm long) or if capillary then us. >40 members; distribution Australia..... *M. lanceolata*

*Microseris scapigera* (Sol. ex A. Cunn.) Sch.-Bip.

- Microseris scapigera* (Sol. ex A. Cunn.) Sch.-Bip. emend. Chambers, Contr. Dud. Herb. 4(7): 278. 1955, p.p.; Allan, Fl. N.Z. 1: 761. 1961, p.p.; Healy, Ident. Weeds & Clovers 96, 97. 1970, p.p.
- Microseris scapigera* (Forst. f.) Schultz-Bipontinus, Pollichia 22-24: 306, 310. 1866, p.p.
- Scorzonera scapigera* Sol. ex Forst. f. Prodr. 91 n. 534. 1786, *nomen nudum*.
- Scorzonera* ? *scapigera* (Sol. MSS.) A. Cunn. Ann. Nat. Hist. 2: 125 n. 430. 1838.
- Microseris pygmaea* sensu Raoul, Choix Pls. N.Z. 45. 1846, non Don, Phil. Mag. 11: 388. 1832.
- Microseris forsteri* Hook. f. Fl. N.Z. 1: 151. 1852, *nom. illeg.*, p.p.; Hook. f. Hdbk. N.Z. Fl. 164. 1864, p.p.; Kirk, Stud. Fl. N.Z. 356. 1899, p.p.; Cheeseman, Man. N.Z. Fl. 384, 385. 1906, p.p.
- Microseris scapigera* (Forst. f.) Hoffmann in Engler & Prantl, Die Nat. Pflanzen. 4(5): 358. 1894, *comb. superfl.*, p.p.; Cheeseman, Man. N.Z. Fl. ed. 2. 1028. 1925, p.p.

ILLUSTRATIONS IN LITERATURE: Miles, and Somers Cocks in Healy, Ident. Weeds & Clovers *figs.* 21 & 24. 1970; Salmon, N.Z. Fls. & Pls. *t.* 192: *fig.* 608. 1970, as *M. scapigera* var. *pinnatifida*.

DESCRIPTION: *Plant*— caudex up to 30 (-80) mm long and 11 mm wide, us. sparingly branched but sts multicapital, with one or more non-tuberous roots up to c. 33 cm long, 1-5 (-8) mm wide, tapering gradually from near insertion. *Leaves*— membranous to subfleshy, (2-) 8-25 (-38) {-41} cm long, 1-10 (-17) {-28} mm wide, linear (sts filiform) to lanceolate or obovate-spathulate, acute to obtuse or apiculate, entire or toothed and/or lobed; lobes of deeply pinnatifid leaves up to 25 {-35} mm long, ± remote and horizontal, acute or obtuse; blades glabrous or ± furfuraceous on both sides but not on margin. *Inflorescence*— scapes (2-) 10-30 (-50) {-67} cm long, (0.7-) 1-2 (-3) {-4.3} mm diam. *Capitula*— {13-} 20-60 {-96} -flowered, oblong-ellipsoid to obovoid in bud, up to {54} mm diam. fully open. Involucre of {14}-{35} parts; bracteoles broadly elliptic, ± oblong

or narrowly to very broadly ovate-triangular, obtuse to acute or acuminate, glabrous or margins pubescent; phyllaries (7-) 9-12 (-15) {-17.4} mm long, (1.4-) 2-3 (-3.8) {-6} mm wide,  $\pm$  narrowly -oblong-elliptic, -ovate or (rarely) -obovate, obtuse to acute, outer phyllaries not black tomentose without (but  $\pm$  tomentose-villous at tip). *Florets*— corolla {8.5}-{26} mm long, tube {2.5}-{8.5} mm long, ligule {2.2}-{5.2} mm wide; anther tube {2.1}-{5.1} mm long, appendages {0.3}-{0.6} mm long; style branches {0.8}-{1.6} mm long. *Fruits*— achenes {3.9} 4.5-7 (-8) mm long, narrow-fusiform to truncate-columnar, yellow-brown to dark brown, sts grey; ribs rounded or acute, glabrous or scaberulous and/or sts very sparsely villous. Embryo filling achene. Pappus members 8-37, {4.1}-6.5-10.5 {-12} mm long, silvery, stramineous or sordid,  $\pm$  fragile, paleaceous below or some or all members essentially capillary throughout; base of capillary members up to c. 2.5 mm long, 0.08-0.2 mm wide; palea up to 4 {-4.3} mm long and 0.7 {-0.9} mm wide, narrowly -elliptic, -ovate or -ovate-triangular,  $\pm$  scarious, wings each c. 1-1.5x the width of the midrib at widest point; palea tapering  $\pm$  abruptly above into the awn or sts bifid at the apex (the teeth to c. 0.3 mm long), margins minutely denticulate and  $\pm$  lacerate; awn {4.2}-{10} mm long,  $\pm$  spiculate.

Chromosome number:  $2n = 36$ .

TYPIFICATION: "New Zealand (Northern Island).—1769, *Sir Jos. Banks*. Among fern, on the hills, Bay of Islands.—1834, *R. Cunningham*." {lectotype (Sneddon, unpublished): Nova Zealandia, in collibus prope Totara nui, *Sir J. Banks & Dr. Solander*, --.1769, BM, (early fr.) n.v., photograph! (Plate 3); isoelectotype: WELT! ; syntype: specimen not located}. The proposed lectotype differs from A. Cunningham's citation in locality and in having Solander as co-collector. The validity of "(Northern Island)" however is doubtful since the only locality recorded for *Scorzonera scapigera* in Solander's MSS is Totaranui (Queen Charlotte Sound). The

isolectotype consists of several obovate-spathulate leaves up to 6 cm long (similar to the leaves of two of the plants on the BM sheet), and an old seedless scape c. 10 cm long.

TYPES OF SYNONYMS (New Zealand): *Scorzonera scapigera* Sol. ex Forst. f.: "Noua Zeelandia." {holotype: Noua Zeelandia(?), *Forster s.n.*, undated, K, (fl.)!}; *M. forsteri* Hook. f.: "Northern and Middle Islands; ..., *Banks and Solander*, etc." {probable holotype: BM n.v., photograph! = lectotype (Sneddon, unpublished) of *M. scapigera* (Sol. ex A. Cunn.) Sch.-Bip. (Plate 3)}.

ILLUSTRATIONS: Plates 2 A (Parkinson's ic.); 3 (lectotype); 10 (plants); 14 A-I (roots and stems); 18 A-E, 19 A-I, 20 A-N (leaf form); 24 G-I (leaf surfaces); 25 A-L, 26 A-L, 27 A-L (capitula); 32 A-P, 33 A-F (bracteoles and phyllaries); 35 A-X, 37 A-D (achenes and pappus); 34 Fig. 2A & B (pappus awn detail); 42 A (chromosomes).

DISTRIBUTION (Plate 7): New Zealand. North Island (North Auckland(?), South Auckland, Hawke's Bay and Wellington Land Districts), South Island (Nelson, Marlborough, Canterbury, Westland, Otago and Southland Land Districts), and possibly Stewart Island. Altitudinal range from near sea level to c. 1 500 m.

ECOLOGY: *M. scapigera* grows on cliffs (coastal or river gorge) and open places at low altitudes, and in grassland or herbfield (well drained or in flushed or boggy ground) at higher elevations. It occurs in a variety of soils that include skeletal, clayey (or mudstone), sandy, pumicey, loamy and organic types. Flowering period: (x-) xii-iv (-vii).

VERNACULAR NAME: None

TOTAL COLLECTIONS EXAMINED: 216

## REPRESENTATIVE SPECIMENS EXAMINED:

## NEW ZEALAND

NORTH AUCKLAND: Baie des Îles (locality probably in error), *Raoul s.n.*, -.1843, P, (fl., fr.).

SOUTH AUCKLAND: Pureora, W Taupo, *Wilcox 556*, -.v.-59, NZFRI, (fl.); Wairapukao, *Bibby s.n.*, 19.i.1950, NZFRI 2898, (fl.); Cambridge, Waikato, *Kirk 467*, -iv.1870, AK 11813, CHR 289930, (fl.); Matamata, Thames Valley, *Cheeseman s.n.*, -.i.1899, AK 10781, (fl.); Kaitiririria, Taupo, *Kirk s.n.*, undated, OTA 016371, (fl.).

HAWKE'S BAY: Puketiritiri, Eastn. slope of Ruahines, *Hodgson s.n.*, 16.i.1925, CHR 289937, (fl.); Te Waka Range, 3 000 ft (914 m), *Druce s.n.*, -.i.1972, CHR 246375, (fl.); Ahuteatua, Maungaharuru Range, 3 700 ft (1 128 m), *Druce s.n.*, -.xii.1970, CHR 221052, (st.).

WELLINGTON: slope of Pukeonake, Volcanic Plateau, *Carse & Matthews 1656/3*, -.i.1921, CHR, (fl.); Mt. Ruapehu, Whakapapaite Strm., *Oliver s.n.*, 23.i.1954, WELT 9572, (fl. - eaten); Desert Road, Mt. Ruapehu, 3 000 ft (914 m), *Hynes s.n.*, -.ii.1954, AK 42581, (fl., fr.); Hauhungatahi basin, Tongariro National Park, 3 700 ft (1 128 m), *Druce s.n.*, -.ii.1971, CHR 210308, (fl.); Erua, Volcanic Plateau, *Carse & Matthews 1656/4*, 28.xii.--20, CHR 289936, (fl.); Onetapu Desert, Volcanic Plateau, *Zotov s.n.*, 4.iv.1931, CHR 6434, (st.); Waiouru, S of Ruapehu, *Petrie s.n.*, 30.i.1916, WELT, (fl., fr.); N end of Pinnacle Creek Valley, Kaimanawa Range, 3 000 ft (914 m), *Garnock-Jones s.n.*, 24.ii.1970, CANU 019090, (fl.); Waipakahi Stream, Kaimanawa Forest Park, *Ecroyd s.n.*, 31.iv.1974, NZFRI 9401, (fl.); Three Kings Range, Kaimanawa Mts (N122: 35-50-), 3 700 ft (1 128 m), *Druce s.n.*, -.i.1974, CHR 260265, (fl.); SW foot of Maungaraki, Kaimanawa Mts, 3 500 ft (1 067 m), *Poole s.n.*, 4.i.1939, CHR 22701, (fl.); Upper edge of Tikitiki Bush, Ngamatea, Inland Patea, Rangitikei, *Hamlin s.n.*, 10.i.1950, CHR 68826, (fl.); Makirikiri tarns, NW Ruahines, 3 700 ft (1 128 m), *Druce s.n.*, -.xii.1973, CHR 260477, (fl.); NW Ruahine Range, c. 3 200 ft (975 m), *Druce s.n.*, -.ii.1956, CHR 86033, (fl.); Oterei Taipos, E Wairarapa, c. 1 000 ft (305 m), *Druce s.n.*, -.xii.1965, CHR 158785, (fl.); White Rock, Wairarapa, *Zotov s.n.*, 24.ii.1947, CHR 59198, (fl.); Waitetumu Strm. E of Cape Palliser, *Hay s.n.*, 25.iv.1952, CHR 75810, (st.); Island Bay, Wellington, *Phillips-Turner 49*, undated, AK, (fl., fr.); Te Ikaamaru Bay, Wellington, *Mason 2565*, 14.xi.1953, CHR, (fl.).

NELSON: Goulard Downs, *Burke s.n.*, 1.i.1967, WELTU 5389, (fl.); Edge of Boulder Lake and Darby Pond and tarns, c. 3 000 ft (914 m), *Chambers & Rattenbury 716*, -.ii.1955, AKU, (fl.); Douglas Range, c. 4 000 ft (1 200 m), *Mason s.n.*, 22.ii.1946, CHR 34902, (fl.); Salisbury's Opening, *Mason s.n.*, 26.xii.1942, CHR 36089, (fl.); Mt. Arthur, 4 500 ft (1 352 m), *Burke s.n.*, 17.i.1962, WELTU 5391, (fl.); N branch Wangapeka River, NZMS 1 S17/18: 873150, *Macmillan 71/69*, 23.i.1971, CHR, (fl.); Gordon's Knob, c. 4 500 ft (1 352 m), *Petrie s.n.*, 5.ii.1910, WELT, (fl., fr.); Outlet of Lake Rotoiti, *Mason & Moar 5005*, 25.ii.1957, CHR, (fl., fr.); Mole hut, head of Mole Stream, 3 900 ft (1 189 m), *Simpson 4062*, CHR, (fl.); Boundary Peak, Buller district, c. 3 800 ft (1 158 m), *Chimock s.n.*, 18.ii.1968, WELTU 6858, (fl., fr.); Happy Valley, Upper Waimangaroa, 2 250 ft (686 m), *Morgan s.n.*, 12.iv.1912, WELT, (fl.); Lewis Pass, 3 000 ft (914 m), *Burrows s.n.*, -.ii.1964, CANU 6680, (fl.).

MARLBOROUGH: N.Z. (Totara nui ?), *Banks & Solander* 31, undated, WELT, (seedless scape) - isoelectotype of *M. scapigera* (Sol. ex A. Cunn.) Sch. -Bip.; Stephens Island, Cook Strait, *Atkinson s.n.*, 9.iv.1970, CHR 203143, (fr.); Little Brother Island, Cook Strait, *Collett s.n.*, 15.vi.1965, CHR 203199, (fl.); Cape Campbell, *Collett s.n.*, -vii.1964, CHR 153806, (fl.); Weld Cone (nr mouth of Flaxbourne River), 600 ft (183 m), *Druce s.n.*, -ii.1969, CHR 208918, (fl., fr.); nr Napoleon, NZMS 1 S36: 28-46-, 2 500 ft (762 m), *Druce s.n.*, -v.1971, CHR 208568, (fl.); Chalk Range, Inner Clarence Basin, *Simpson s.n.*, -ii.1933, CHR 96230, (fr.); lower slope Molesworth Hill, *Allan s.n.*, 30.iii.1945, CHR 51273, (fl.); above fence towards Cat Creek, Tarndale, NZMS 1 S40: 29-19-, *Moore s.n.*, 16.iv.1952, CHR 203098, (fr.); Carters Saddle, NZMS 1 S41: 557143, *Moore s.n.*, 21.iv.1952, CHR 203097, (fl., fr.); Mt. Seymour, Upper Clarence, 3 000 ft (914 m), *Frockie s.n.*, 9.ii.1937, CHR 222136, (fl.); Terako, Waiau, *Moore s.n.*, 6.i.1958, CHR 141663, (fl.); Hanmer Plains, *von Haast s.n.*, -i.1877, CHR 289932, (fl., fr.).

CANTERBURY: Te Ngapere (= Te Ngapari), Kaiwarra R., *Healy s.n.*, 19.xii.1943, CHR 41425, (fl.); road to Motunau Beach, *Simpson* 1520, 10.x.1961, CHR, (st.); Leithfield Beach, *Mason* 7108, 1.iii.1959, CHR, (fl., fr.); sandhills at Sumner, *Armstrong s.n.*, --.1887, MEL 64912, (fl.); Castle Rock, Port Hills, 2 500 ft (735 m), *Laing s.n.*, -iii.1920, CANU 4463, (fl., fr.); Akaroa, *Raoul s.n.*, undated, K. (fl., fr.); Bankside Reserve, Ellesmere Co., NZMS 1 S83: 582325, 230 ft (70 m), *Molloy s.n.*, 11.xii.1969, CHR 201447, (fl.); Broken River (lower part of), *Petrie s.n.*, 8.i.1908, WELT, (fr.); Mt. Cloudesley, *Wall & Molesworth s.n.*, 26.i.1947, AK 22415, (fl., fr.); Mt. Potts, N Canterbury Alps, *Laing s.n.*, -i.1910, CANU 4465, (fr.); Lower Cass River, Lake Tekapo, 2 500 ft (762 m), *Scott s.n.*, 23.i.1958, OTA 004358, (fl., fr.); Edward's Creek near Lake Tekapo, Mackenzie Co., *Petrie s.n.*, 8.ii.1911, WELT, (fr.); Leibig Range, S Canterbury, Littles Creek, Mt. Cook Station, *Macmillan s.n.*, 28.xii.1962, CHR 211398, (fl.); Red Lake, Mt. Sebastopol, Mt. Cook area, c. 3 500 ft (1 067 m), *Hynes s.n.*, 20.i.1965, AK 104539 (fl.).

WESTLAND: Arthurs Pass, Otira side, *Oliver s.n.*, 22.i.1928, K, (fl.); Lower flat, Architects Creek, Westland National Park, 1 750 ft (533 m), *Wardle s.n.*, 8.ii.1971, CHR 214887, (fl., fr.); Moraines of La Perouse Glacier, Westland National Park, 2 600 ft (792 m), *Wardle s.n.*, 3.iii.1967, CHR 166857, (fl.).

OTAGO: Maitland Range, Lake Ohau, 2 000 ft (610 m), *Mitchell s.n.*, -iii.1943, CHR 168235, (fl.); c. 5 miles east of Lake Ohau, N Otago, *Sneddon s.n.*, 5.i.1970, WELTU 9155, (fl.); Motatapu, Lake Wanaka, *Zotov s.n.*, 16.i.1950, CHR 77315, (fl.); Paradise, open flats, *Holloway s.n.*, undated, OTA 002552, (fl.); Mt. St Bathans, Central Otago, c. 2 600 ft (792 m), *Petrie s.n.*, -xii.1892, WELT, (fl.); Maniototo Co. near Naseby, c. 2 000 ft (610 m), *Petrie s.n.*, -ii.1886, WELT, (fl., fr.); Flagstaff (Dunedin), *Petrie s.n.*, -iii.1875, CANU 4466, (fl.); Blue Mts, *Anon s.n.*, 7.i.1940, CHR 24168, (fl.).

SOUTHLAND: Takahe Valley, Fiordland, c. 3 000 ft (914 m), *Baylis s.n.*, -ii.1956, OTA 003608, (fl., fr.); Wilderness, Te Anau, *Oliver s.n.*, 10.xii.1944, WELT, (fl., fr.); Island Lake, near Green Lake, *Burrows s.n.*, -i.1967, CANU 10726, (fl.); above Athol (Eyre Mts), *Poppelwell s.n.*, --.1940, AK 35254, (fl.); Garvie Range, *Speden s.n.*, -i.1923, WELT 9750, (fl. - eaten); Glen Ure Station E of Dipton, *Melville* 6493, 22.ii.1962, CHR, (fl.).

NOTES: Both the northern and southern limits of *M. scapigera* are uncertain. The species has not been collected recently north of 38° 30' (Wairapukao), and there are only three localities north of this latitude represented by herbarium specimens: Cambridge, Matamata, and the Bay of Islands. The Bay of Islands has two records and both are dubious: *R. Cunningham*, 1834 (syntype), and *Raoul*, 1843, P. Cunningham's specimen could not be traced. Its locality was apparently in error (Kirk 1899). The locality on Raoul's specimen seems likely to have been a mistake for Akaroa. In 1843 Raoul was in Akaroa, not the Bay of Islands which he visited in 1840 (Cheeseman 1925, p. xxiii). Also, morphologically the specimen appears to be a duplicate of a collection from Akaroa (*Raoul*, undated, K). The southern limit of *M. scapigera* may extend to Stewart Island, though this is not substantiated by herbarium specimens. Cheeseman (1925) cites a Cockayne record for Stewart Island, but the species is not listed in Cockayne's (1909) Botanical Survey of the island. Also, Allan (1961) includes Stewart Island in the distribution of *M. scapigera* forma *pinnatifida*.

In this treatment of *M. scapigera* no infraspecific taxa are recognised (see p. 51).

*Microseris lanceolata* (Walp.) Sch.-Bip.

*Microseris lanceolatus* (Walp.) Schultz-Bipontinus, Pollichia 22-24: 310. 1866, p.p.?

*Phyllopappus lanceolatus* Walpers, Linnaea 14: 507, 508. 1840; Walpers, Rep. Bot. Syst. 6: 344. 1846; Sonder, Linnaea 25: 529. 1853.

*Scorzonera (Moniermos) lawrencii* Hook. f. Lond. Journ. Bot. 6: 124, 125. 1847; Walpers, Rep. Bot. Syst. 6: 733. 1847.

*Microseris forsteri* Hook. f. Fl. N.Z. 1: 151. 1852, *nom. illeg.*, p.p.; Hook. f. Fl. Tas. 1: 266, 267. 1856, p.p.; Bentham, Fl. Aust. 3: 666, 667. 1866, p.p.; Bentham, Gen. Pl. 2(1): 507. 1873, p.p.; Mueller, Syst. Census Aust. Pl. 1: 85. 1882, p.p.; Bailey, Syn. Qld. Fl. 269. 1883, p.p.; Mueller, Key Syst. Vict. Pl. 2: 36. 1885, & 1: 292. 1887-1888, p.p.; Mueller, Sec. Syst. Census. Aust. Pl. 1: 143. 1889, p.p.; Tate, Fl. S. Aust. 130, 244. 1890, p.p.; Moore, Hdbk. Fl. N.S. Wales 299. 1893, p.p.; Bailey, Qld. Fl. 3: 881. 1900, p.p.; Rodway, Tas. Fl. 95. 1903, p.p.; Maiden & Betche, Census N.S. Wales Pl. 205. 1916, p.p.

*Microseris forsteri* var.? *subplumosa* Bentham, Fl. Aust. 3: 667. 1866.

*Microseris scapigera* (Forst. f.) Sch.-Bip. Pollichia 22-24: 306, 310. 1866, *nomen nudum*, p.p.\*; Black, Fl. S. Aust. 4: 656. 1929, p.p.; Ewart, Fl. Vict. 1191. 1930, p.p.; Gardner, Enum. 139. 1931, p.p.; Black, Fl. S. Aust. ed. 2. 4: 938. 1957, p.p.; Beadle et al., Fl. Syd. Region ed. 2. 478. 1972, p.p.

*Microseris scapigera* (Forst. f.) Hoffmann in Engler & Prantl, Die Nat. Pflanzen. 4(5): 358. 1894, *comb. superfl.*, p.p.

*Microseris teakleana* Gardner, Enum. 139. 1931, *nomen nudum*.

*Microseris scapigera* (Sol. ex A. Cunn.) Sch.-Bip. emend. Chambers, Contr. Dud. Herb. 4(7): 278. 1955, p.p.; Curtis, Stud. Fl. Tas. 2: 381. 1963, p.p.; Eichler, Suppl. Black's Fl. S. Aust. 328. 1965, p.p.; Burbidge & Gray, Fl. A.C.T. 395, 396. 1970, p.p.; Willis, Hdbk. Pl. Vict. 2: 768. 1972, p.p.

---

\* It is here assumed that Schultz-Bipontinus's circumscription of *M. scapigera* included both Australian (Tasmanian & South Australian) and New Zealand plants, for although he gave the distribution as "Nova Zeelandia" (p. 310) he included both *Moniermos lawrencii* Hook. f. and *Microseris forsteri* Hook. f. in the species (p. 306).

## ILLUSTRATIONS IN LITERATURE: Fitch in Hook. f., Fl. Tas. 1:

*t.* 66. 1857; Black, Fl. S. Aust. 4: *fig.* 321. 1929; Black, Fl. S. Aust. ed. 2. 4: *fig.* 1248. 1957; \*Baglin in Murray, Alp. Fls. Kosc. State Park *t.* 15. 1962; \*Mass, Fls. Aust. Alps 15. 1967; Cochrane et al., Fls. & Pls. Vict. *t.* 348. 1968; \*Hösel, Wildflowers S.-E. Aust. 34. 1969; Burbidge, Fl. A.C.T. *fig.* 398. 1970; Harris, Alp. Pls. Aust. *fig.* 177. 1970; \*Ashby, S. Aust. Mus. Wild Flower Post Card *n.* 142. 1971.

DESCRIPTION: *Plant*— caudex up to c. 20 x 10 mm, us. sparingly branched, with one or more tuberous or non-tuberous roots, the latter to {>50} cm long, 1-5 (-10) mm wide, ± tapering from near insertion. *Leaves*— membranous to subcoriaceous, 3.5-40 cm long, 1-22 {-26} mm wide, linear (sts filiform) to lanceolate or obovate-spathulate, acute to obtuse or apiculate, entire or toothed and/or lobed; lobes of deeply pinnatifid leaves up to 30 mm long, close-set to remote, horizontal to ± ascending, ± acute; blades glabrous or ± furfuraceous on both sides and/or margin. *Inflorescence*— scapes 7-45 (-63) {-90} cm long, 0.8-4.0 {-4.3} mm diam. *Capitula*— 8-60 {-98} -flowered, ovoid-fusiform to obovoid in bud, up to {74} mm diam. fully open. Involucre of 15-{44} parts; bracteoles us. ovate-triangular or narrowly so, mostly acute or acuminate, glabrous or pubescent on back and/or margins; phyllaries 8-25 mm long, 1.4-6.0 mm wide, narrowly -elliptic or -ovate, mostly acute, outer phyllaries glabrous or sts black-tomentose without. *Florets*— corolla 9-{35} mm long, tube 3.1-{12.2} mm long, ligule c. 2.0-{5.8} mm wide; anther tube 2.1-{7.2} mm long, appendages 0.3-{0.9} mm long; style branches 0.8-{2.0} mm long. *Fruits*— achenes (4.5-) 6-10 (-11.5) mm long, narrow-fusiform to truncate-columnar or obconic, yellow-brown to dark brown, sts white, pinkish or blotched with purple; ribs flattened or rounded (sts acute), glabrous or sts sparsely to densely strigulose

---

\* Cited in Willis (1972) but not seen by this writer.

and/or with scattered villous hairs or occ. scaberulous. Embryo filling to 3/4-filling achene. Pappus members 8-66, (7.4-) 10-16 (-19) mm long, white-silvery, stramineous or sordid, fragile or persistent, paleaceous below or some or all members essentially capillary throughout; base of capillary members up to c. 3 mm long, 0.08-0.2 mm wide; palea up to 14 mm long and 1.6 mm wide, narrowly -elliptic, -ovate or -ovate-triangular to ovate-subulate, scarious to somewhat cartilaginous, wings each c. 1-3x the width of the midrib at the widest point; palea us. tapering gradually above into the awn but sts oblique, truncate or bifid at the apex (the teeth to c. 0.6 mm long), margins very minutely denticulate to spiculate and  $\pm$  lacerate; awn 4-11.5 mm long, minutely spiculate to barbellulate or subplumose. Chromosome number:  $2n = 36, 72$ .

TYPIFICATION: "In *Nova Hollandia* legit *Lhotsky*." {holotype? (Plate 4 A): In *Nova Holland(ia)*, *Lhotsky* legit, undated, KIEL, (fl., fr.)!; isotype? (Plate 4 B): BM!}. The probable holotype shows close agreement with Walpers' description\* of *Phyllopappus lanceolatus* (Table 3), but in the absence of any notation by the author it cannot be confirmed as the actual specimen cited. The KIEL sheet bears two annotation labels that relate to the protologue but they are not written in Walpers' hand (H.M. Burdet via H. Usinger of KIEL, pers. comm.). The probable isotype closely matches the KIEL specimen in leaf, achene and pappus details (Table 3) and seems likely to be a duplicate.

TYPE LOCALITY: Although there is no precise location for *Lhotsky*'s collection some evidence points to the Mt. Kosciusko region. *Lhotsky* visited the alps in this vicinity (and possibly climbed Mt. Kosciusko)

---

\* Assuming that Walpers' line measurement was English (1 line = 2.1 mm): if he used the French line (2.25 mm) the specimen would not correspond quite so closely in most of its measurements.

in early March 1834 (Rotherham et al. 1975) and collected plants there (Lhotsky 1843). Both of Lhotsky's sheets have a collector's slip bearing the notation "Alp" (less certain on the BM slip) and they match other herbarium specimens from the Kosciusko region.

TYPES OF SYNONYMS (Australian): *Scorzonera (Moniermos) lawrencii* Hook. f.: Tasmania - "Hab. Abundant." {lectotype† (Sneddon, unpublished): Tasmania, Gunn 506, Lawrence 134 & 87, --.1832, K, (fl.)! - largest plant on sheet (Plate 5 A); isoelectotype?: K! (Plate 5 B)}; *M. forsteri* var.? *subplumosa* Benth.: "W. Australia, Drummond, 5th Coll. n. 366; Scott's Brook, near Cape Arid, Maxwell." {lectotype (Sneddon, unpublished): S.W. Australia, Drummond 366, undated, K, (fl.)! (Plate 6 A); syntype: MEL 64832! and isosyntype?: MEL 64833 (Plate 6 B)}; *M. teakleana* Gardner: {type untraced}.

DISTRIBUTION: Australia. Possibly occurring in south-eastern Queensland, widespread through New South Wales, Victoria, Tasmania and temperate South Australia, less common in southern Western Australia. Open places in Eucalyptus forest or woodland, and in grassland, herbfield, and on valley flats, in ± damp or seasonally damp (summer-dry) sites from near sea level to about 2 210 m.

---

† Hooker did not cite any types in his protologue. There are two sheets in the Herbarium Hookerianum at Kew that bear the annotation *Scorzonera lawrencii* (Plate 5 A & B), and both fit the description and predate publication of the name. The sheet chosen as lectotype has the additional annotations "Moniermos" and "n.sp" (almost certainly = n. sp.) and thus comes closer to satisfying guide 4d for the selection of types in the International Code of Botanical Nomenclature (Stafleu et al. 1972). Since this sheet consists of three heterogeneous collections the lectotype is specified as the largest plant present (Plate 5 A), which, from the position of the writing on the sheet, seems likely to be Gunn's collection. The second sheet, which is a homogeneous collection of Gunn's, resembles the lectotype and is possibly a duplicate (isoelectotype).

NOTES: *M. lanceolata* is distinguished from *M. scapigera* by a combination of vegetative and reproductive character differences (Table 4). Some of these characters overlap between the species (e.g. pappus length), while many others are diagnostic for *M. lanceolata* but do not occur constantly within the species (e.g. tuberous roots). There is no universally occurring diagnostic character in either species. One of the most widespread, and hence useful, differential characters in *M. lanceolata* is the presence of furfuraceous hairs along the leaf blade margins. These were found in approximately half of the specimens examined (throughout the range of the species), often on otherwise glabrous blades.

*M. lanceolata*, as treated herein, is divided into three morphological groups, which are described informally as races. The races are regarded as potential subspecies which still require further investigation (especially certain problem forms, in cultivation) before they can be given formal recognition.

It is not known yet to what extent the three races are sympatric. Herbarium collections seen include very few examples of sympatric occurrence (and only with two races occurring together, not all three) the great majority of localities being represented by specimens of a single race.

## KEY TO INFRASPECIFIC RACES

- A. Pappus members 30-66, minutely paleaceous (palea up to 4 mm long and 0.3 mm wide) to capillary at the base; capitula with 8-25 (rarely more) florets; roots non-tuberosus.....race 3
- Pappus members 8-30,  $\pm$  distinctly paleaceous below (palea us.  $>4$  mm long and 0.4 mm wide); capitula with 20-60 florets; roots tuberosus or non-tuberosus.....B.
- B. Roots us. swollen into short tubers, leaves us. membranous and  $\pm$  dying back in summer; involucre us.  $<24$  parts; flowering mostly viii-xii.....race 1
- Roots elongated and non-tuberosus; leaves somewhat thicker and not dying back in summer; involucre us.  $>24$  parts; flowering mostly i-iii.....race 2

## RACE 1

DESCRIPTION: *Plant*—  $\pm$  renascent (after dying back in mid-summer); caudex very short ( $<5$  mm long) with 1-3 (-6) us. tuberosus roots.

Tubers (12-) 20-50 (-90) mm long, (3.5-) 6-12 (-19) mm wide, fusiform, ellipsoid, ovoid or obovoid. *Leaves*—  $\pm$  membranous, (6-) 10-25 (-40) cm long, (1-) 2-7 (-12) {-21} mm wide, narrow-linear (sts filiform) to lanceolate or rarely obovate-spathulate, acute or obtuse, entire or toothed and/or lobed (to deeply pinnatifid), the lobes up to 30 mm long.

*Inflorescence*— scapes (9-) 20-40 (-60) {-80} cm long, 1-3.5 mm diam.

*Capitula*— 20-40 {-61} -flowered, ovoid-fusiform in bud, up to {60} mm diam. fully open. Involucre of us. 15-24 parts; bracteoles us. 7-12,  $\pm$  glabrous, phyllaries us. 8-12, outer ones (9-) 12-20 (-25) mm long, (1.8-) 2-4 (-6) mm wide,  $\pm$  attenuate above, not black-tomentose without.

*Florets*— corolla {15.2}-{28.3} mm long, tube {4.2}-{8.7} mm long, ligule {3.6}-{5.2} mm wide; anther tube {3.2}-{5.2} mm long; style branches {1.0}-{1.5} mm long. *Fruits*— achenes (4.5-) 6-10 (-11.5) mm long, ribs flattened to rounded, glabrous or sts sparsely to densely strigulose and/or with scattered villous hairs. Embryo filling to 3/4-filling achene. Pappus members 8-21, 8-19 mm long,  $\pm$  persistent, white-silvery, stramineous or sordid, paleaceous below. Palea (2.8-) 5-10 (-14) mm long, (0.3-) 0.5-1.2 (-1.6) mm wide, wings each c. 2-3x the width of midrib at widest point, margins of the palea very minutely denticulate (almost smooth) to (in W. Australian plants) spiculate and  $\pm$  lacerate; awns (4-) 4.5-8.7 mm long, spiculate to subplumose (bristles up to 0.6 mm long). Chromosome number:  $2n = 36$ .

TYPES INCLUDED: *M. forsteri* var.? *subplumosa* Benth; *M. teakleana* Gardner?

ILLUSTRATIONS: Plates 6A-D, 11 (plants); 15 A-I (roots and stems); 21 A, B & D (leaf form); 24 D-F (leaf surfaces); 25 M-P, 28 A-D, 29 A-J, 30 A-G (capitula); 33 G-J (bracteoles & phyllaries); 36 A-M, 37 F-H (achenes & pappus); 34 Fig. 2D & E (pappus awn detail); 42 B (chromosomes).

DISTRIBUTION (Plate 8): South eastern Queensland(?), New South Wales (Coast, Tablelands, Western Slopes, Western Plains and southern Far Western Plains), Victoria, southern Tasmania, temperate South Australia, southern Western Australia. Altitudinal range from near sea level to c. 1 200 m

ECOLOGY: Race 1 grows in  $\pm$  open places in mallee, coastal heathland, savannah woodland and sclerophyll forest, and in frost flat grassland of montane-subalpine valleys, in sandy, silty, clayey or loamy (rarely rocky) soils ranging from alkaline calcareous-saline soils fringing salt lakes to acidic podzols of forests. Restricted in drier parts of range to river flats and valley floors where the ground is flooded in winter.

Flowering period: (vii-) viii-xii (-v).

USES: The tubers were used as a food by the aborigines  
(Mueller 1888; Maiden 1889).

VERNACULAR NAMES: 'Yam-daisy', 'Yam', 'Native Dandelion';  
aboriginal - 'Murrnong' or (less commonly) 'Mirr n' yong' (Maiden,  
1889), 'Myrnong' (Cochrane et al. 1968).

TOTAL COLLECTIONS EXAMINED: 320

#### REPRESENTATIVE SPECIMENS:

QUEENSLAND: Stanthorpe (locality possibly in error), *Davidson 11*,  
undated, BRI 184838, (st.).

NEW SOUTH WALES. NORTH COAST: Tweed, *Thom 12*, undated, MEL, (fl.).  
CENTRAL COAST: Port Jackson, *Anon s.n.*, undated, MEL 64869, (fl.).  
NORTHERN TABLELANDS: Tenterfield, *Stuart s.n.*, undated, MEL 64856,  
(fl.); Glen Innes, *Porter s.n.*, -.iv.1885, MEL 64840, (fl.); Glen Elgin,  
*J.W.H. 28D12*, 16.i.—30, CANB, (fl.); University of New England grounds,  
Armidale, *Roberts s.n.*, 28.i.1960, NE 021161, (fl., fr.); Moona Plains  
near Walcha, *Crawford s.n.*, -.x.1884, MEL 64830, (fl.); Tia Falls,  
*Forsyth & Cheel s.n.*, -.x.1900, NSW 125037, (fl.) - isotype of *M. latifolia*  
Gandoger. CENTRAL TABLELANDS: Barbers Creek (Tallong), *Rumsey s.n.*,  
-.x.1899, NSW 128909, (fl.); E side of Little Bald Hill, c. 3½ miles  
(5.6 km) N of Hill End, *Pickard 474*, 20.x.1969, NSW, (fl., fr.); Mullion  
Creek State Forest, *Mair s.n.*, 14.x.1966, NSW 128907, (fl.); Sunny Corner,  
*Boorman s.n.*, -.xi.1899, NSW 128910, (fl.); Jenolan Caves, *Blakely s.n.*,  
-.xi.1899, NSW 128911, (fl.); Abercrombie Caves (c. 30 miles (48.3 km)  
S of Blayney), *Mair s.n.*, 20.x.1951, K, (fl.), NSW 128912, (fl., fr.).  
SOUTHERN TABLELANDS: near Gundaroo on road to Murrumbateman, *Moore 3162*,  
8.ix.1959, CANB, (fl.); near Doughboy Ck on Bungendore-Braidwood road,  
*Moore 1777*, 18.ix.1952, CANB, (fl.); Kowen area, NSW-ACT border, *Burbidge  
& Gray 6531*, 30.ix.1959, CANB, NSW, (fl.); Tinderry Mts, *Hartley 13448*,  
14.xi.1971, CANB, (fl.); near Cabramurra, *Moore 3213*, 20.xii.1960, CANB,  
(fl.); Cooma district, *Parkins s.n.*, -.xi.1897, NSW 12924, (fl.).  
NORTH WESTERN SLOPES: Barraba, *Rodway 11746*, -.ix.1924, NSW, (fl.);  
Plains, Coorianawa Station, Castlereagh River, *Lamont 164*, -.viii.1883,  
BM, (fl.); Liverpool Plains, *Moore s.n.*, undated, K, (fl.). CENTRAL  
WESTERN SLOPES: Gulgong (River Cudgegong), *Barnard 166 & 87*, --.1882,  
MEL, (fl.); Wellington, *Betchs s.n.*, -.x.1883, NSW 128999, (fl.); Strahorn  
State Forest, Mungerie (25 miles (40.2 km) NW of Peak Hill), 900 ft  
(274 m), *Constable s.n.*, 1.x.1951, K, NSW 17329, (fl., fr.); Muginoble  
(nr Parkes), *Constable s.n.*, 22.ix.1947, NSW 4600, (fl., fr.); Cowra,  
*Beattie s.n.*, -.ix.1915, NSW 128995, (fl.); Wyalong, *Boorman s.n.*,  
-.x.1903, NSW 128994, (fl.); Ardlethan, *Cabbage s.n.*, 2.x.1916, NSW  
128996, (fl.); Temora, *Dwyer 607*, -.ix.1915, NSW, (fl.). SOUTH WESTERN  
SLOPES: Wagga, *Dwyer s.n.*, --.1929, WA, (fl., fr.); Nangus, *Robertson s.n.*,  
-.xi.1840, K, (fl.); Mulwala, *Fletcher s.n.*, -.x.1890, NSW 128987, (fl.).

WESTERN PLAINS: Pallamallawa (Gwydir R.), *Hickey s.n.*, -.viii.1884, MEL 64829, (fl.); 8 miles (13 km) SE of Nymagee on Bobadah Road, *Cunningham & Milthorpe 1244*, 22.ix.1973, NSW, (fl.); Lachlan River (c. 15 km W of L. Cargelligo), *Cunningham s.n.*, 23.vii.1817, K, (fl.); Booligal, Lachlan R., *Bell s.n.*, -.ix.1887, MEL 64842, (st.); Hay *Fletcher s.n.*, 22.ix.1889, NSW 128985 & 128986, (fl., fr.); Mt Waabalong, Hillston, *Cunningham & Milthorpe 1283*, 24.viii.1973, NSW, (fl.); Newell Highway 2 miles (3 km) N of Morundah, *Whaite 2151*, 2.ix.1960, NSW (fl.); Faltimar Field Station, Deniliquin, *Willoughby 53*, -.xii.—45, CANB, (fl.). FAR WESTERN PLAINS: Balranald, *Lucas 105*, -.1878, MEL, (fl.); Wentworth, *Flores s.n.*, undated, MEL 64848, (fl.).

VICTORIA. EASTERN HIGHLANDS & COASTAL PLAINS: Beechworth, *Falck s.n.*, undated, MEL 64876, (fl.); Bald Hill, (possibly the locality c. 4 km NE of Wulgulmerang), *Anon 131*, 16.x.1892, MEL, (fl.); Warby Ranges, E end of Taminick Gap in vicinity of "Kurring-gai", *Nason s.n.*, 10.xi.1959, MEL 64893, (fl.); Delatite River, *Thom s.n.*, -.1891, MEL 64808, (fl.); Fraser National Park, on Western side of Eildon Reservoir, *Muir 3585*, 29.x.1964, MEL, (fl.); Alexandra, Goulburn River, *Hardy 13*, -.1882, MEL, (fl.); Christmas Hills, *St. John s.n.*, 1.x.1903, MEL 64904, (fl.); Woodside, Gippsland, *Howitt 198*, -.1887, MEL (fl.); Greensborough (Envs. Melbourne), 500 ft (150 m), *Aldrich s.n.*, -.x.1962, MEL 64892, (fl.); nr the sea at Brighton, *Hannaford s.n.*, 21.viii.1853, NSW 128929, (fl.); Mentone (Envs. Melbourne), *St. John s.n.*, 9.vii.1900, MEL 64905, (fl.); Beaconfield, *St. John s.n.*, 24.x.1901, MEL 64903 (fl., fr.); Frankston, *Morrison 1378*, 13.ix.1891, K, (fl.). WESTERN VOLCANIC & COASTAL PLAINS: Werribee, *Morrison 2107*, 24.ix.1892, K, (fl.); Little River nr Geelong, *Anon 3*, 30.vii.1866, MEL 64791, (fl.); Queenscliff, *Tepper s.n.*, 21.xi.1886, AD 966051442, (fl., fr.); Hawkesdale, *Williamson s.n.*, -.xi.1901, NSW 128939, (fl.); on Portland Road 18 miles (29 km) E of Nelson, *Belcher 687*, 6.xi.1967, MEL, (fl.). WESTERN HIGHLANDS: Kilmore Junction, *St. John s.n.*, 10.xi.1906, MEL 64907, (fl.); Bendigo, *Burns s.n.*, about vii.—69, MEL 64899, (fl.); Castlemaine, *Kendall 68*, 24.xi.1860, K, (fl.); Brisbane Ranges, *Williamson s.n.*, -.x.1926, CANB 190385, (fl.); Ballarat, *Spence s.n.*, -.viii.1885, MEL 64828, (fl.); cemetery at Kingower, about 7 miles (11.3 km) SW of Inglewood, *Muir 1372*, 9.x.1960, MEL (fl., fr.); nr Mt Warrenheip, *Wilhelmi s.n.*, -.iii.1857, MEL 64781, (fr.); Skipton, *Whan s.n.*, undated, MEL 64811, (fl., fr.); Moyston, *Sullivan 75*, -.xi.1871, MEL (fl.); Grampians, Mt Arapiles S of P.M.G. Tower, *Beaglehole 26939*, 19.xi.1968, MEL, (fl.); Halls Gap, Grampian Mountains, *Tilden s.n.*, -.xii.1912, BM, K, (fl.). NORTHERN PLAINS: Ovens River, *Henleys s.n.*, -.1891, MEL 64805, (fl.); Lower Loddon, *Thom 14*, -.1882, MEL, (fl.); Charlton, *Watts 1167*, -.ix.1918, NSW, (fl.); nr Wycheproof, *Watts 511*, -.ix.1917, MEL, (fl.); about 2 miles (3.2 km) E of Kanya on the Kanya-St. Arnaud road, *Muir 1218*, 13.ix.1960, MEL, (fl.); Kulkyne State Forest, W of Lake Hattah, *Aston 113*, 1.xi.1958, MEL, (fl.). MALLEE: Lake Kenyon (Pink Lakes), *Henshall 3789*, 25.ix.1971, NT, (fl.).

TASMANIA: Cambridge, *Giblin s.n.*, -.x.1929, HO, (fl.); Jordan River, *Rodway 4930*, -.xi.1898, NSW, (fl.); Tasmania, *Rodway 4929*, -.i.1918, NSW, (fl.); Show Ground, Hobart, *Lucas s.n.*, -.x.1924, NSW 128936, (fl.) - mixed with race 3; Van Diemen's Land, *Mossman s.n.*, undated, K, (fl.).

SOUTH AUSTRALIA. SOUTH EAST DISTRICT & MURRAY MALLEE: Big Heath National Park, c. 25 km SW of Naracoorte, *Alcock 2905*, 4.xi.1969, AD, (fl.); Beachport, c. 75 km WNW of Mt Gambier, *Malin & Ising s.n.*, 6.xi.1929, AD 966051445, (fl.); Lake Hawdon, *Mueller s.n.*, undated, MEL 64872, (fl.); Mt Scott, c. 25 km E of Kingston, *Roach 87*, 24.ix.1972, AD, (fl.); 4 miles (c. 6 km) S of Cooke Plains, which is c. 40 km SE of Murray Bridge on Adelaide - Melbourne railway, *Sharrad 789*, 8.ix.1960, AD, (fl.); versus Guichen Bay, *Sonder s.n.*, -.ii/iii.1849, MEL 64823 & 64824, (fl.); Lake Bonney, *Wehl s.n.*, -.1882, MEL 64852, (fl.); c. 3 km NE of Nangawarry,

which is c. 30 km N of Mt Gambier, *Wilson 539*, 26.ix.1966, AD, CHR, CANB, (fl.); Marsh's Swamp, which is between Glencoe & Mt Burr township, c. 45 km NW of Mt Gambier, *Wilson 892*, 12.x.1968, AD, (fl.); nr the Glenelg River on E side, c. 26 km SE of Mt Gambier, *Wilson 1320*, 18.xi.1959, AD, (fl.); Keith, *Crocker s.n.*, undated, CANB 11687, (fl.); Murray Mallee Plains Lameroo, about 180 km ESE of Adelaide, *Black s.n.*, 10.x.1918, AD 96940076, (st.); about 2 km NW of Scorpion Springs Conservation Park, S of Pinnaroo, *Symon 8766B*, 24.x.1973, ADW, (fl.). KANGAROO ISLAND: Pennington Bay, south coast, *Jackson 321*, 6.x.1963, AD, (fl.); south coast, Karatta, which is c. 20 km W of Vivonne Bay, *Tepper s.n.*, 12.xi.1881, AD 966051442, (fl.). ADELAIDE PLAINS & FLEURIEU PENINSULA: Norwood (a central suburb of Adelaide), *Black 2*, -.ix.1903, NSW, (fl.); Adelaide Plains at Royal Park c. 10 km NW of Adelaide, *Smith 1429*, 23.ix.1968, AD, (fl.); prope Macclesfield - procula Port Adelaide, *Blandowsky s.n.*, -.1850, MEL 64866, (st.); East of St. Vincent Gulf, Marino Rocks, c. 16 km SW of Adelaide, *Smith 398*, 25.ix.1967, AD, (fl.); W side of Port Elliot which is c. 75 km S of Adelaide, *Smith 422*, 26.ix.1967, AD, (fl.); Normanville sand dunes, c. 65 km SSW of Adelaide, *Whibley 2918*, 11.ix.1969, AD, (fl.). MOUNT LOFTY RANGE: Ashbourne, c. 45 km SSE of Adelaide, *Andrew s.n.*, 6.ix.1919, AD 96940078, (st.); Torrens Gorge nr Reservoir, *Chinnock 1338*, 11.x.1973, WELTU, (fl.); c. 3 km W of Tepko, which is c. 50 km E of Adelaide, *Czornij 172*, 3.x.1968, AD (fl.); c. 3 km E of Hahndorf, which is 25 km SE of Adelaide, *Donner 880*, 8.x.1963, AD, (fl.); nr Prospect Hill (c. 38 km SSE of Adelaide) via Meadow, *Ising s.n.*, 2.xi.1962, AD 96421146, (fl.); c. 1.6 km S of Freeling, which is c. 55 km NNE of Adelaide, *Kraehenbuehl 1750*, 17.ix.1966, AD, (fl.); Tanunda, c. 65 km NE of Adelaide, *Kraehenbuehl 671*, 22.ix.1962, AD, (fl.); Tothill Range, Tarnma, which is c. 90 km NNE of Adelaide, *Kraehenbuehl 2276*, 5.x.1968, AD, (fl.); Lenswood Research Centre, c. 20 km ENE of Adelaide, *Dam 243*, 25.x.1969, AD, (fl.). OLARY SPUR: Mt Victor, Mt Victor Station, 400 km NNE of Adelaide, *Crisp & Lay 429*, 4.ix.1971, AD, (fl.). FLINDERS RANGE: Wirrabara, c. 210 km N of Adelaide, *Black s.n.*, 24.x.1917, AD 96940077, (st.); nr Mt Hack, c. 15 km E of Warraweenah, *Callen 24*, 7-10.ix.1969, AD, (fl.); between Hawker & Moolooloo Station (Moolooloo Station is c. 100 km N of Hawker), *Carrodus s.n.*, -.ix.1956, AD 96212068, (fl.); Wilpena Chalet, *Symon 539*, 13.ix.1960, ADW, (fl.); Gammon Ranges (c. 75 km E of Leigh Creek), gorge of western branch of Balcanoona Creek above Loch Ness Well, *Eichler 12933*, 23.ix.1956, AD, (fl.); Mt Remarkable, *Ising s.n.*, 25.x.1928, AD 966051427 (fl.); Oraparinna National Park, central portion, *Jackson 1760*, 15.ix.1971, AD, AK, (fl.); Oraparinna National Park, above Aroona Valley on W-facing slopes of the ABC Range almost opposite Mt Haywood, *Symon 7206*, 12.ix.1971, ADW, (fl.); Arkaroola Sanctuary, Nooldoo Nooldooma Rock Hole, *Kuchel 3068*, 22.x.1971, AD, (fl., fr.); 12 miles (c. 20 km) E of Parachilna, which is on Adelaide-Alice Springs railway, *Lothian 950*, 6.x.1960, AD, (fl.); S slope of Mt Serle (c. 45 km E of Leigh Creek), 2 500-2 900 ft (c. 760-880 m), *Lothian 3146*, 10.xi.1964, AD, (fl., fr.); Windy Hill, Hawker (c. 90 km NE of Port Augusta), *Telfer 74*, 14.ix.1968, AD, (fl.). YORKE PENINSULA: Hundred of Curramulka, c. 72 km WNW of Adelaide, *Blaylock 285*, 8.x.1966, AD, (fl.); c. 8 km SSW of Corny Point Lighthouse, which is c. 80 km SW of Maitland, *Blaylock 338*, 11.x.1966, AD, (fl.); Pondalowie Bay, c. 10 km NW of Cape Spencer, *Blaylock 211*, 9.x.1966, AD, (fl.); Hundred of Ramsay (c. 15 km ESE of Minlaton), Section 19, *Blaylock 1738*, 23.ix.1971, AD, (fl.); Old Mona Railway Yard, c. 5 km W of Bute, which is c. 130 km NNW of Adelaide, *Copley 540*, 27.viii.1966, AD, (fl.); 24.5 miles (41 km) from Yorketown towards Foul Bay, *Phillips s.n.*, 18.x.1966, NT 30561, (fl.); Ardrossan, *Tepper s.n.*, 19.ix.1879, MEL 64863, (fl., fr.); Tubb's Lake Hill nr Yorketown, *Wylly s.n.*, 13.ix.1929, AD 966051429, (fl.); Moonta, *Beythum 128*, -.1888, MEL, (fl.); Head of St. Vincents Gulf, South Hummocks Range,

c. 20 km NNW of Port Wakefield, *Kraehenbuehl* 1399, 14.viii.1965, AD, (fl.). EYRE PENINSULA & GAWLER RANGES: 23 km W of Minippa, *Chinnock* 1221, 22.ix.1973, WELTU, (fl.); c. 8 km NNW of Bascombe Well H.S. (c. 25 km WSW of Lock), County Musgrave, Hundred of Blesing, *Jackson* 1070, 1.x.1967, AD, (fl.); West Point (c. 35 km SSE of Port Lincoln), Lincoln National Park, *Alcock* 1671, 1.x.1967, AD (fl.); Arno Bay, 105 km NE of Port Lincoln, *Ising s.n.*, 27.viii.1935, AD 966051443, (fl.); Wudinna, c. 190 km NNW of Port Lincoln, *Ising s.n.*, 8.ix.1938, AD 966051423, (fl.); "Big Swamp" on Flinders Highway (c. 15 km NW of Port Lincoln), Sec. 513, Hundred of Lincoln, *Alcock* 1406, 18.ix.1967, AD, ADW, (fl.); Hundred of Nicholls (c. 80 km N of Port Lincoln), part of Hinks National Park, *Alcock* 2119, 1.ix.1968, AD, (fl.); 20 miles (32.2 km) N of Streaky Bay, *Hilton s.n.*, 26.viii.—55, ADW 18309, (fl.); between Port Lincoln & Streaky Bay, *Richards s.n.*, —.l882, MEL 64843, (fl.); Mt Ive, c. 160 km W of Port Augusta, *Donner* 3251, 28.ix.1969, AD, (fl.); nr the summit of Mt Nott, 9 km S of Thurlga Station, *Symon* 8049B, 1.x.1972, ADW, (fl.).

WESTERN AUSTRALIA: Lionestone brook (33.45 lat. 122.40 long.) entering into an inlet W of Cape Arid Bay, Scotts brook, *Maxwell s.n.*, undated MEL 64832, (fl.) - Syntype of *Microseris forsteri* var.? *subplumosa* Benth.; W. Australia, *Maxwell s.n.*, undated, MEL 64879, (fl.); between Esperance Bay & Frasers Range, *Anon s.n.*, undated, MEL 64834, (st.); Fraser Range, *Alpin* 1806, 7.xi.1962, WA, K, (fl.); Southern Hills Station in Fraser Range, *Gardner* 2851, 20.x.1931, (fl., fr.); between Norseman & Balladonia, *Gardner & Blackall* 1140, 24.x.1931, WA, (fl.); W end of Stirlings Range, *Anon s.n.*, undated, MEL 64909, (fl.).

NOTES: Race 1 is distinguished from the other two races principally by its tuberous roots and very short stems. It also has leaf, capitulum and fruit characters that tend to be correlated (Table 5) so that fertile plants can usually be identified with confidence on aerial parts alone. Many herbarium specimens with missing or incomplete roots were placeable on aerial parts (Plate 8).

The northern limit of this race is uncertain. The only specimen record of *M. lanceolata* from Queensland (Stanthorpe, BRI 184838) is equivocal since Melbourne is also given as its locality. This specimen has a tuberous root typical of race 1.

A collection from Tia Falls (*Forsyth*, LY (Plate 6 D); *Forsyth & Cheel*, NSW 125037) has been given the unpublished name *M. latifolia* by Gandoger\*. An inquiry to LY, where Gandoger's Herbarium and manuscripts

---

\* Stafleu (1967) comments that Gandoger was "one of the greatest splitters ever".

are held, did not locate any description or notes relating to this name. The collection fits race 1 in all features though the roots are unusually long and narrow for tubers. However, the second season roots are shrivelled (more evident in the NSW specimen) which is a tuberous characteristic.

Specimens seen from Western Australia differ uniformly from those in other States in possessing much longer (subplumose) bristles on the pappus awns. In all other features Western Australian plants agree with race 1. Gardner (1931) recognised two species in Western Australia: *M. scapigera* (Forst. f.) Schultz et Bip. (= Sch.-Bip.) and *M. teakleana* Gardn. MS. It seems that Gardner left no evidence of what he regarded as the new species: it is unlikely that he prepared a MS description (K.F. Kenneally of WA, pers. comm.), and no herbarium specimen with his annotation could be traced. Only one herbarium specimen with the determination *M. teakleana* has been located: *Blackall 3206*, WA (Plate 6C). This is a subplumose-awned plant typical of Western Australian members of race 1.

Population LC had essentially non-tuberous roots (Plate 15 F-I). It is the only non-tuberous collection referred to race 1 though possibly others may be included after study in cultivation\*. Population LC was found to resemble race 1 in the great majority of its vegetative and reproductive features. (For example, its leaves often died back after flowering.) It was also found to be highly interfertile with tuberous populations in experimental crosses, though whether it was any less interfertile with race 2 (tetraploid populations) could not be tested as the seeds from the only cross made all failed to germinate (see SECTION III).

---

\* Some of the non-tuberous herbarium specimens from eastern Victoria and New South Wales which are currently included in race 2 *sens. lat.* (see on) may, on examination of living material, be found to belong with population LC in race 1.

Race 1 occurs sympatrically with race 2 at two localities in New South Wales: Glen Innes (*Porter*, MEL; *Boorman*, BRI & NSW) and Barbers Creek (*Rumsey*, NSW 128909; *Rumsey*, NSW 128908); and with race 3 in Tasmania (see p. 44). In these localities it is quite distinct from the other race present. Race 1 may also co-exist with race 2 in the Canberra region of New South Wales: both races inhabit subalpine frost flats (e.g. race 1: *Park*, population LB; race 2: *Hartley* 13643, CANB) but the only known collections are from different flats.

## RACE 2

DESCRIPTION: *Plant*— leafy in all seasons; caudex up to c. 20 mm long with 1-10 non-tuberous roots. Roots elongate (distally incomplete in all herbarium specimens seen), to {>50} cm long, 2-5 (-10) mm wide,  $\pm$  tapering from near insertion. *Leaves*— membranous to subcoriaceous, (5-) 10-25 (-32) cm long, (3-) 12 (-22) {-26} mm wide, lanceolate to obovate-spathulate or occ. linear, acute to obtuse or apiculate, entire or toothed and/or lobed (to pinnatifid), the lobes up to 20 mm long. *Inflorescence*— scapes (11-) 20-45 (-63) {-90} cm long, (1.5-) 2-4 {-4.3} mm diam. *Capitula*— 30-60 {-98} -flowered, us. obovoid in bud, up to {74} mm diam. fully open. Involucre of (20-) 30 (-40) {-44} parts; bracteoles 10-20, glabrous or pubescent without and on margin; phyllaries 10-20, outer ones (11-) 13-17 (-21) mm long, (2-) 3 (-4) mm wide, not strongly attenuate above, sts black-tomentose without. *Florets*— corolla {14.6}-{35} mm long, tube {4.1}-{12.2} mm long, ligule {3.6}-{5.8} mm wide; anther tube {3.8}-{7.2} mm long; style branches {1.2}-{2.0} mm long. *Fruits*— achenes 6-10 mm long, ribs rounded or sts acute, glabrous or sts sparsely to densely strigulose and/or with scattered villous hairs, or occ. scaberulous

along midline of ribs. Embryo filling to 3/4-filling achene.

Pappus members (11-) 15-23 (-30), 10-15 (-18.5) mm long,  $\pm$  persistent, stramineous or sordid, paleaceous below. Palea (2.5-) 5 (-7) mm long, (0.3-) 0.6 (-0.85) mm wide, wings each c. 1-2x the width of midrib at widest point, margins of the palea minutely denticulate to minutely spiculate and  $\pm$  lacerate; awns 7-11.5 mm long, spiculate to barbellulate. Chromosome number:  $2n = 36, 72$ .

TYPES INCLUDED: *M. lanceolata* (Walp.) Sch.-Bip.; *Scorzonera* (*Moniermos*) *lawrencii* Hook. f.

ILLUSTRATIONS: Plates 4 A-B, 5, 12 (plants); 16 A-E (roots and stems) 17 A-C (adventitious suckers); 18 F, 21 C, E & F (leaf form); 24 A-C (leaf surfaces); 25 Q-S, 28 E-G, 30 K, 31 A-H (capitula); 33 K-M (bracteoles and phyllaries); 36 N-V, 37 E (achenes & pappus); 34 Fig. 2C (pappus awn detail); 42 C & D (chromosomes).

DISTRIBUTION (Plate 9): New South Wales (South Coast and Northern, Central and Southern Tablelands), Victoria (Eastern Highlands) and northern Tasmania. Altitudinal range usually between 1 200 and 2 210 m but descending to near sea level in a few localities.

ECOLOGY: No information on lowland habitats but at higher elevations it grows in grassy places under alpine ash (*Eucalyptus delegatensis*) mountain forest and snow gum (*E. pauciflora* ssp. *niphophila*) woodland; and in grassland and herbfield above the treeline. Soils range from thin sts dry soils under forest to organic soils and bogs of alpine meadows. Flowering period: (xi-) i-iii (-iv).

VERNACULAR NAME: 'Native Dandelion'.

TOTAL COLLECTIONS EXAMINED: 66

REPRESENTATIVE SPECIMENS: (An asterisk denotes race 2 *sens. lat.*)

NEW SOUTH WALES. SOUTH COAST: Conjola, *Heron* 42, -.xi.1899, NSW, (fl.)\*; S Crookhaven Head, *Rodway* 11756, l.i.1941, NSW, (fl.)\*. NORTHERN TABLELANDS: Glen Innes, *Boorman s.n.*, -.iii.1917, BRI 184834, NSW 128906, (fr.)\*. CENTRAL TABLELANDS: Barbers Creek (Tallong), *Rumsey s.n.*, -.ii.1900, NSW 128908, (fr.)\*. SOUTHERN TABLELANDS: Shoalhaven, *Bannerlen* 656, -.ix.1884, MEL, (fl.)\*; Tidbinbilla, Federal Territory, 5 100 ft (1 554 m), *Cabbage s.n.*, 7.xi.1911, NSW, (fl.); Ski run, Mt Franklin, 5 600 ft (1 707 m), *Burbidge* 1675, 6.ii.1947, CANB, (fl.); Ginini Flat, Brindabella Range, *Hartley* 13643, 21.iii.1972, CANB, (fl.); Mt Gingera, 6 000 ft (1 829 m), *Tindale s.n.*, 16.i.1954, NSW 128918, (fl.); Mt Bimberi F.C.T., 5 500 ft (1 676 m), *Bunges s.n.*, -.xii.1930, NSW 128922, (fl.); c. 43 km N of Adaminaby, Currangorambla Creek, Currango Plain, N of Tantangara Dam, 1 280 m, *Thomson* 796, 19.i.1971, NSW, (fl.)\*; Rule's Point N of Kiandra, c 4 500 ft (1 372 m), *Salasoo* 3497, 22.i.1969, NSW, (fl.); Happy Jacks Plain, headwaters of the H.J. river, c. 15 miles (24.1 km) S of Kiandra, 4 900 ft (1 493 m), *Thompson* 82, 17.i.1958, NSW, (fl.); above Island Bend on Plains of Heaven Track, c. 5 000 ft (1 524 m), *Garden s.n.*, 9.i.1956, NSW 128916, (fl.); Bald Hill, Main Range W of Eucumbene Dam, 5 700 ft (1 737 m), *Johnson s.n.*, 31.iii.1964, NSW 128921, (fl.); summit of Kosciusko above 7 250 ft (2 210 m), *Cabbage* 4318, 16.ii.1920, NSW, (fl.); lower slopes of Mt Kosciusko, 3 000 ft (914 m), *Scarth-Johnson* 3, -.iv.1970, BRI, (fl., fr.); Lake Cootapatamba, Kosciusko, 6 800 ft (2 073 m), *Johnson & Constable s.n.*, 24.i.1957, NSW 15937, (fl.); Kosciusko, Lower Twynham Cirque, 6 400 ft (1 951 m), *Walker* 183, 11.ii.1962, CANB, (fl.); Charlotte Pass, *Skottsberg s.n.*, 14.iii.1949, NSW 128915, (fl.); Kosciusko National Park, Blue Cow (c. 20 km E of Jindabyne), *Ashby* 2817, 16.ii.1969, AD, (fl., fr.); Mt Kosciusko National Park, Spencers Creek, *Ashby* 1752, 11.ii.1966, AD, (fl.).

VICTORIA. EASTERN HIGHLANDS (INCLUDING ALPS): Mt Cope, Bogong High Plains, c. 5 800 ft (1 768 m), *Craven* 1792, 24.i.1970, CANB, (fl.); Razorback track to Mt Feathertop, 3 miles (4.8 km) from Mt Hotham, c. 5 800 ft (1 768 m), *Briggs* 133B, 1.i.1953, NE, (fl.); on penstock line, McKay's Creek, Kiewa River, *Phillips & Carr* 3240, 26.xi.1957, NE, (fl.); Mt Buffalo, 4 000 ft (1 219 m), *Stewart s.n.*, 9.i.1950, BRI 184908, (fl.); Mt Buller, *Park s.n.*, -.ii.1972, WELTU 12490, (fr.); tributary of Nigothoruk Creek 1½ miles (2.4 km) SW of Mt Wellington, Gippsland, in alpine grassland, *Muir* 3091, 3.i.1964, MEL, (fl.)\*; Emu Plains nr Mt Wombargo, between Benambra & Suggan Buggan, c. 4 400 ft (1 322 m), *Park s.n.*, -.i.1972, WELTU 12301, (fl.)\*; Delegate Hill, just over Victoria side of NSW-VICT. border, 4 307 ft (1 294 m), *Park s.n.*, -.i.1972, WELTU 12303, (fl., fr.)\*; Glen Falloch (property), Big Hill, Gippsland, *Howitt* 1186, undated, MEL, (fl.)\*.

TASMANIA: Launceston, V.D. Land, *Gunn* 506, 11.xi.(18)44, K, (fl.)\* - isolectotype(?) of *Scorzonera (Moniermos) lawrencii* Hook. f.; Tasmania, *Hooker s.n.*, Antarctic Expedition 1839-1843, MEL 64821, (fl., fr.)\*; South Esk, *Anon* 277, 20.xii.(?), MEL 64850, (fl.)\*.

NOTES: Race 2 is distinguished by non-tuberous roots in combination with a ± distinctly paleaceous pappus and usually a large stature, together with associated features detailed in Table 5.

Race 2 can be divided into two subgroups: *sens. strict.* and *sens. lat.* The former subgroup comprises the majority of the herbarium specimens placed in race 2 (including the type of *M. lanceolata*), and the experimentally cultivated populations LD, LE and LF. It is fairly uniform morphologically and ecologically with an altitudinal range usually between 1 200 and 2 210 m. Plants in this subgroup are mostly robust and tend to have subcoriaceous broad (>7 mm) leaves and a high number of involucre parts (>24) and florets. The *sens. lat.* subgroup consists of a relatively small number of herbarium specimens (cited under representative specimens) which all show some traits (varying in number, combination and degree) that are more typical of either race 1 or race 3. The distribution of this subgroup is mostly peripheral to that of *sens. strict.*, with an altitudinal range from near sea level to c. 1 400 m. Specimens that show some degree of intermediacy with race 1 include those from Glen Innes, Conjola, South Crookhaven Head, Shoalhaven, Nigothoruk Creek, Emu Plains, Delegate Hill, Big Hill, and Launceston (isolectotype(?) of *Scorzonera lawrencii* Hook. f.). A specimen from Barbers Creek shows some tendencies towards Race 3 in its small size and unusually high number (25-30) of pappus members. The plants in race 2 *sens. lat.* are problematical and require study in cultivation to resolve their relationships. There is a particular need to verify the racial status of the synonym *Scorzonera lawrencii* for if it is found to be more closely allied to race 1 than race 2 its name will have priority when race 1 is published as a subspecies.

Race 2 occurs sympatrically with race one at two localities in New South Wales (see p. 38) and possibly with race 3 in Tasmania (see p. 44).

## RACE 3

DESCRIPTION: *Plant*— leafy in all seasons; caudex up to c. 10 mm long with c. 1-6 non-tuberous roots. Roots elongate (distally incomplete in most herbarium specimens seen), to >10 cm long, 1-4 (-7) mm wide,  $\pm$  tapering from near insertion. *Leaves*— membranous to subcoriaceous, (3.5-) 9-15 (-20) cm long, 1-4 (-9) mm wide, filiform to linear or lanceolate, acute or obtuse, entire or toothed and/or lobed (to deeply pinnatifid), the lobes up to c. 10 mm long. *Inflorescence*— scapes (7-) 10-20 (-30) cm long, 0.8-2.5 mm diam. *Capitula*— 8-20 (-30) -flowered, bud shape not known, up to c. 20 mm diam. when open. Involucre of us. 16-24 parts; bracteoles us. 8-12,  $\pm$  glabrous, phyllaries us. 8-12, outer ones 8-15 mm long, 1.4-3.3 mm wide, not strongly attenuate above, not black-tomentose without. *Florets*— corolla 9-12.5 mm long, tube 3.1-4.8 mm long, ligule c. 2-3 mm wide; anther tube 2.1-2.8 mm long; style branches 0.8-1.1 mm long. *Fruits*— achenes (6-) 7-9 (-10) mm long, ribs flattened or rounded, glabrous. Embryo filling to 3/4-filling achene. Pappus members (30-) 40-60 (-66), (8-) 10 (-14) mm long, fragile, stramineous or sordid, minutely paleaceous below or some or all members essentially capillary throughout; base of capillary members up to c. 3 mm long, 0.08-0.2 mm wide; palea up to 4 mm long and 0.3 mm wide, wings each c. 1x the width of the midrib at widest point; margins of the palea minutely denticulate and  $\pm$  lacerate; awns 6.2-11.5 mm long,  $\pm$  minutely spiculate. Chromosome number: not known.

TYPES INCLUDED: None

ILLUSTRATIONS: Plates 13 (plants); 30 H-J (capitula); 36 W-Y, 37 I (achenes and pappus); 34 F & G (pappus awn detail).

DISTRIBUTION (Plate 9): Victoria (mid-Western Volcanic Plains) and Tasmania. Altitudinal range from near sea level to c. 1 200 m.

ECOLOGY: Grassland and open places, mostly on soils derived from igneous rocks (basalt and dolerite). Flowering period: (x-) xi-iii (-iv)

VERNACULAR NAME: 'Native Dandelion'

TOTAL COLLECTIONS EXAMINED: 18

REPRESENTATIVE SPECIMENS:

VICTORIA. WESTERN VOLCANIC PLAINS: Lake Calvert (Lough) on basalt plains, *Mueller(?) s.n.*, -.iii.1875, MEL 64786, (fl., fr.).

TASMANIA: Port Arthur, *Buften s.n.*, --.1892, MEL 64837, (fr.); Pine Lake, *J.S. s.n.*, 7.i.1960, HO, (fr.); "var montana", *Archer s.n.*, undated, HO, NSW 128932, (fl.); Projection Bluff, *Burns 523*, 8.i.1962, K, (fl.); Hampshire Hills, *Milligan 1026*, 4.iv.1841, HO, K, (fl.); Tasmania, *Archer s.n.*, undated, HO, (fl., fr.) - mixed with race 1 or 2, NSW 128934, (fr.) - mixed with race 1; Show ground, Hobart, *Lucas s.n.*, -.x.1924, NSW 128936, (fl., early fr.) - mixed with race 1; Cradle Valley, *Rodway 4934*, -.xii.1915, NSW, (fr. - but possibly added and not intrinsic); Bruni Island, *Rodway 4932*, -.i.1901, NSW, (fl.); New Norfolk, *Gunn(?) 506*, 2.xi.1839, K, (fr.); Circular Head, *Gunn 506*, 24.xi.1837, K, (fl.); Woodcutter's Point, *Rodway 4931*, -.i.1901, NSW, (old fr.). Race 3 *sens. lat.*: Mt Nelson Range, *Rodway s.n.*, -.i.1893, NSW 128933, (fl.); Mt Nelson, *Rodway 4929*, -.i.1918, NSW, (fl.).

NOTES: Race 3 can readily be distinguished from the other races by its pappus (Table 5). Frequently associated features include a small stature, less than 20 florets per capitulum, and short corollas.

Race 3 is known only from herbarium specimens.

A collection from Tasmania (*Archer*, HO, NSW) has the annotation "*M. Forsteri* var. *montana* Archer. MS." This is an unpublished name and the whereabouts of Archer's manuscript is not known to the writer. The specimens are typical of race 3 (Plate 13) with pappus members ranging from 38 to 45 in five florets counted.

The fruit illustrated in Fitch's plate in *Flora Tasmaniae* (Hooker 1857) is placed in race 3 although its pappus only shows about 22 members (Plate 2 B). This number is probably not accurate since the source material for the illustration (New Norfolk, *Gunn*(?) 506, K) has more members: 30, 38, 40 & 40 in four fruits counted.

Race 3 occurs sympatrically with race 1 at Hobart Show Ground, with specimens of the two races on the one sheet (*Lucas*, NSW). Only the race 1 plants have roots and these are tuberous. The plants of the two races, which both have flowering heads, are quite distinct on pappus features: race 3 has a capillary pappus of c. 40 members; while race 1 has a paleaceous pappus of 10 members. Possible (but equivocal) examples of sympatric occurrence are provided by two sheets collected in Tasmania by Archer. Both contain mixtures of race 3: one with race 1 (NSW); and the other with incomplete plants that may be race 1 or race 2 (HO double sheet - respective fruits illustrated in Plate 36 X & Z). The sheets do not indicate whether one (hence sympatric) or several localities are represented. In both sheets the race 3 plants have a typical pappus of 40-plus members.

Two similar collections from Mt Nelson and the Mt Nelson Range (both *Rodway*, NSW) are included tentatively as race 3 *sens. lat.* (but have not been incorporated in the racial description). They agree with race 3 in their small size and narrow-linear leaves. Also, their roots, though incomplete, seem likely to be non-tuberous. However, both collections differ from race 3 in having long corollas (c. 20 mm), long anther tubes (4.3-5.2 mm) and fewer pappus members (20-22 (-27)). Their status is uncertain.

## VARIATION

## PHENOTYPIC PLASTICITY

(1) Differences between cultivated and wild plants

Allan (1961) noted that plants of *M. scapigera* grown in cultivation often assumed large dimensions.

A comparison between cultivated plants and herbarium voucher specimens from nature, at the same stage of development (flowering and/or fruiting), could only be made in a few cases. The populations in which the comparisons were made were found to differ in their response to cultivation conditions. In *M. scapigera*, population SA (flowering wild material) showed an overall increase in the size of vegetative parts (leaf length and width increased 3-fold) together with a noticeable increase in branching frequency. The only reproductive part to show a marked enlargement in cultivation was the scape (maximum length increase of 4.5-fold): increase in the maximum size of involucre parts was much less (1.15-fold and 1.25-fold for phyllary length and breadth respectively). A contrast was provided by population SQ (flowering and fruiting wild material). In this population there was no increase in overall size or in branching frequency, and some vegetative and reproductive parts were in fact smaller than in nature. Thus leaves were narrower and showed no increase in length or margin division. Scares were somewhat shorter, as were the maximum lengths of achenes ( $4/5$  wild length) and pappus ( $2/3$  wild length). Involucre part size was similar under both conditions. In *M. lanceolata*, cultivated plants of three populations were compared with voucher specimens from nature, LB, LE & LF (only flowering material could be compared). All three showed growth increases in cultivation as follows:

Roots and stems were larger in all populations. Branching frequency only showed a significant increase in LB (in older plants). Leaves had similar length maxima for wild and cultivation conditions in LB and LE, with a  $1\frac{1}{2}$ -fold increase in LF, while leaf blade width showed a  $1\frac{1}{2}$ - to 2-fold increase, and lobing was accentuated in all three. Ratio of maximum peduncle length in cultivation to that of wild plants was 1.48 in LB, 2.25 in LE and 2.79 in LF, while the corresponding ratios for phyllary length and breadth were 1.23 & 1.94 in LB, 1.15 & 1.37 in LE and 1.35 & 1 in LF.

The following general trends occurred in cultivation, based on the preceding information, and on comparisons of many of the other cultivated populations with herbarium material (non-voucher) from the appropriate localities.

- (a) The size of vegetative parts of the plant, especially the leaves, is often increased though some populations may produce smaller parts.
- (b) Plants tend to produce longer stem axes which bear more leaves per season than in nature.
- (c) Branching frequency is accentuated in some populations (e.g. SA, SF, SH, SK, SP) but remains low in others (e.g. SQ, SV, SW).
- (d) Scape length increase parallels or exceeds that of the leaves.
- (e) The size of involucre parts may be unaffected or increase slightly, with the longer phyllaries of *M. lanceolata* showing the greatest change.
- (f) The number of involucre parts is unaltered or only slightly increased.
- (g) Fruits, like involucre parts, are not greatly modified but may be slightly larger or smaller in cultivation (both achenes and pappus).

## (2) Aspects of plasticity in cultivation

ROOTS. In general, plasticity in roots was limited to change in size. However, the shapes of tubers and of non-tuberous roots of population LC both varied somewhat depending on the nature of the growing medium. Tubers grown in clay-rich soil were slightly narrower and more elongated than when grown in sandy soil (the tuberous character was unchanged). All tubers illustrated in Plate 15 (A-E) were grown in sandy soil. The non-tuberous roots of LC differed in shape according to the pot size used: roots were club-shaped in small pots (Plate 15 F & G) but long and cylindrical in large pots (Plate 15 H). In LC, suckers growing on a piece of cylindrical root in pure sand produced roots that were fusiform in shape (Plate 15 I). However, suckers from another plant of LC produced long cylindrical roots under the same conditions. Thus, the nature of the plastic response varies according to the genotype.

LEAVES. Leaves were found to be very plastic in cultivation. Leaf size and lobing showed the greatest plasticity while leaf shape (excluding margin division) remained basically the same, whatever the size of the leaf.

In cultivation plants often showed marked seasonal differences in leaf size, producing large leaves in summer and much smaller ones in winter and early spring (cf. Plate 18). A 3- to 4-fold increase in length between seasons was common with the greatest difference, a 6-fold increase, occurring in the leaves of population SM.

Some plants only produced entire or nearly entire leaves throughout the year (e.g. all plants of population SA), whereas others produced at least a few lobed leaves. As Plate 18 shows, lobing is accentuated on large leaves. In some plants lobing on leaves was

relatively constant (lobes always present on all leaves) but in others it varied considerably. In the latter plants lobing was often confined to large summer leaves with the small winter ones being dentate or subentire, e.g. population SD and some plants of population SK (plate 18 B & C). In these two examples most of the summer leaves were lobed, but in other examples lobed leaves occurred in fewer numbers together with entire and/or dentate leaves, e.g. populations SE & SI (Plate 19 E & H) and SJ (Plate 20 A). Plants in which both large and small leaves were always lobed (pinnatifid leaves) occurred in populations SB, SC, SF & SH (large leaves shown in Plate 19) & SV (large leaf shown in Plate 20 M).

The variations observed indicate that while margin division (toothing or lobing) is under quite rigid genetic control in some plants, in others it is modified in expression by environmental-developmental factors.

#### GENETIC VARIATION WITHIN POPULATIONS

Preliminary evidence on the extent of genetic based variation in populations was obtained from the samples studied in cultivation, and from herbarium material. Variation was readily observable within some population samples, but many other samples were very uniform. Similarly, in herbarium material variation between plants was evident on some sheets containing more than one plant, but was not obvious on many other such sheets. (A large proportion of all herbarium sheets seen contained two or more plants.) The study of variation within cultivated populations was limited by the frequently low number of plants per sample (sometimes a reflection of small natural population size), so that lack of variation in some samples could not be taken as applying to the natural population. No significant variation was apparent in the following population samples of two or more plants (with the number of plants per sample in brackets): SA(18), SB(3),

SD(16), SH(12), SI(3), SJ(13), SL(2), SP(12), SQ(4), SR(6), SS(6), SU(6), SW(2), SX(12). Population samples showing obvious variation were SC(12), SE(10), SF(15), SG(12), SK(11), SM(6), SN(16), SO(14), ST(3), SV(6), LA(20), LB(3), LC(20). Not all of these varied to the same degree: in some variation was limited to one individual or to one part, but in others it was more extensive.

In variable populations, the differences between individuals did not exceed variation between populations. In spite of differences, individuals still retained numerous shared characters, so that their provenance could be identified without referring to labels.

Variation was more frequent in some parts of the plant than in others. The part most commonly affected by genetic-based variation was the leaf. Capitula sometimes differed between plants as did the fruits, though in general fruits showed the least variation within populations. Pubescence and anthocyanin pigmentation were variable on all parts. Leaves varied in shape and margin division (whether entire, toothed or lobed), though in the latter variation was sometimes masked by the effects of plasticity. Capitula varied in the size, number and shape of involucre parts and the number of florets. Fruits varied mainly in the size of achenes and the number of pappus members and size of their bases.

An example of population variability from each species is provided by SF (*M. scapigera*) and LC (*M. lanceolata*). Both examples were strongly self-incompatible, as were the majority of populations studied (see SECTION II).

In SF the population sample comprised 15 plants, collected at various points on an extensive coastal cliff. The plants differed from one another in leaf form, the leaves ranging from entire to dentate-short lobed, to pinnatifid (extremes shown in Plate 19 F). Capitula

on the other hand did not show marked variation: there were small differences in the shape of outer phyllaries and in the numbers of involucre parts and florets. Fruits, which were examined in 14 plants, exhibited some variation in achene length and pappus characters (Plate 40).

In LC the sample comprised 20 plants, grown in cultivation from seed obtained from several plants in nature. Details on the exact number and spacing of the latter plants were not available. The 20 individuals differed considerably from one another in leaf form, with leaves ranging from linear-pinnatifid to broad-lanceolate and the latter from entire to lobed (leaves from four plants are shown in Plate 21 B). Capitula were also quite variable in size and in the number, length and shape of involucre parts (cf. Plate 28 C & D). Fruits were produced in a few plants only (those deliberately cross-pollinated). These fruits, together with fruits examined from about nine plants in nature showed some variation in the achenes (length, colour and pubescence) and size of the pappus; but great uniformity in the number of pappus members, which only ranged from 9 to 11.

#### GEOGRAPHICAL VARIATION

##### (1) Geographical variation in *M. scapigera*

*Microseris scapigera* is a very polymorphic species, widely distributed in New Zealand (Plate 7), and found in a variety of different habitats.

Variation within the species is shown in a comprehensive selection of illustrations, detailed on p. 22. Measurements of reproductive characters, based largely on glasshouse-cultivated material, are shown pictorially in Plates 38 (pappus) and 41 (reproductive

character averages other than those in Plate 38)\*. Plate 41 also includes the population samples studied in *M. lanceolata* for comparison. In this Plate the average states of 12 characters are displayed in metroglyph form†.

The writer has been unable to treat taxonomically the infraspecific variation observed in cultivated population samples and in herbarium specimens of wild plants. Morphological-ecogeographical patterns occur involving several characters in association, but the patterns are complex and often intergrade and are therefore difficult to delimit satisfactorily.

Allan (1961) recognised four formae within the species. These taxa were each based on several characters (cf. Table 1), but were named according to leaf shape. Plants matching his descriptions are shown in Plate 10. In this study it has been found that leaf shape (including lobing) is an unreliable taxonomic character. Plants from the same population or locality can sometimes differ considerably in leaf shape and yet be very uniform in reproductive and other vegetative characters. In such cases two or even occasionally three (in the South Island) leaf shapes may occur together. It does not seem taxonomically useful to separate, as formae, closely related plants from the same locality which differ essentially in only one part. Accordingly, taxonomic form names have not been recognised in this treatment.

In order to give an indication of the main variation patterns in

---

\* Populations SI and SL were not measured. The reproductive parts of SI were similar to those of SH, while those of SL were similar to SK.

† The relative scale used for 11 of the 12 characters was obtained by dividing the difference between highest and lowest averages for a given character into eighteenthths (18 mm being the maximum arm length before reduction of the Plate). The arm was then extended to the appropriate length (fraction) for each average.

*M. scapigera* several non-taxonomic morphological-geographical groups are described. In most cases the groups can not be sharply defined.

GROUP 1. This group comprises the formae *linearis* and *pinnatifida*, both in part.

The most distinctive features of group 1 are: long, linear to narrow-linear leaves (entire to dentate and/or pinnatifid);  $\pm$  broadly -elliptic or -ovate-triangular obtuse bracteoles; narrowly elliptic (or occasionally obovate) obtuse outer phyllaries (length : width = c. 2.5-4); and a pappus of  $\pm$  20 members with minutely paleaceous bases up to c. 2 mm long and 0.4 mm wide. The group has an inland central North Island distribution bounded by latitudes  $38^{\circ}$  and  $40^{\circ}$ S (approximately), and occurs in montane to subalpine grassland. It is relatively uniform within this area although involucre features are not quite so marked in several depauperate herbarium specimens. Group 1 includes populations SB and SC and numerous herbarium specimens. Plants from North Island localities outside this region mostly grow in coastal habitats, and differ in the affinity they show to group 1 plants. Those from Castlepoint (pop. SD) and Pahaoa Gorge (pop. SE) are similar, especially in involucre and pappus features, and could probably be included in group 1. However, plants from the Bay of Islands (?), Cape Kidnappers (pop. SA), Cape Palliser area (e.g. pop. SF), and Wellington south coast (e.g. pop. SG) show little or no morphological similarity to group 1.

GROUP 2. This group consists of forma *linearis* in part.

The most distinctive features of group 2 are: long filiform, narrow-linear or linear leaves (entire or dentate or with occasional runcinate teeth);  $\pm$  narrowly ovate-triangular acute or acuminate bracteoles; narrowly ovate subacute or acute outer phyllaries (length:

width = c. 4-6); and a pappus of c. 20-30 (-37) members which are sometimes minutely paleaceous but more often have capillary bases. Group 2 plants are frequently small and tend to have more slender scapes and heads and fewer florets than the other three groups. Group 2 has a South Island distribution between latitudes  $41^{\circ}$  and  $46^{\circ}$  S (approximately), and occurs mostly in grassland, from lowland to subalpine levels. Populations SO, SR, SW, SX and SU belong in group 2 (the last having somewhat atypical leaves). Several herbarium specimens have short corollas and may therefore be weakly self-incompatible like SW (see SECTION II), e.g. Boltons Gully (Plate 10) and Glen Ure Station (CHR 140072). Group 2 grades into wider leaved forms with less distinctive involucre in various parts of its range, especially in Nelson: such plants are difficult to separate from Group 3 B plants.

GROUP 3. This group comprises forma *obovata*.

The most distinctive features of group 3 are: obovate-spathulate, oblanceolate or lanceolate leaves (entire or dentate and/or lobed); usually ovate-triangular to broadly ovate-triangular obtuse or acute bracteoles; and narrowly -elliptic or -ovate  $\pm$  obtuse outer phyllaries (length : width = c. 3-4). The pappus varies considerably from 8 to 33 members and ranges from paleaceous to capillary. Group 3 has a South Island distribution between latitudes  $41^{\circ}$  and  $44^{\circ} 30' S$  (approximately), and occurs from coastal to subalpine levels in a variety of open habitats. Group 3 is a heterogeneous assemblage which can be divided into several subgroups:

SUBGROUP A. Plants from the mountains of Marlborough often have in common broad obovate-spathulate dentate to lobed leaves,  $\pm$  obtuse bracteoles, and narrowly elliptic obtuse phyllaries. Pappus features often contrast sharply in such plants, e.g. a specimen from Carters Saddle (CHR 203097) has c. 10 paleaceous pappus members (paleas c. 3 mm long and 0.6 mm wide), whereas plants from Mt. Miro Miro (Plate 10)

have 30-33 capillary pappus members. Population SM from Mt Fyffe belongs to this subgroup.

SUBGROUP B. Other plants in inland Marlborough and a large number from Nelson form a second subgroup differing from the former in having narrower, more frequently entire leaves and more pointed bracteoles and phyllaries. Pappus features appear to be more constant in this subgroup with c. 20-30 members ranging from minutely paleaceous to capillary. Subgroup B tends to occur in damp montane to subalpine grassland. Examples of experimentally studied populations in this subgroup are SS & ST. The subgroup grades into more linear-leaved types, sometimes in the same locality. Populations SP and SQ had essentially linear leaves but were similar to SS and ST in involucre and pappus features. Plants with leaves matching those of the subgroup but often having larger less narrowly acute bracteoles occur in Canterbury, sometimes together with linear- or pinnatifid-leaved (but otherwise similar) plants, e.g. population SV (cf. leaves of two plants in Plate 20 M).

SUBGROUP C. Plants from Hakataramea Pass, South Canterbury, form a third subgroup with large broad entire to subentire leaves and very broad obtuse bracteoles (Plate 27 L). The pappus consists of c. 20 mostly paleaceous members (Plate 35 U).

SUBGROUP D. Plants in maritime habitats in Marlborough often have obovate or broad-lanceolate leaves. Such plants resemble subgroup A in the shape of involucre parts. The pappus is relatively constant with less than 20 (and mostly <15) paleaceous members. In some localities plants with linear or pinnatifid leaves occur together with or in close proximity to obovate-leaved ones, e.g. Marfell's Beach (populations SH & SI) and Ward Beach (cf. suite of specimens collected by Collett at CHR). The type sheet of *M. scapigera*, collected at Totaranui in the Marlborough Sounds also contains linear- and obovate-

leaved plants (Plate 3).

GROUP 4. This group comprises forma *major*.

The distinctive features of group 4 are: large linear-lanceolate leaves (entire or dentate and/or lobed); broadly ovate-triangular obtuse bracteoles; and large elliptic or ovate obtuse outer phyllaries (length : width = c. 2.5-3). The pappus appears to be quite uniform (examined from three localities) with c. 9-14 distinctly paleaceous members, the paleas up to 4.3 mm long and 0.9 mm wide. Group 4 is confined to the Waima (Ure) River catchment in Marlborough where it occurs on shaded limestone cliffs. Populations SK and SL belong in the group. Group 4 plants resemble members of group 3 (subgroups A & D) in the shape of phyllaries and in pappus features though involucre parts and paleas are mostly much larger.

## (2) Geographical variation in *M. lanceolata* race 1

Race 1 is the most widely distributed and abundant of the three races. It has a disjunct distribution with a gap of nearly 1000 km separating Western Australian localities from the main area to the east (Plate 8). The race exhibits variation in different parts of its range. Some morphological-geographical patterns occur but are apparently limited to single characters. None seem significant enough to warrant subdivision of the race. Geographical variation occurred as follows:

**PLANT SIZE.** Plant size varies considerably in most States, in a random pattern. Plate 11 (upper left & right specimens) shows maximum and near minimum sized plants.

**ROOTS.** Roots are typically tuberous, though one population included in race 1 (LC) has non-tuberous roots (see p. 37). As Plate 8 shows, plants with tuberous roots occur widely within the distribution area

of the race. However, many herbarium specimens lacked roots or had roots which could not be identified because they were incomplete. It seems likely that most of the latter plants were also tuberous. Tuberous roots showed some variation in shape. The majority were short and broad, though in most States long narrow ones sometimes occurred. The two narrowest examples (length : breadth ratio of 12-15:1) were from Tia Falls (Plate 6 D), and Rendezvous Creek District, A.C.T., *Adams 542*, CANB, (Northern and Southern Tablelands of New South Wales, respectively). No definite geographical pattern was apparent with narrow tubers though there were indications that they may be more common in wetter areas.

LEAVES. Leaves were extremely variable throughout most of the range of the race though those of Western Australian plants examined were more uniform, usually linear to narrow-lanceolate and dentate.

CAPITULA. Form of capitula showed variation but no regional trends were apparent. A representative selection of capitula from herbarium specimens is shown in Plates 29 & 30 A-G, in which variation in head size, and in the number, size and shape of bracteoles & phyllaries can be seen.

FRUITS. Fruit form exhibits regional differences in pappus features. A representative selection of fruits is illustrated in Plate 36 A-M and pappus measurements are shown pictorially in Plate 39 (race 1). The most distinct regional difference is in the length of bristles (spiculae) on pappus awns. All Western Australian material seen had long bristles (0.2-0.6 mm) whereas in other States the bristles were short (<0.2 mm). Short and long bristles are illustrated in Plate 34 D & E. Preliminary evidence indicates some regional variation in the number of pappus members. Counts of pappus members in mature fruit collections (shown as range in Plate 39) and immature fruit collections (not shown) tended to be low (c. 10) in south-eastern S.A.,

Victoria, Tasmania, and south-eastern N.S.W. and higher (up to c. 21) elsewhere.

DISCUSSION. *Microseris lanceolata* race 1 appears to be a climatic ecotype which is adapted to withstand periods of summer drought. Adaptations include tuberous storage roots, soft thin leaves that tend to die back after flowering, and an early flowering season timed for completion before the onset of the dry spell. In South Australia race 1 (as the native yam, *M. forsteri*) is reported by Wood (1937 pp. 61 & 145) as being a prominent geophytic member of a geophytic and ephemeral community frequenting flat alluvial areas where "the ground is flooded throughout the winter months, ... remains saturated during the short spring and is baked dry in summer." A similar habitat in dry inland regions of New South Wales and Victoria is indicated by numerous riverine localities for herbarium specimens (see Plate 8 for distribution along major rivers).

The distribution of race 1 spans an annual rainfall gradient from 25 cm on the dry inland side to over 100 cm in wetter areas such as the NE coast of N.S.W.). The writer does not know whether seasonal droughts also occur in the higher rainfall areas. If not, a gradient (cline) in drought-adaptive features - becoming less marked in wetter regions - might be expected. There are indications of some diminution in directly adaptive traits in plants from wetter localities (e.g. Tia Falls, see pp. 36-37) but more sampling is necessary before this can be confirmed.

### (3) Geographical variation in *M. lanceolata* race 2

Race 2 is divided into two morphological-eco-geographical subgroups referred to as *sens. strict.* and *sens. lat.* (see p. 41).

Race 2 *sens. lat.*, which is the smaller subgroup, is a residuum of the variation in *M. lanceolata* that does not fall within race 2 *sens. strict.* or either of the other two races. It comprises a

heterogeneous assemblage of specimens showing some intermediacy between race 2 *sens. strict.* on the one hand and race 1 or 3 on the other hand. The distribution of race 2 *sens. lat.* is shown in Plate 9, and illustrations of herbarium material include Plates 5 A-in part & B (plants); 30 K (capitulum); and 36 O (fruit).

Race 2 *sens. strict.*, which comprises many specimens, has an alpine distribution extending for c. 300 km in south-eastern N.S.W. and eastern Victoria (Plate 9). The subgroup shows variation over its range, but this is relatively minor. Representative herbarium specimens are shown for comparison in Plates 12 (plants); 31 (capitula); and 36 N, P-V (fruits). Pappus measurements are shown pictorially in Plate 39 (race 2), in which all but the upper two circles (*sens. lat.*) are *sens. strict.*

One of the three populations of race 2 *sens. strict.* grown in cultivation (LF) was found to be an octoploid ( $2n = 72$ ). Of the other two, LE had the tetraploid number ( $2n = 36$ ) typical of the subgenus while LD was not investigated cytologically but was probably tetraploid also\*. The octoploid, LF, had larger capitula than LE & LD (Plate 25 Q-S) but did not show gigantism in other parts of the plant. It is not known whether octoploids occur naturally at any locality other than Mt. Hotham. Two microscopic characters were examined to see whether they could be used to identify probable octoploids (and tetraploids) from among herbarium specimens: mean pollen protoplast diameter and the relative proportion of 4-pored grains (together with much less numerous 5- & 6-pored grains) to 3-pored grains. A third morphological marker used for separating different ploidy levels, the average length of leaf stomata guard cells (Babcock and Stebbins

---

\* Based on crossing relationships: LD, like LE, set fruit from uncontrolled outdoor cross-pollinations (intra- and interspecific pollen) - unlike LF in which fruit set failed to occur.

1938), is a subject for future study. The octoploid population LF was found to have a larger mean pollen protoplast diameter (with a higher maximum) than any population known from cytological examination to be tetraploid, and it also had a much higher percentage of 4-pored grains (Table 7). In *M. lanceolata* race 2 *sens. strict.* there were also herbarium specimens from several localities which had mean pollen diameters and/or 4-pored grain percentages similar to LF (cf. Table 7) and which might, therefore, also be octoploid. However, the value of the 4-pored percentage as an octoploid indicator is undermined by the following preliminary evidence: Firstly, it is apparently influenced by environmental or developmental factors since it can vary widely in the same genotype (plants of the same clone). Such variation occurred in LF. Secondly, it may be genetically controlled: several highly 4-pored individuals occurred in F<sub>2</sub> and BC<sub>1</sub> generations of crosses whose parents were from 98% to 100% 3-pored e.g. H205-3 = 38% and H189-6 = 72% 4-pored. Furthermore, 4-pored grains have a frequency of 51-88% in *M. campestris* (subgenus *Microseris*) - a tetraploid species (Chambers 1955, p. 237). Mean pollen protoplast diameter, on the other hand, may be a better octoploid marker although here too there is conflict with *M. campestris*, in which mean pollen (protoplast?) diameters of 33-36  $\mu$ m have been recorded (Chambers 1955). Clearly, more chromosome counts are necessary in *M. lanceolata* race 2 *sens. strict.* to assess properly the reliability of protoplast diameter.

#### (4) Geographical variation in *M. lanceolata* race 3

Race 3 is apparently the least abundant race, comprising only 18 collections from Tasmania and Victoria (Plate 9).

Race 3 *sens. strict.* (16 collections) exhibits some variation in leaf, capitula and fruit form. Representative herbarium specimens are shown for comparison in Plates 13 (plants); 30 H-J (capitula);

and 36 W-Y (fruits). Pappus member measurements (mature fruits only) are shown pictorially in Plate 39 (race 3). A high number of pappus members is a characteristic feature of the race (confirmed in most collections) but some numerical variation occurs. The Victorian and some of the Tasmanian plants have c. 50-60 members; however other Tasmanian plants have c. 40 members, e.g. plants from Pine Lake, Projection Bluff, New Norfolk, and the geographically unplaced "*var. montana*". In most localities the pappus members were largely of the same length but in a collection from Port Arthur, Tasmania (49-56 members) more than half the members were shorter and weaker than the rest.

Race 3 *sens. lat.* consists of two collections from the same area (Mt. Nelson) in Tasmania. They differ considerably from race 3 *sens. strict.* plants in floret and pappus features (see p. 44) but agree in other respects.

## SECTION II. BREEDING SYSTEM

## METHOD

Plants were tested for self-compatibility and self-incompatibility both by bagging individual heads and by growing whole plants in isolation. (Plants were usually isolated, one at a time, at the writer's home, where no other *Microseris* plants were growing.) All heads were manually self-pollinated except those of population SW, which were left to self-pollinate naturally. Initially one plant per population (two or more heads per plant) was investigated, but in populations where self-compatibility was found testing was more extensive. Other information on the breeding system was obtained from crossing experiments (see SECTION III).

## RESULTS

FLOWERING AND POLLINATING BEHAVIOUR (GENERAL). The two species of subgenus *Monermos* have the following flowering and pollinating features in common. Florets mature in centripetal sequence. Heads open daily for 1 to 5 days (depending largely on the number of florets per head) until all the florets have expanded. At anthesis the styles elongate rapidly, carrying the pollen mass from the anthers. The pollen often coheres quite strongly and is not easily disturbed, except by visiting insects and rain. Cohesion is aided by the minute bristles on the style and probably also by tiny oil droplets scattered amongst the pollen grains. When the style tips separate the stigmas are free of pollen. Unless the floret is fertilized the stigmatic tips stay receptive for about two days before withering, becoming progressively more recurved. Some self-pollination (but not self-fertilization) probably occurs in all populations when the heads close at night. Closing brings the recurved stigmas into contact with the pollen on neighbouring styles. Open heads are visited by a variety of flying insects but especially honey bees, bumble bees and hover flies.

## SELF-INCOMPATIBILITY

The type of self-incompatibility in *Microseris* is not known but other compositae have the sporophytic system (Lewis 1966).

Three levels of self-incompatibility were found to occur within subgenus *Monermos*, herein termed strong self-incompatibility, moderate self-incompatibility and weak self-incompatibility. The distribution of populations studied within these classes is shown in Table 8 A. The two extremes, strong and weak self-incompatibility, were also accompanied by differences in capitulum form and opening behaviour, which appeared to be adaptations to promote, respectively, outbreeding and autogamy (cf. Ornduff 1969).

**STRONG SELF-INCOMPATIBILITY.** The majority of populations tested were strongly self-incompatible. These included all six populations of *M. lanceolata* and most of those in *M. scapigera*. No fruit set occurred in manually self-pollinated bagged heads, indicating obligate outbreeding. Capitula varied considerably in size among populations but all shared the following features, which were apparently associated with outbreeding. Corollas always projected well beyond the phyllaries (refer to appropriate populations in Plates 26-28); heads had a daily opening time of about 5-6 hours and mostly took 2-5 days to complete flowering; anthers were often long (range: 3-7 mm), with abundant pollen; and styles were usually prominently exerted.

Although self-pollination always failed to produce fruits some selfing occurred when heads were cross-pollinated with the octoploid LF, and in one head, by the tetraploid LE (Table 8 A). It appears that populations LE & LF can stimulate selfing in strongly self-incompatible populations, from which they are almost genetically isolated. Remotely related plants can have the ability to stimulate

selfing in otherwise self-sterile plants (Clausen 1951, p. 172).

In subgenus *Monermos* it is not known whether stimulation of selfing involves self-fertilization or pseudogamous apomixis. However, the apparent absence of parental selfs in the numerous hybrid progenies of crosses made with strongly self-incompatible ovule parents (see SECTION III) suggests that apomixis is unlikely. How the LE/LF pollen could overcome the self-incompatible reaction, allowing self-fertilization to occur, is uncertain. The site of inhibition in many compositae is restricted to the stigma (Arasu 1968). Therefore a possible explanation requiring further study, is that the LE/LF pollen, which was applied in large quantities, in some way alters the stigmatic surface (enzymatic breakdown?) enabling germination and penetration by domestic pollen to proceed. Presumably the self-pollination would have occurred several hours after cross-pollination, when the heads closed.

MODERATE SELF-INCOMPATIBILITY. Two populations (and one hybrid examined) were moderately self-incompatible: SD & SG. In both, average fruit set in single plants, under the same conditions (whole plant isolation) was approximately 50%. The capitula of SD & SG were little or no different in appearance and opening time from those of strongly self-incompatible populations though the corollas of SG were not strongly exerted (Plate 26 G). In population SD, 15 plants were investigated to see whether the degree of self-incompatibility varied between plants (Table 8 B). In the nine plants in which sufficient heads (>10) were tested by bagging there was general agreement in the level of self-incompatibility. Eight of the plants had fruit set averages between 34% & 43% and maxima between 70% & 87%. The plant that differed (SD 12) had an average of 20%, though its maximum, 84%, agreed with the others. (Here the average was lowered by seven fruit set failures.) More heads failed to set fruit after bagging than when left unbagged, in isolation. For example, in SD 16 fruit set failed in three out of the sixteen

heads bagged, but occurred in all 28 heads when the same plant was grown in isolation. Therefore bagging probably caused some of the failures. It could also explain some of the fruit set failures that occurred in artificial hybridizations.

**WEAK SELF-INCOMPATIBILITY.** One population, SW, was weakly self-incompatible or, conversely, strongly self-compatible. Self-pollination fruit set in a sample of eight plants averaged 83% (with no obvious difference between plants), and in many heads the full complement of ovules developed into fruits (Table 8 B). The population may, indeed, be wholly self-compatible, with the difference between observed and full fruit set due only to inefficiency in self-pollination. The capitula of SW exhibited a number of features which seemed to be associated with autogamy. Thus, corollas projected little (if at all) beyond the phyllaries (Plate 27 J, showing maximum exertion); and the heads had a restricted opening time of about 2-3 hours. {These two traits also occur in the species of subgenus *Microseris*, which are all highly self-fertile (Chambers 1955, p. 220)}. Also, anthesis was usually simultaneous in all florets, the head only opening on one day; anthers were short (<3 mm) and contained a relatively small amount of pollen; and the styles were not greatly elongated.

Population SW could be crossed in both directions with strongly self-incompatible populations (Table 9). Thus, unilateral incompatibility, which is sometimes encountered in crosses between self-compatible and self-incompatible parents (Ornduff 1969) does not occur.

*M. lanceolata* race 3, which was not available for study, could possibly be weakly self-incompatible, based on the form of its capitula. Like SW, it has small capitula with relatively short corollas and small anthers.

## SECTION III. ARTIFICIAL HYBRIDIZATIONS

## METHODS

CROSS PROGRAMME. The cross programme comprised interpopulation crosses within and between *M. scapigera* & *M. lanceolata* (subgenus *Monermos*) and between these species and *M. borealis* (subgenus *Apargidium*). In *M. scapigera*, populations used in crossing were selected to represent as much of the morphological variation within the species as possible. Two pairs of closely related populations were included: SH & SI; and SK & SL. In the first pair, SH was used widely in crosses but SI was only crossed with its partner. In the second pair, SK & SL were used as interchangeable alternatives in crosses with other populations. In *M. lanceolata*, only race 1 & race 2 were used in crossing: race 3 could not be obtained. In *M. borealis*, only one population was available. Most populations in the programme were used in more than one cross. Usually they were employed as ovule parents in some crossings and as pollen parents in others but SM, SP, LA & BA were used wholly in one parental direction. The localities of the populations involved in the cross programme are listed in Table 2.

CROSSING TECHNIQUE. Crossing was carried out in a glasshouse which, because of ventilation requirements, could only be kept closed to pollinating insects in the mornings. Consequently, it was necessary to isolate heads in bags, although the heads of SW were not bagged because of their short opening time. The bagging apparatus consisted of a cellophane bag stretched over a wire frame and sealed with paper clips (Plate 43 A). A head of the desired ovule-parent was tagged, and pollen from the pollen parent was applied daily (bagging after each application) until all florets had been crossed. Several days later, when the florets had withered, the bag was removed and the head left to ripen. Donor pollen was usually applied by removing

pollen-coated styles one at a time with forceps and gently dusting them on the stigmas of the ovule parent, but sometimes it was applied simply by rubbing donor and recipient heads together. In the majority of head-crossings only one donor plant was used. Care was taken to avoid contamination with unwanted pollen during crossing: the glasshouse was closed; forceps were flame-sterilised; and donor pollen was taken only from florets at early anthesis age.

Crossing was straightforward in strongly self-incompatible populations, but in those less strongly self-incompatible there was a problem at first with self-pollination, which sometimes occurred to the exclusion of hybridization. However, it was found that self-fertilization in such populations (notably SD) could be greatly reduced or eliminated by applying donor pollen early - as soon as the style arms separated - and taking special care not to disturb the domestic pollen.

RECORDS AND REFERENCE NUMBERS. The great majority of crosses were recorded. The unrecorded crosses were mostly made between  $F_1$  hybrids of *M. scapigera* x *M. lanceolata* race 1, in which available flowers were crossed randomly, for the purpose of obtaining an  $F_2$  generation. Records were kept using two separate number series. In the first series, prefixed by the letter X, each head crossed was given a serial number for recording crossing details, including: bud opening date, parent plants, number of florets crossed, harvest date and fruit yield. The X-number was also used to label the appropriate head (Plate 43 A) and the seed packet in which its fruits were stored. X-numbers apply to primary data and are not referred to further in the text. The second series, prefixed by the letter H, was used to refer to the crosses that were sown. In this series each uni-directional cross (comprising the fruits of one or more heads) was given a separate number. H-numbers are listed with their crosses in Tables 9 & 10.

**SOWING AND CULTIVATION.** Limited space restricted the numbers of fruits that could be sown. Fruits of each cross were sown in seedling trays in labelled rows spaced 4 cm apart (Plate 43 B). Usually one row was used per cross with up to 25 fruits per row. Most fruits were between two and four months old at sowing. To ensure that the fruits remained fixed in their rows they were covered with a thin layer of finely sieved soil and only watered with mist-spray. Seedlings were kept in their trays almost until flowering age. Then, depending on the number available, up to six plants per cross were potted-out into plastic bag-pots, in standard soil mixture. In the majority of crosses, all potted plants were plunged in outdoor sawdust beds (Plate 43 C). But in selected crosses some individuals were also grown in the glasshouse for comparison with their parents.

**FERTILITY OF HYBRIDS.** Fertility was based on the percentage of morphologically well-developed ('good') pollen grains staining in lactophenol cotton blue. The percentage was calculated from a minimum sample size of 300 grains. Pollen grains classed as 'bad' were either empty (most) or had stainable contents but were vacuolated or malformed. 'Bad' grains were invariably smaller than 'good' ones. In  $F_1$  hybrids, whenever possible the fertility of at least three plants was tested. In the majority of crosses only one count was made per plant, though plants with disparately low fertilities were often retested. Individual percentages were then averaged to provide an average fertility value for each cross.

**DIRECTION OF CROSSES.** Crosses represented in symbol form are uni-directional, with the ovule parent always first (see p. 6), unless the parents are separated by a hyphen. Crosses designated by the names of the parents are similarly one-way in Tables 9 & 10 but refer elsewhere to two-way combinations, whether reciprocals were made or not.

CROSSES WITHIN SUBGENUS *MONERMOS*

## GENERAL RESULTS

CROSS PROGRAMME. The recorded crosses made within subgenus *Monermos* in which fruits were sown are listed in Tables 9 & 10.

Selected representatives of different  $F_1$  hybrids and one  $F_2$  progeny are illustrated in Plates 16 F-I (roots and stems); 22 & 23 (leaf form); 42 E-F (chromosomes); and 46-52 (capitula).

GERMINATION. Hybrid (and parental) fruits usually started germinating one to two weeks after sowing. In the majority of crosses germination ceased about one month after sowing but sometimes fruits continued to germinate, sporadically, two to three months later. Percentage germination ranged from 0 to 100%. There was no apparent correlation between low germination and low hybrid fertility: interspecific hybrids, which had the lowest fertilities, often had high germinability. The fruits of 24 crosses failed to germinate (Table 9, Plate 44). Some failures were probably due to fungal pathogens (fruits were sometimes attacked by a fungus when ripening, though only visibly unaffected ones were sown). In other failures (notably SX crosses) the cause may have been physiological (need for cold temperature?).

PROGENY STATUS. Of the 178  $F_1$  progenies raised 159 were hybrid in that no non-hybrids were detected. The other 19 cross progenies contained parental selfs (Table 9): either mixed with hybrid plants (6 cases) or as the only plants, crossing therefore having failed (13 cases). Progenies with parental selfs were either from crosses in which the ovule parent was moderately to strongly self-compatible, or from crosses with LE or LF as pollen parents which apparently stimulated selfing in strongly self-incompatible ovule parents (see SECTION II).

FERTILITY. Fertilities of  $F_1$ ,  $F_2$  &  $BC_1$  crosses are listed in Tables 9-11. The average fertilities of  $F_1$  crosses are scheduled in Plate 44 (where unsuccessful crosses are shown also) and summarised pictorially in Plate 45. The fertilities of two  $F_1$  progenies were not determined: SN x SD (4 plants) was lost when a plunge bed was moved, and LC x LB (1 plant) died accidentally. The fertilities of parent plants were not determined accurately for comparison with hybrids. However, in investigating pollen morphology (for Table 7) it was noted that the plants of all populations examined had high fertilities (estimated at 95-100%).

HETEROSIS. Several crosses showed hybrid vigour. However, most hybrids could not be assessed for hybrid vigour because they were not grown under the same conditions as their parents. Hybrid vigour was noticeable as a slight increase in leaf size (mainly length). There was no apparent increase in the size of any other organ. Both intraspecific and interspecific crosses showed leaf vigour, e.g.: SW x SK (*M. scapigera*); and SK x LC (*M. scapigera* x *M. lanceolata*). In these two hybrids leaf maxima were 76 mm and 125 mm longer respectively than the mean of the maxima of their corresponding parents.

$F_1$  INTERMEDIACY. Most  $F_1$  progenies were approximately intermediate between their parents in overall morphology. Usually they were relatively uniform though some showed obvious individual variation in one or more characters. (The commonest variable in such progenies was leaf shape). Characters which tended to be intermediate included: root tuberosity (Plate 16 F-I); leaf shape (Plates 22-23); number and shape of bracteoles and phyllaries (see capitula in Plates 46-52); pappus part number and palea size. The breeding system character, degree of self-incompatibility, was also approximately intermediate in the one hybrid tested, SW x SK (see Table 8 A).

Some cases of dominance were also observed: non-sucker production was dominant over adventitious sucker production on roots in all crosses (SK x LF, SM x LF, LC x SA, LE x LB, LE x SD and LE x SG). Glabrous leaf margins were dominant over furfuraceous leaf margins in all *M. scapigera* x *M. lanceolata* hybrids. Rugulose leaf surface was dominant over smooth surface in SK x LF, but intermediate in SM x LF (subrugulose), and recessive in LE x SD & LE x SG.

RECIPROCAL DIFFERENCES. No reciprocal differences in morphology were observed: reciprocals were indistinguishable from one another. Some reciprocal differences in average pollen fertilities were noted (see on) but these could have been because too few plants were tested.

#### CROSSING RELATIONSHIPS

INTRASPECIFIC CROSSES: *M. scapigera*. Crossability between populations of *M. scapigera* was high. Heads occasionally failed to form fruits after crossing but fruit set was always obtained when these crosses were repeated. The fruit set per head was 75-100% in the majority of crossings.

In general the average fertility of crosses between populations was high (Plates 44 & 45). No population was consistently less interfertile than other populations though SQ had the most crosses with reduced fertilities. The average fertility of the 141 crosses tested ranged from 80-100%. Of these, 107 crosses had fertilities between 100 & 96%, 20 between 95 & 90%, ten between 89 & 85%, and four between 84 & 80%. Individual plant fertility (not tabulated) often varied widely in crosses with average fertilities of less than 95%. The fertility range within such progenies was often 20% and had a maximum of 30% (SQ x SC: 68% & 98%). The lowest fertility for a single plant was 68%. The 141 crosses comprised 61 one-way and 40 two-way combinations. The difference in average

fertility between reciprocal crosses was less than 10% in 34 cases and greater in the following six: SC-SA (17%); SK-SC (14%); SK-SD (15%); SK-SE (11%); SQ-SH (13%); and SX-SF (19%). The larger differences are probably not significant in view of individual variation within progenies.

The F<sub>2</sub> generation was studied in one cross, SW x SK, which was selected because it represented the combination of morphological extremes within the species. The F<sub>2</sub> plants were mostly vigorous and highly fertile, like the F<sub>1</sub> progeny, but unlike the latter some were abnormal, weak or had low pollen fertility. Eleven out of 143 F<sub>2</sub> seedlings were abnormal or weak and died early as small plants (five of these were white to pale-green dwarfs). Four plants out of a sample of 30 (picked at random) had low fertilities (76%, 63%, 53%, 8%); fertilities in the other 26 plants ranged from 90 to 99%. The F<sub>2</sub> progeny showed limited segregation for parental characters: plants approached, but did not match, one or other of the parents in some characters (e.g. leaf width) but none approached either parent in all of their characters. The limited segregation towards parental types is shown for capitula form in Plate 49 fig. B (compare with parental capitula in fig. A). The heads illustrated were selected to represent the range of segregation.

#### INTRASPECIFIC CROSSES: *M. lanceolata* - race 1 x race 1.

Crossability between the populations of race 1 was moderate to high: fruit set was 38% in the LC x LB head crossing, and averaged 61% & 87% respectively in the LC x LA & LB x LC crossings. The average fertility was 96% in the two crosses in which it was determined (Plate 44).

The fertility of the F<sub>2</sub> was tested in LC x LA. Only a small number of seeds could be obtained from the F<sub>1</sub> plants (Table 10), possibly because being from the same progeny they shared too many of the same self-incompatible alleles. Seven seeds germinated and all seedlings were

normal and vigorous. Two died accidentally prior to fertility testing and the remaining five had fertilities of 84% (1 plant) and 98% (4 plants).

INTRASPECIFIC CROSSES: *M. lanceolata* - race 1 x race 2.

Crossability was low with either ploidy level in race 2: fruit set per head ranged from 0-10%.

Fertility was 94% in the one cross in which hybrid progeny (one plant) was raised (Plate 44). The hybrid, LE x LB, only showed some intermediacy, limited mainly to leaf (Plate 23 G) and root (Plate 16 G) traits. Other parts such as the stem, capitula (Plate 52 A) and fruits showed closer resemblance to the ovule parent LE than to LB. Preliminary evidence from crossing tests indicated that the plant was possibly an octoploid (amphiploid) derived from tetraploid parents. The hybrid failed to set seed when backcrossed with its parents (each parent was tested twice) whereas it readily formed fruits (average fruit set in three heads: 47%) when crossed with the octoploid LF (Table 10). However, another line of evidence, pollen morphology, is negative for octoploidy and stresses the need for cytological investigation. The pollen of the hybrid had an average protoplast diameter of 32.7  $\mu\text{m}$  and a 4-pored grain frequency of 0% (based on 100 & 300 grains respectively) - two attributes which agree more closely with the pollen of known tetraploids (cf. Table 7).

INTERSPECIFIC CROSSES: *M. scapigera* x *M. lanceolata* race 1.

Crossability between populations was high: fruit set per head was 75-100% in most crossings.

The average fertilities of crosses were low, ranging from 9-49% in the 15 crosses tested (Plates 44 & 45). Fertility sometimes varied widely between individuals; variation was greatest in the following crosses (three plants per cross): SA x LA (19%, 31%, 45%); SB x LA (7%, 42%, 45%); and SE x LA (20%, 20%, 45%). The lowest plant fertility was 5% and the

highest 57%.

A preliminary study of meiotic behaviour was made in the hybrid LC x SA. Only three cells were analysed, all at diakinesis. One cell contained 18 bivalents while two contained 16 bivalents and one ring quadrivalent (one such cell is illustrated in Plate 42 F). A comparison with pairing in parents was not made, but Chambers (1955, p. 248) found 18 bivalents in two accessions of New Zealand material. The high frequency of bivalents in the hybrid LC x SA indicates strong homology between the two parents. The probable explanation for the observed configurations (unless pairing is being influenced by genic factors) is that 16 chromosomes of *M. scapigera* are homologous with 16 of *M. lanceolata* race 1, but that the other two chromosome pairs differ by a reciprocal translocation (interchange). Depending on the nature of the translocation and/or chiasma conditions this would result in either a quadrivalent or two bivalents being formed in the hybrid.

Because of the low fertility of the  $F_1$  hybrids the fertility of the  $F_2$  generation could not be tested. Numerous unrecorded crossings (both within and between progenies) were made among various hybrids but fruit set was extremely low. Many heads failed to set fruit and none set more than one. A total of six fruits were produced and all failed to germinate.

Notwithstanding their low fertility,  $F_1$  hybrids could be backcrossed in both directions (Table 10). Fruit set per head was usually low in all ovule parents: it was mostly less than 33%, with a maximum of 54% in one head of H160. Originally it had been intended to backcross the least fertile and most fertile combinations: SM x LA (9%) and SO x LA (49%), but availability of flowering material dictated the choice of two hybrids with a smaller difference in mean fertilities: LC x SA (32%)

and SK x LA (42%). The progenies of five backcrosses (two of them reciprocal) were raised. They showed some morphological variation but in general were intermediate between the  $F_1$  and backcross parent. The fertilities of three  $BC_1$  progenies are detailed in Table 11 A. As Table 11 B shows, the  $BC_1$  fertilities mostly exceeded the  $F_1$  mean, though large individual differences occurred. The most fertile individual (89%) and the greatest range of fertilities occurred in the backcross progeny of the more fertile hybrid tested, SK x LA (H160). Thus, one generation of backcrossing raises hybrid fertility but does not restore it to normal.

INTERSPECIFIC CROSSES: *M. scapigera* x *M. lanceolata* race 2

Crosses were made with both tetraploid (LE) and octoploid (LF) populations of *M. lanceolata* race 2. Crossability was low with either ploidy level: in the direction most LF crosses were made (*M. scapigera* as ovule parent) there was interference by selfing (Table 9), but in the reverse direction fruit set in the three heads crossed was 3%, 4% (both LE) and 2% (LF).

Both  $F_1$ 's made with tetraploid *M. lanceolata* race 2 (LE x SD and LE x SG) were highly sterile. In all individuals raised (two plants in each cross) the anthers were shrivelled and devoid of pollen. The capitula of the LE x SD plants opened normally, but those of LE x SG mostly turned brown and died prior to opening. The  $F_1$  hybrids were precluded from forming an  $F_2$  generation by their male sterility. Whether they were also ovule sterile was not determined. Backcross tests and the investigation of meiotic behaviour are subjects for future study.

Hybrid progenies were obtained in two crosses made with octoploid *M. lanceolata* race 2: SK x LF (2 plants) and SM x LF (1 plant). Unlike the *M. scapigera* x LE hybrids these plants all produced pollen, and had fertilities ranging from 20-63%. One of the SK x LF plants was examined cytologically and found to have the expected hexaploid chromosome number,  $2n = 54$  (Plate 42 E). The two SK x LF plants

provide an example of the morphological variation sometimes exhibited within F<sub>1</sub> progenies. Both plants had similar leaves (with the rugulose adaxial leaf surface of the pollen parent), but differed markedly in capitulum form. The plant known to be hexaploid (fertility 63%) had capitula intermediate between those of its parents in all features (Frontispiece, Plate 51 A-upper head). The other plant (fertility 48%) had capitula which differed from those of its sibling in the number, size, shape and pubescence of involucre parts (Plate 51 A-lower head). The crossing relationships of the known and presumed hexaploids were not investigated.

#### CROSSES BETWEEN SUBGENERA: *MONERMOS* X *APARGIDIUM*

Five attempted crosses between the two subgenera all failed: no fruit set occurred. The crosses were all in the same direction, using the two species of *Monermos* as ovule parents and the one species of *Apargidium* (*M. borealis*) as the pollen parent. Four crosses were with *M. scapigera* (populations SJ, SK, SM & SP) and none were replicated. One cross was with *M. lanceolata* race 2 (population LF) which was attempted three times.

The results indicate that the two subgenera are cross-incompatible, at least in one direction. However, many more crossings, made in both directions, would be necessary to prove that they are completely unable to cross.

The pollen of *M. borealis* apparently is unable to stimulate selfing in *M. scapigera* as LE & LF pollen is able to do (see SECTION II).

## DISCUSSION: GENETIC RELATIONSHIPS

(1) Intraspecific relationships in subgenus *Monermos*.

*MICROSERIS SCAPIGERA*: The high crossability and generally high interfertility of populations in *M. scapigera* indicate that little or no genetic isolation exists within the species, at least under experimental conditions. Sterility barriers are absent or slight at the F<sub>1</sub> level even between populations differing greatly in morphology, habitat, altitude and geographic separation. Vigorous growth and high fertility are largely maintained in the F<sub>2</sub> generation. However, the appearance in the F<sub>2</sub> of SW x SK of a relatively small proportion of abnormal and weak hybrids and hybrids with reduced fertility shows that the parent populations concerned (SW and SK) are not completely compatible genetically. Such an incidence of abnormality and infertility could, perhaps, be expected among the offspring of a cross whose parents differed as greatly as these do, not only in morphological features (vegetative and reproductive) but also ecologically and in the nature of their breeding system.

*MICROSERIS LANCEOLATA*: Race 1 x Race 1. Tuberous (LA and LB) and non-tuberous (LC) populations were highly interfertile. This is in keeping with the overall morphological similarity between the two types, apart from the roots. The F<sub>2</sub> generation raised comprised too few individuals (five) to exclude the possibility of abnormal, weak or infertile hybrids.

*MICROSERIS LANCEOLATA*: Race 1 x Race 2 (tetraploid). More investigations need to be made before the interfertility of these two races can be assessed. The fertility of the one hybrid raised was high (94%). However, there are indications (though equivocal) that

this hybrid may be an octoploid (derived from unreduced gametes?), in which case its fertility may not be comparable to that of a tetraploid interracial hybrid. Tetraploid race 2 might be expected to show reduced interfertility with race 1 in view of the difference between the two races in their genetic isolation from *M. scapigera* (race 1: semi-interfertile; race 2: intersterile).

(2) Interspecific relationships in subgenus *Monermos*.

The generally low fertility or sterility of hybrids between *M. scapigera* and *M. lanceolata* indicates that the two species are quite strongly isolated genetically, with *M. lanceolata* race 2 (tetraploid) more strongly isolated (low crossability, intersterile) than race 1. The genetic barrier between the two species supports the taxonomic decision to separate them.

The basis of the low fertility of *M. scapigera* x *M. lanceolata* race 1 hybrids has not been established. Preliminary cytological evidence from the hybrid LC x SA (fertility: 32%) indicates a high level of homology between the chromosomes of the two parents, which may differ in gross chromosome structure by only a single reciprocal translocation in one parent (see p. 73). Although the translocation could be expected to cause some reduction in fertility it seems likely that other factors are contributing, perhaps with even greater effect, to the low fertility. Such factors could be chromosomal, e.g. cryptic structural hybridity, which does not affect chromosome pairing at meiosis (Stebbins 1950), or genic - or a combination of the two. The wide range of average fertilities (9% to 49%) in crosses between *M. lanceolata* population LA and different populations of *M. scapigera*, as well as the variation in fertility between individuals in some of these crosses, suggests that genic factors at least are involved in lowering fertility.

Cytological investigation of *M. scapigera* x *M. lanceolata* race 2 hybrids is necessary to determine whether the greater genetic barrier of male sterility is associated with a more irregular meiosis than that found in the *M. scapigera* x *M. lanceolata* race 1 hybrid, LC x SA.

It is not known whether *M. scapigera* and *M. lanceolata* are able to form a vital, fertile F<sub>2</sub> generation. The male sterility of *M. scapigera* x *M. lanceolata* race 2 (tetraploid) hybrids (LE x SD, LE x SG) is an absolute barrier to the formation of F<sub>2</sub> offspring. However, *M. scapigera* x *M. lanceolata* race 1 hybrids are only semi-sterile and can produce at least some (albeit few) apparently good fruits. In this case, barring inviability at the embryo stage, it should be possible to raise F<sub>2</sub> hybrids. The potential for forming a F<sub>2</sub> generation is also borne out by backcrossing tests, made in both directions, which show that the F<sub>1</sub> does have some good ovules and pollen grains which can, respectively, be fertilized by or fertilize non-hybrid parents to form good, viable fruits.

### (3) Comparison with crosses within subgenus *Microseris*.

Genetic relationships among the nine species of subgenus *Microseris* were studied by Chambers (1955, 1963) who produced hybrids from 15 artificial crosses, representing one intraspecific combination and 11 different interspecific combinations.

**INTRASPECIFIC CROSSES.** The intraspecific cross made by Chambers (an inter-subspecific cross in *M. douglasii*) had a fertility of 86%, which was higher (substantially) than in all but one of the interspecific crosses.

The fertility values of intraspecific (and interspecific) hybrids in subgenus *Monermos* cannot be compared directly with those obtained by Chambers in subgenus *Microseris*, since the former were based on pollen

fertility while the latter were determined from fruit set after self-pollination. Fertility cannot be assessed from self-pollination fruit set in subgenus *Monermos* because of the presence of self-incompatibility. For example, in the intraspecific hybrid of *M. scapigera*, SW x SK, the low fruit set ( $\pm 40\%$ ) is attributed to partial self-incompatibility rather than low fertility, since pollen fertility is very high (97%).

**INTERSPECIFIC CROSSES.** Only one of the interspecific crosses made by Chambers was highly fertile (fertility:  $F_1 = 94\%$ ;  $F_2 =$  mostly 90-100%), and had normal meiotic behaviour. Interestingly, this cross was between two geographically remote species (both diploid): *M. pygmaea* (Chile) and *M. bigelovii* (California). The two species are morphologically close however, though taxonomically distinct (Chambers 1963), both belonging to the same section (*Microseris*) of the subgenus. Chambers' other crosses were made between Californian species. In these,  $F_1$  hybrids were not difficult to obtain, whether between species of the same or different ploidy levels (diploid or tetraploid). The fertility of such hybrids was mostly low and ranged from 0% to 61%. The most fertile crosses were between diploid species, but some diploid combinations had low fertilities (0% to 1.3%) as had all tetraploid-tetraploid and diploid-tetraploid combinations tested. Chambers found that sterile or poorly fertile crosses between species at the same ploidy level (diploid or tetraploid) had irregular meiosis with reduced or no bivalent formation. In crosses involving diploid species, the lowest fertility and least chromosome pairing occurred in hybrids between the most morphologically divergent species (Chambers 1955).

The correspondence between sterility and meiotic irregularity in interspecific crosses of subgenus *Microseris* may point to a similar situation being found in the male sterile interspecific cross in subgenus *Monermos*, *M. scapigera* x *M. lanceolata* race 2 (tetraploid).

(4) Origin of *Microseris* subgenus *Monermos*.

Chambers (1955, pp. 216, 248) suggested that subgenus *Monermos* is an amphiploid derived from a hybrid between subgenus *Apargidium* and subgenus *Microseris* (section *Microseris*). Evidence to support this suggestion came in part from the karyotype of *Monermos*, in which half the chromosomes were small (as in subgenus *Microseris*) and half large (as in the subgenera *Apargidium* and *Scorzonella*); and in part from external morphology, where there were several parallels between *Monermos* and *Apargidium* (especially in the fruits).

As an amphiploid, subgenus *Monermos* could be represented as having the genome constitution AABB, where (say) AA and BB correspond to the genome pairs of the parent subgenera *Microseris* and *Apargidium*, respectively.

In this study no progress could be made towards verifying *Apargidium* as an ancestor, as attempts to cross it with *Monermos* were unsuccessful. If it had been possible to cross tetraploid *Monermos* with *Apargidium* (diploid) then the latter genus could have been checked for the ancestral B genome by a study of meiotic pairing in the triploid hybrid. Chambers (pers. comm.) was also unsuccessful in attempts to cross these two subgenera. He used material from near Adelaide, South Australia (almost certainly *M. lanceolata* race 1, which was not crossed by the writer) as the maternal parent in a 'good number' of crossings. However, Chambers (pers. comm.) did have success in crossing *Monermos* (*M. lanceolata* race 1?) with subgenus *Microseris* (*M. bigelovii*), and found that there was some association of the smaller sets of chromosomes in the hybrid. Thus subgenus *Microseris* (section *Microseris*) at least appears to be implicated in the ancestry of *Monermos*.

On morphological grounds, *Apargidium* seems to be more likely than *Scorzonella* as the second putative parent of *Monermos*, since it has more similarities. However, as far as could be judged from the one population of *M. (Apargidium) borealis* available, *Apargidium* and *Monermos* are quite distinct in most respects and hence do not appear to be closely related (*M. scapigera* and *M. lanceolata* are much closer to each other morphologically than either is to *M. borealis*). Although *Monermos* and *Scorzonella* are morphologically remote, the former (in *M. lanceolata* race 1) does appear to resemble the latter in having seasonal roots that become shrivelled (cf. Chambers 1955, p. 213). However, this feature may have evolved independently in both groups in response to habitat conditions and so not be an indicator of true relationship.

(5) Genome differentiation in subgenus *Monermos*.

Crossing tests within subgenus *Monermos* indicate that *M. scapigera* and *M. lanceolata* are related, but that they have diverged from a homogeneous genome constitution of AABB. The following constitutions are suggested by crossing relationships, where the subscripts 0, 1 and 2 represent genic and/or chromosomal differences in the genomes sufficient to cause lowered fertility, or sterility in hybrids. The constitutions in *M. lanceolata* race 2 are tentative, being based on incomplete crossing data and no cytogenetic information, but they may provide a framework for future testing.

<i>M. scapigera</i> :	$A_0A_0B_0B_0$
<i>M. lanceolata</i> race 1:	$A_1A_1B_1B_1$
<i>M. lanceolata</i> race 2:	$A_2A_2B_2B_2$ and $A_2A_2A_2A_2B_2B_2B_2B_2$
<i>M. lanceolata</i> race 3:	? (no data)

The octoploid of race 2 is represented as an autoallopolyploid derived from tetraploid race 2. This is suggested by the semi-fertility of hexaploid hybrids (e.g. SK x LF) compared with the sterility of tetraploid

hybrids (e.g. LE x SD) in crosses between race 2 and *M. scapigera*. The fertility of the hexaploid hybrids could perhaps be explained by the constitution:

$$A_0A_2A_2B_0B_2B_2$$

as pairing between respective  $A_2$  and  $B_2$  genomes should confer some fertility.

## SUMMARY

*Microseris* subgenus *Monermos* is interpreted as consisting of two species, namely *M. scapigera* and *M. lanceolata*, which are confined to New Zealand and Australia respectively.

In *M. scapigera*, no infraspecific taxa are recognised. The four formae described by Allan (1961) are not upheld because of the unreliability of their main diagnostic character, leaf shape. *Microseris scapigera* is very polymorphic but the variation is complex and intergrading, and hence not suited to taxonomic treatment.

*Microseris lanceolata* is divided into three morphological groups which are described informally as races. The races are regarded as potential subspecies which still require further investigation before they can be given taxonomic status.

Chromosome counts made in this study and those previously published indicate prevalence of the tetraploid number,  $2n = 36$ , in Australian and New Zealand material. The only other number recorded,  $2n = 72$ , occurs in *M. lanceolata* race 2, which also has the tetraploid number.

Both species exhibited phenotypic plasticity, though in *M. scapigera* populations differed considerably in the extent to which they could be modified by the environment. The most affected part of the plant was the leaf, which often varied greatly not only in size, but also in degree of margin division (toothing and lobing). In contrast, taxonomically useful parts of the plant such as bracteoles, phyllaries and fruits were much less plastic.

The majority of populations examined in *M. scapigera* and all six tested in *M. lanceolata* were strongly self-incompatible. Plants of such populations set no fruits when heads were isolated in bags, although apparently some self-fertilization could be induced by cross-pollinating with pollen from the genetically isolated populations LE and LF. In

*M. scapigera*, two populations were only moderately self-incompatible, with a self-pollination fruit set of  $\pm 50\%$ ; while a third population was more self-compatible, with a fruit set of  $\pm 80\%$ . The last population showed a number of apparent morphological and behavioural adaptations to promote autogamy.

Artificial hybridizations were made within and between *M. scapigera* and *M. lanceolata* (races 1 and 2). Crossability was low in all crossings involving *M. lanceolata* race 2 (both ploidy levels), whereas it was mostly high in all other crossings. In intraspecific crosses there appeared to be no strong barriers to gene exchange within either *M. scapigera* or *M. lanceolata* race 1, with hybrids in both cases mostly highly fertile (pollen fertility mostly  $>90\%$ ). The lack of a genetic barrier between *M. lanceolata* race 1 and race 2 (tetraploid) is less certain and requires further study. Quite strong sterility barriers exist between the two species, with *M. lanceolata* race 2 (tetraploid) more strongly isolated than race 1 from *M. scapigera* in that hybrids are male-sterile. In interspecific hybrids with race 1 a lesser barrier of semi-fertility (pollen fertility 5 to 57% in tetraploid hybrids) permitted production of a few  $F_2$  fruits, but none germinated. Backcrosses of semi-fertile interspecific hybrids were mostly more fertile than their  $F_1$  parent, though none were fully fertile. The high degree of meiotic pairing in a semi-fertile hybrid indicated that the chromosomes of *M. scapigera* and *M. lanceolata* race 1 are largely homologous.

Attempts to obtain an intersubgeneric cross between *Monermos* and *Apargidium* were unsuccessful, although not enough crossings were made to prove absolute cross-incompatibility.

## ACKNOWLEDGMENTS

I wish to thank Professor H.D. Gordon and Dr. J.W. Dawson for advice and for valuable criticism of the manuscript; Dr. G.K. Rickards for helpful comments on part of the manuscript; Professor K.L. Chambers for suggestions, information and fruits of *M. borealis*; Professor C.W. Dearden for help with translating Latin descriptions; Dr. R.E. Rowland for advice and assistance with cytological techniques; Mrs M. Cooper for typing most of the script and Mrs O. Vincent for typing the remainder; Mrs J. Benfield for many photographs, in particular for preparing copies on document paper of Plate originals; and Mr W.R. Hoverd for making items of equipment and cytological reagents.

I am grateful to the Keepers of the Herbaria mentioned in the text for the loan of specimens and for providing information vital to the study; to the many collectors who provided live material, especially Dr. G.N. Park; and to Mr H. Alexander and Mr R. Lucas for assistance in maintaining plants grown in cultivation.

Finally, I would like to thank the many other persons who have contributed in various ways to the completion of this work.

## REFERENCES

- ALLAN, H.H. (1961). "Flora of New Zealand". Vol. I. Government Printer, Wellington. liv, 1 085 pp.
- ARASU, N.T. (1968). Self-incompatibility in angiosperms: a review. *Genetica* 39: 1-24.
- BABCOCK, E.B. (1947). The genus *Crepis*. Part two: systematic treatment. *Univ. Calif. Publ. Bot.* 22: x, 199-1 030.
- BABCOCK, E.B. and STEBBINS, G.L. (1938). The American species of *Crepis*: their interrelationships and distribution as affected by polyploidy and apomixis. *Carnegie Inst. Wash. Publ.* No. 504: 200 pp.
- BAILEY, F.M. (1883). "A synopsis of the Queensland flora". Government Printer, Brisbane. xxxii, 890 pp.
- (1900). "The Queensland flora". Part III. H.J. Diddams & Co., Brisbane. x, 739-1 030 pp.
- BEADLE, N.C.W., EVANS, O.D., CAROLIN, R.C. and TINDALE, M.D. (1972). "Flora of the Sydney Region". 2nd ed. A.H. & A.W. Reed, Sydney. 724 pp.
- BENTHAM, G. (1866). "Flora Australiensis". Vol. III. Lovell Reeve & Co., London. 704 pp.
- (1873). Compositae, in G. Bentham and J.D. Hooker "Genera plantarum". Vol. 2(1): 163-533. Reeve, London.
- BLACK, J.M. (1929). "Flora of South Australia". Part IV. Government Printer, Adelaide. 515-746 pp.
- (1957). "Flora of South Australia". Part IV. 2nd ed. Government Printer, Adelaide. 685-1 008 pp.
- BURBIDGE, N.T. and GRAY, M. (1970). "Flora of the A.C.T." Australian National University Press, Canberra. 447 pp.
- CHAMBERS, K.L. (1955). A biosystematic study of the annual species of *Microseris*. *Contr. Dudley Herb.* 4(7): 207-312.
- (1957). Taxonomic notes on some Compositae of the western United States. *Contr. Dudley Herb.* 5(2): 57-68.
- (1963). Amphitropical species pairs in *Microseris* and *Agoseris* (Compositae: Cichorieae). *Quart. Rev. Biol.* 38: 124-140.
- CHEESEMAN, T.F. (1906). "Manual of the New Zealand flora". Government Printer, Wellington. xxxvi, 1 199 pp.
- (1925). "Manual of the New Zealand flora". 2nd ed. Government Printer, Wellington. xlv, 1 163 pp.

- CLAPHAM, A.R., TUTIN, T.G. and WARBURG, E.F. (1962). "Flora of the British Isles". 2nd ed. Cambridge University Press, Cambridge. xlviii, 1 269 pp.
- CLAUSEN, J. (1951). "Stages in the evolution of plant species". Cornell University Press, Ithaca. viii, 206 pp.
- COCHRANE, G.R., FUHRER, B.A., ROTHERHAM, E.R. and WILLIS, J.H. (1973). "Flowers and plants of Victoria". Revised ed. A.H. & A.W. Reed, Sydney. 216 pp. (Australian flora in colour).
- COCKAYNE, L. (1909). "Report on a botanical survey of Stewart Island". Dept. of Lands, Wellington, N.Z. C-12. 68 pp.
- CUNNINGHAM, A. (1838). *Florae insularum Novae Zelandiae precursor; or a specimen of the botany of the islands of New Zealand*. *Ann. Mag. nat. Hist.* 2(8): 125-132.
- CURTIS, W.M. (1963). "The student's flora of Tasmania". Part 2. L.G. Shea, Government Printer, Tasmania. 475 pp.
- DON, D. (1832). Descriptive catalogue of the Compositae contained in the herbarium of Dr Gillies; with some additions from other sources. *Phil. Mag. n.s.* 11: 387-392.
- EICHLER, H.J. (1965). "Supplement to J.M. Black's Flora of South Australia (Second Edition, 1943-1957)". Government Printer, Adelaide. 385 pp.
- EWART, A.J. (1930). "Flora of Victoria". Government Printer, Melbourne. 1 257 pp.
- FITCH, W.H. *Plate 66, in* Hooker, J.D. (1857).
- FORSTER, G. (1786). "Florulae insularum australium prodromus". Göttingen. 8, 103 pp.
- GARDNER, C.A. (1931). "Enumeratio plantarum Australiae occidentalis". Government Printer, Perth. 150 pp.
- HARRIS, T.Y. (1970). "Alpine plants of Australia". Angus and Robertson, Sydney. 193 pp.
- HEALY, A.J. (1970). "Identification of weeds and clovers". Editorial Services Limited, Wellington. 191 pp.
- HOFFMANN, O. (1894). Compositae, *in* A. Engler and K. Prantl (Editors) "Die natürlichen Pflanzenfamilien". Vol. 4(5): 87-391. Engelmann, Leipzig.
- HOLMGREN, P.K. and KEUKEN, W. (1974). "Index Herbariorum Part I. The Herbaria of the world". 6th ed. Oosthoek, Scheltema and Holkema, Utrecht. vii, 397 pp. (*Regnum veg.* 92).
- HOOKE, J.D. (1847). *Florae Tasmaniae spicilegium; or contributions towards a flora of Van Diemen's Land*. *London J. Bot.* 6: 106-125.

- HOOKE, J.D. (1852). "The botany of the antarctic voyage of H.M. discovery ships Erebus and Terror in the years 1839-1843...II. Flora Novae-Zelandiae. Part 1, Flowering plants". No. 2: 81-160. Lovell Reeve, London. (Part 1 completed in 1853).
- (1856). *ibid.* "III. Flora Tasmaniae. Part 1, Dicotyledones". No. 3: 161-240. Lovell Reeve, London. (Part 1 = Vol. 1 completed in 1857).
- (1857). *ibid.* "III. Flora Tasmaniae. Part 1, Dicotyledones". No. 4: 241-320, *Plates 61-80*. Lovell Reeve, London.
- (1864). "Handbook of the New Zealand flora". Part I. Reeve & Co., London. 392 pp.
- JACKSON, B.D. (1928). "A glossary of botanic terms". 4th ed. G. Duckworth & Co., London. x, 481 pp.
- KIRK, T. (1899). "The student's flora of New Zealand and the outlying islands". Government Printer, Wellington. vi, 408 pp.
- LEWIS, D. (1966). The genetic integration of breeding systems, pp. 20-25. In J.G. Hawkes (Editor) "Reproductive biology and taxonomy of vascular plants". Pergamon Press, Oxford.
- LHOTSKY, J. (1843). Some data towards the botanical geography of New Holland. *London J. Bot.* 2: 135-141.
- MAIDEN, J.H. (1889). "The useful native plants of Australia". Turner and Henderson, Sydney. 696 pp.
- MAIDEN, J.H. and BETCHE, E. (1916). "A census of New South Wales plants". Government Printer, Sydney. xx, 216 pp.
- MOORE, C. (1893). "Handbook of the flora of New South Wales". Government Printer, Sydney. 582 pp.
- MUELLER, F.v. (1882). "Systematic census of Australian plants, with chronologic, literary and geographic annotations. Part I - Vasculares". M'Carron, Bird & Co., Melbourne. viii, 152 pp.
- (1885). "Key to the system of Victorian plants II". Government Printer, Melbourne. 60 pp.
- (1887-1888). "Key to the system of Victorian plants I". Government Printer, Melbourne. xiii, 559 pp.
- (1888). "Select extra-tropical plants". 7th ed. Government Printer, Melbourne. ix, 517 pp.
- (1889). "Second systematic census of Australian plants, with chronologic, literary and geographic annotations. Part I. - Vasculares". McCarron, Bird & Co., Melbourne. 244 pp.
- ORNDUFF, R. (1969). Reproductive biology in relation to systematics. *Taxon* 18(2): 121-133.
- RAOUL, M (= Monsieur). E. (1846). "Choix de plantes de la Nouvelle-Zelande". Fortin, Masson et Cie. Paris. 53 pp.

- RODWAY, L. (1903). "The Tasmanian flora". Government Printer, Hobart. xix, 320 pp.
- ROTHERHAM, E.R., BLAXELL, D.F., BRIGGS, B.G. and CAROLIN, R.C. (1975). "Flowers and plants of New South Wales and southern Queensland". A.H. & A.W. Reed, Sydney. 191 pp. (Australian flora in colour).
- SALMON, J.T. (1970). "New Zealand flowers and plants in colour". Revised and enlarged ed. A.H. & A.W. Reed, Wellington. 235 pp.
- SCHULTZ-BIPONTINUS, C.H. (1866). Beitrag zum systeme der Cichoriaceen. *Pollichia* 22-24: 296-322.
- SNOW, R. (1963). Alcoholic HCl-carmines as a stain for chromosomes in squash preparations. *Stain Technol.* 38: 9-13.
- SONDER, O.W. (1853). Compositae, in Müller F. *Plantae Muellerianae. Linnaea* 25: 450-530.
- STAFFLEU, F.A. (1967). "Taxonomic literature. A selective guide to botanical publications with dates, commentaries and types". International Bureau for Plant Taxonomy and Nomenclature, Utrecht. xx, 556 pp. (*Regnum veg.* 52).
- STAFFLEU, F.A. *et al* (1972). "International code of botanical nomenclature". Oosthoek, for the International Association for Plant Taxonomy, Utrecht. 426 pp. (*Regnum veg.* 82).
- STEARNS, W.T. (1973). "Botanical Latin". 2nd ed. David & Charles, Newton Abbot. xiv, 566 pp.
- STEBBINS, G.L. (1950). "Variation and evolution in plants". Columbia University Press, New York. xix, 643 pp.
- (1953). A new classification of the tribe Cichorieae, family Compositae. *Madroño* 12: 65-81.
- TAIT, R. (1890). "A handbook of the flora of extratropical South Australia". Education Department, Adelaide. vi, 303 pp.
- WALPERS, W.G. (1840). Compositarum novarum. *Linnaea* 14: 503-10.
- (1846). "Repertorium botanices systematicae". Vol. 6, part 2: 193-384. Leipzig.
- (1847). *ibid.* Vol. 6, part 4: 577-768. Leipzig.
- WILLIS, J.H. (1972). "A handbook to plants in Victoria". Vol. II. Melbourne University Press. 832 pp.
- WOOD, J.G. (1937). "The vegetation of South Australia". Government Printer, Adelaide. 164 pp.

Comparison of *Microseris scapigera* formae (from Allan, 1961).

Character	forma <i>linearis</i>	forma <i>pinnatifida</i>	forma <i>obovata</i>	forma <i>major</i>
Leaves: <i>size</i> <i>shape</i> <i>tip</i> <i>margin</i>	3-15 cm x <1-4 mm filiform to linear obtuse entire or with very few runcinate teeth	5-12 cm long linear to lanceolate in outline obtuse with distinct patent linear lobes up to 1 cm long, widened at base, diminishing towards apex to 1 mm long	5-10 cm x 5-10 mm obovate-spathulate apiculate subentire to distantly runcinately toothed	10-25 cm x 5-10 mm linear, tapering above to tip apiculate entire or remotely sharply dentate, sts sparingly lobed towards base
Scapes:	5-15 cm long, not > c. 1 mm diam.	10-15 cm long, c. 1 mm diam.	10-20 cm long, up to 2 mm diam.	up to c. 40 cm long, 3 mm diam.
Capitula: <i>size</i> <i>bracteoles</i> <i>phyllaries</i> <i>florets</i>	10-15 mm long and wide broadly ovate to bluntly triangular, up to 4 mm long linear, subacute up to 10	c. 18 mm long and wide ovate-oblong, up to 5 mm long elliptic to obovate-oblong, obtuse c.20	c. 2 cm long and wide ovate-oblong, up to 5 mm long narrow-linear c.20	2-2.5 cm long, 1-1.5 cm diam. broadly ovate- triangular, 2-4 mm long, margins ciliate oblong, dentate- ciliate c.20
Achenes: <i>pubescence</i> Pappus:	c. 5 mm long glabrous or with very sparse hairs when young up to 8 mm long	c. 5-6 mm long glabrous up to 1 cm long	6-7 mm long thinly clad in slender hairs when young up to 7 mm long	c. 7 mm long, oblong up to 7 mm long
Distribution:	N., S., Montane to sub- alpine damp grassland, herbfield, and boggy ground from lat. 38°30' southwards.	N., S., St. Lowland to montane, mainly damp grassland, from lat. 39°30' southwards.	S. Grassland and open places from lat. 41° to 42°.	S. Moist limestone cliffs, Ure River Marlborough, B.C. Aston, G. Simpson.

Comparison between Walpers' description of *Phyllopappus lanceolatus* and probable types

<i>P. lanceolatus</i> description (abridged)	Holotype? <i>Lhotsky</i> , KIEL (Plate 4, Fig. A)	Isotype? <i>Lhotsky</i> , BM (Plate 4, Fig. B)
LEAVES		
lanceolate, attenuate longest towards base	as for description	as for description
quite entire or with small teeth here and there	as for description	as for description
glabrous	sparsely furfuraceous on margin only	sparsely furfuraceous on underside of blade
7.6-20.3 cm (3-8 inches) long 4.2-12.6 mm (2-6 lines*) wide	7.6-20.5 cm long (3.5-)4.5-15 mm wide	20.5-23.5 cm long 7.5-14 mm wide (folded over)
acuminate towards apex	tapering to apex	tapering to apex
INVOLUCRE		
scales (=phyllaries): c. 12, 14.7 mm (7 lines) long, 2.1-3.15 mm (1-1½ lines) wide, linear-lanceolate, acute, glabrous	13 in fruiting head, 13-14.5 mm long, 2.7 mm wide, as for description	number incomplete, 15 mm long, 3.8 mm wide†, linear-lanceolate, subacute, pubescent†
accessory scales (=bracteoles): ovate-lanceolate, mostly acuminate	as for description	as for description
RECEPTACLE		
pits with ciliate-fimbriate margin	as for description	obscured
FLORETS		
organs not known precisely since the flower bearing capitulum became too compressed through incautious drying of it and could not be opened by boiling	organs of only flowering head obscured. Head is distorted and may have been boiled	not present - only head is in fruit
ACHENE		
8.4 mm (4 lines) long	8.5 mm long §	c. 9 mm long (bases eaten)
deeply grooved	as for description	as for description
most-minutely papillose, otherwise quite glabrous	scaberulous on some ribs	scaberulous on some ribs
PAPPUS		
irregularly arranged in several rows	18, 21 members	19-22 members
10.5-14.7 mm (5-7 lines) long	up to 15 mm long	13-15 mm long
paleaceous, palea lanceolate, scarious, extended into a long awn	as for description (palea up to 6.5 mm long, 0.85 mm wide)	as for description (palea up to 6.5 mm long, 0.85 mm wide)
awn plumose-serrate	awn barbellulate	awn barbellulate

\* One line (English) = 2.1 mm.

§ Longer of two achenes present.

† Inner phyllary.

Comparison between *Microseris scapigera* and *M. lanceolata*

Character	<i>M. scapigera</i>	<i>M. lanceolata</i>
Roots:	non-tuberos, elongate, tapering gradually from near insertion, not producing adventitious suckers in cultivation	tuberos or non-tuberos, the latter elongate, $\pm$ tapering from near insertion, and producing adventitious suckers in cultivation (universal?)
Caudex and branches:	up to 30 (80) mm long and 11 mm wide in wild	up to c. 20 mm long and 10 mm wide in wild
Leaf blades: surfaces (Plate 24 )  pubescence	$\pm$ smooth adaxially; midrib raised, lateral veins $\pm$ inconspicuous abaxially  glabrous or $\pm$ furfuraceous on both sides but not on margin	smooth to rugulose adaxially; midrib and lateral veins $\pm$ prominent abaxially  glabrous or $\pm$ furfuraceous on both sides and on margin
Scapes:	(2) 10-30 (50) {67} cm long	7-45 (63) {90} cm long
Capitula:   bud  diameter  bracteoles  phyllaries (outer)  corolla  anther tube	oblong-ellipsoid to obovoid  up to {54} mm  broadly elliptic, $\pm$ oblong, or $\pm$ ovate-triangular (l:w = c. 5:6-4:1); obtuse, acute or acuminate  up to 15 {17.4} mm long, l:w (2.3) 3.5 (7); $\pm$ narrowly oblong-elliptic or ovate; obtuse to acute; not tomentose without  up to {26} mm long  up to {5.1} mm long	ovoid-fusiform to obovoid  up to {74} mm  ovate-triangular to narrowly ovate-triangular (l:w = c. 3:2-6:1); mostly acute or acuminate  up to 25 mm long, l:w 3-9; narrowly elliptic or ovate; mostly acute; sts tomentose without  up to {35} mm long  up to {7.2} mm long
Achenes:   size  colour  pubescence  embryo	{3.9} 4.5-7 (8) mm long, 0.5 - 1.1 mm wide  yellow-brown to dark brown, sts grey  not strigulose  filling achene	(4.5) 6-10 (11.5) mm long, 0.5 - 1.6 mm wide  yellow-brown to dark brown, sts white, pinkish or blotched with purple  sts strigulose (Plate 37 E)  filling to 3/4-filling achene
Pappus:	8-37 members; {4.1} 6.5-10.5 {12} mm long; paleaceous to capillary, palea up to 4 {4.3} mm long, 0.7 {0.9} mm wide; awns {4.2} - {10} mm long, $\pm$ spiculate	8-66 members; (7.4) 10-16 (19) mm long; paleaceous to capillary, palea up to 14 mm long, 1.6 mm wide; awns 4-11.5 mm long, minutely spiculate to barbellulate or subplumose
Distribution:	New Zealand: N., S., St.?	Australia: Qsld.?, N.S.W., Vict., Tas., S.A., W.A.

Comparison of *Microseris lanceolata* races

Character	Race 1	Race 2	Race 3
Habit:	leaves $\pm$ dying back in summer	leaves not dying back in summer	leaves not dying back in summer
Roots:	usually tuberous; up to c. 20 mm wide; length:width us. <10	non-tuberous; 2-5 (10) mm wide; length:width >20	non-tuberous; 1-4 (7) mm wide; length:width us. >20
Caudex and branches:	< 5 mm long in wild	up to c. 20 mm long in wild	up to c. 10 mm long in wild
Leaves: <i>size</i>	6-40 cm x 1-12 mm	5-32 cm x (3)-22 mm	3.5-20 cm x 1-9 mm
<i>shape</i>	us. linear (sts filiform) to lanceolate	us. lanceolate to obovate-spathulate	filiform to lanceolate
<i>margin</i>	lobes of pinnatifid lvs up to 30 mm long	lobes of pinnatifid lvs up to 20 mm long	lobes of pinnatifid lvs to c. 10 mm long
<i>Upper surface</i>	smooth to subrugulose	rugulose (Plate 24 )	not known
Flowering time:	mostly viii-xii	mostly i-iii	mostly xi-iii
Scapes:	9-60 {80} cm long, 1-3.5 mm diam.	11-63 {90} cm long, c. 2-4 mm diam.	7-30 cm long, 0.8-2.5 mm diam.
Capitula:	20-40 {60} mm diam.	c. 30-50 {74} mm diam.	c. 20 mm diam.
<i>bracteoles</i>	us. 7-12	10-20	8-12
<i>phyllaries</i>	us. 8-12; outer ones 9-25 mm x 1.8-6 mm (l:w 3.0-9.0), $\pm$ attenuate above, not tomentose without	10-20; outer ones 11-21 mm x 2-4 mm (l:w 3.3-6.3), less attenuate above, sts tomentose without	8-12; outer ones 8-15 mm x 1.4-3.3 mm (l:w 4-7), less attenuate above, not tomentose without
<i>florets</i>	20-40 {61}	30-60 {98}	8-20 (30)
Achenes:	4.5-11.5 mm long	6-10 mm long	6-10 mm long
<i>pubescence</i>	glabrous or strigulose	glabrous or strigulose	glabrous
Pappus:	8-21 members; paleaceous, palea 2.8-14 x 0.3-1.6 mm; awns 4-8.7 mm long, spiculate to sub-plumose	11-30 members; paleaceous, palea 2.5-7 x 0.3-0.85 mm; awns 7-11.5 mm long, spiculate to barbellulate	30-66 members; paleaceous-capillary, palea up to 4 x 0.3 mm; awns 6.2-11.5 mm long, $\pm$ minutely spiculate
Distribution:	Qsld.?, N.S.W., Vict., Tas., S.A., W.A. Near s.l. to c. 1 200 m, open places in forest to riverine flats in summer-dry regions.	N.S.W., Vict., Tas. Occ. near s.l. but mainly > 1 200 m, in damp woodland, grassland and herbfield.	Vict. (mid-Western Volcanic Plains), Tas. Near s.l. to c. 1 200 m, grassland and open places (damp?).

Measurement averages for reproductive characters. All material cultivated except where indicated by an asterisk.

Code	Scape length (cm)	Scape width (mm)	Head diam. (mm)	Number of bract-eoles	Number of phyll-aries	Outer phyllary length (mm)	Outer phyllary L:W	Florets per head	Corolla length (mm)	Ligule length (mm)	Ligule width (mm)	Anther tube length (mm)	Achene length (mm)	Pappus members per fruit
SA	42.7	3.01	39.1	16.6	14.5	11.3	3.08	59.5	18.8	13.5	4.23	4.37	6.46	19.2
SB	31.4	1.83	27.5	12.6	12.8	9.6	3.05	41.7	12.9	9.2	3.36	3.71	5.75	17.7
SC	37.9	1.98	29.1	10.7	12.1	10.2	2.58	38.4	14.6	10.5	3.61	4.24	5.08	20.5
SD	25.6	2.05	35.4	11.8	11.0	9.8	2.82	37.8	16.6	12.2	3.88	3.86	5.71	15.2
SE	21.9	1.60	32.4	10.7	9.7	10.9	3.12	28.1	16.2	11.9	3.58	3.95	4.92	17.2
SF	32.0	2.22	32.3	11.8	9.9	10.4	3.43	30.5	16.3	12.0	3.60	4.15	5.46	10.6
SG	33.9	3.17	36.4	13.1	14.5	16.0	4.71	54.6	17.5	12.4	3.80	3.81	5.22	13.1
SH	30.4	2.15	28.9	13.7	8.8	10.0	3.25	32.6	17.1	12.9	4.01	4.25	4.94	11.2
SJ	36.8	2.06	30.5	15.0	8.7	10.1	3.60	31.3	15.4	11.3	3.95	3.97	4.78	9.8
SK	41.5	2.04	39.4	16.5	11.2	12.9	2.66	48.7	20.1	14.5	4.72	4.69	6.09	10.4
SM	50.7	2.61	35.3	8.7	11.7	11.0	2.97	42.7	16.1	11.7	4.16	4.11	6.44	13.6
SN	29.8	1.79	29.7	11.3	8.1	10.4	3.33	28.6	16.1	12.2	4.37	3.96	5.19	13.2
SO	36.1	1.21	22.2	8.1	8.2	8.5	4.04	17.8	11.3	8.4	3.26	3.27	4.85	25.3
SP	32.9	1.64	27.7	8.7	9.5	10.6	3.56	20.0	14.0	10.3	3.40	3.11	6.05	19.7
SQ	38.1	1.68	31.2	11.1	12.3	11.5	4.29	40.9	15.5	11.6	3.51	3.27	5.87	24.8
SR	35.2	1.62	26.7	8.7	9.5	11.4	4.49	20.8	13.9	9.8	3.57	3.81	5.86	20.3
SS	24.8	1.77	26.0	9.6	8.2	10.0	3.24	24.5	13.5	9.7	3.80	3.09	6.10	26.9
ST	41.6	2.02	27.3	9.5	12.7	10.7	3.77	37.3	13.5	9.5	3.79	3.00	6.60	25.6
SU	30.4	1.36	27.5	8.5	10.2	9.6	4.45	27.6	13.7	9.8	3.24	3.10	6.14	23.8
SV	43.5	1.83	31.3	11.7	12.0	12.5	4.06	31.6	16.5	12.2	3.35	4.26	6.55	17.6
SW	29.3	1.48	20.4	9.3	8.9	13.2	5.94	18.9	13.2	8.7	2.59	2.54	5.75	29.2
SX	29.7	1.44	26.7	8.4	10.1	10.9	4.67	24.4	15.8	10.8	3.38	3.52	5.20	20.2
LA	42.8	1.86	43.8	10.7	10.7	17.0	5.53	31.5	23.3	16.7	4.48	4.41	7.20*	10.1*
LB	37.0	1.77	34.1	10.4	11.5	12.7	4.57	29.0	19.1	13.2	4.35	4.23	5.23	10.4
LC	47.2	2.20	46.1	12.6	12.7	16.0	4.99	42.2	24.0	17.7	4.55	4.35	8.51*	10.0*
LD	69.7	2.62	41.9	16.0	17.8	12.7	3.69	74.5	19.0	13.2	4.61	4.18	6.44	19.4
LE	62.6	3.11	50.4	17.2	18.4	14.1	3.64	62.5	21.2	14.8	4.93	4.19	8.94	19.9
LF	58.4	3.27	59.1	16.9	14.8	18.6	5.37	50.0	30.4	21.3	5.27	6.20	8.72*	18.9*

Comparison of pollen grains in *Microseris* subgenus *Monermos*

LOCALITY	COLLECTION (cultivated populations or herbarium specimens)	PROTOPLAST DIAMETER (µm)			PORES	
		No. of grains	Mean±SD	Range	No. of grains	% of 4- & >4-pored grains
<i>M. scapigera</i>						
Hawke's Bay:						
"Papa Gully"	SA	50	29.17±1.21	26.1-30.8	300	0.00
Maungaharuru Ra.	SB	50	28.79±1.10	26.1-30.8	300	0.00
Wellington:						
Mt Tongariro	SC	50	30.08±1.38	28.4-33.2	300	0.00
Castlepoint	SD	50	27.16±1.24	23.7-28.4	300	0.00
Pahaoa R gorge	SE	50	30.27±1.20	28.4-33.2	300	0.00
Cape Palliser	SF	50	30.85±1.39	28.4-35.5	300	0.00
Red Rocks	SG	50	28.55±0.99	26.1-30.8	300	0.00
Marlborough:						
Marfells Beach	SH	50	28.08±1.04	26.1-30.8	300	0.00
N of Ward Beach	SJ	50	27.76±1.14	26.1-30.8	300	0.00
*Isolation Creek	SK	50	29.17±1.12	28.4-30.8	300	0.00
Mt Fyffe	SM	50	28.74±0.96	26.1-30.8	300	0.00
Kaikoura Pen'sula	SN	50	28.79±1.52	26.1-35.5	300	0.00
nr Red Hills Hut	SO	50	28.04±1.07	26.1-30.8	300	0.00
Nelson:						
Lake Sylvester	SP	50	29.27±1.33	26.1-30.8	300	0.00
btw Cobb L & Pk	SQ	50	27.20±1.15	26.1-28.4	300	0.00
Hoary Head	SR	50	27.07±1.23	26.1-30.8	300	0.33
nr John Reid Hut	SS	50	28.85±2.09	23.7-33.1	300	0.00
Owen Range	ST	50	27.71±1.06	26.1-28.4	300	0.00
Travers Range	SU	50	28.70±1.68	23.7-33.1	300	0.33
Canterbury:						
Glentanner Stn.	SV	50	27.43±1.14	26.1-28.4	300	0.67
Glentanner Stn.	SW	50	29.13±1.52	26.1-33.2	300	0.33
Otago:						
Hopkins Valley	SX	50	27.43±1.88	23.7-30.8	300	0.00
<i>M. lanceolata</i> race 1						
A.C.T. & N.S.W.:						
*Smokers Gap	LB	100	27.04±1.44	23.7-30.8	647	6.81†
Pimpara Ck	<i>Jacobs 1043</i>	50	28.74±1.25	26.1-30.8	300	0.00
Victoria:						
Mt Wheeler	LC	100	32.07±1.85	28.4-35.5	400	0.25
S. Australia:						
3 km NE Nangwarry	<i>Wilson 539</i>	50	29.18±1.86	26.1-35.5	300	0.00
Belair Nat. Park	LA	50	30.03±1.12	28.4-30.8	300	1.67
Flinders Range	<i>Weber 2690</i>	50	28.28±1.59	23.7-30.8	300	0.00
Redcliff Dvpm.	<i>Chinnoek 1718</i>	50	30.08±1.67	26.1-33.2	300	0.00
Corunna Hill	<i>Chinnoek 1994</i>	50	26.50±1.45	23.7-28.4	300	0.00
Mt Ive, Eyre Pen.	<i>Donner 3251</i>	50	28.84±1.32	26.1-33.2	300	0.00
<i>M. lanceolata</i> race 2						
A.C.T. & N.S.W.:						
Ginini Flat	<i>Hartley 13643</i>	50	35.80±1.39	33.2-37.9	336	39.88
Mt Gingera	<i>Hoogland 8472</i>	50	37.76±2.21	33.2-42.7	343	15.16
Snowy Flat	<i>Adams 2565</i>	50	31.90±1.66	28.4-35.5	316	5.06
Mt Bimberi	<i>Darbyshire 121</i>	50	34.17±1.69	30.8-37.9	315	4.76
Murray's Gap	<i>Rodd 995</i>	50	35.05±2.27	30.8-42.7	429	42.89
Rule's Point	<i>Salasoo 3497</i>	50	33.09±1.64	30.8-37.9	313	4.15
Cooleman Plain	<i>Walker 137</i>	50	35.33±1.39	33.2-37.9	371	41.78
Dainers Gap	<i>Thomson 1284</i>	50	33.83±1.88	30.8-37.9	306	46.73
Charlotte Pass	<i>Ashby 2119</i>	50	33.38±2.22	30.8-42.7	303	31.02
Mt Kosciusko	<i>Walker 183</i>	50	34.02±1.67	28.4-37.9	370	18.92
Spencers Creek	<i>Ashby 1752</i>	50	32.99±1.69	28.4-35.5	332	9.64
Bett's Creek	<i>Eichler 13677</i>	50	36.28±1.93	30.8-40.3	306	1.96
Blue Cow	<i>Ashby 2817</i>	50	34.12±1.62	30.8-37.9	300	6.33
Victoria:						
Mt Pinnibar	<i>Park s.n.</i>	100	39.08±2.67	33.2-45.0	355	15.49
Mt Cope	LD	100	29.15±1.29	26.1-33.2	300	0.33
*Mt Cope	LE	50	31.85±2.38	26.1-35.5	500	0.00
**Mt Hotham	LF	300	36.88±2.46	30.8-47.4	600	37.17§
<i>M. lanceolata</i> race 3						
Tasmania:						
Projection Bluff	<i>Burns 523</i>	50	27.11±1.83	23.7-30.8	300	0.00

\* Chromosome number: 2n=36. \*\* Chromosome number: 2n=72.

† Mean of two counts (0.33% &amp; 13.29%) from different clones.

§ Mean of two counts (23.33% &amp; 51.00%) from the same clone.

## 8 B

Self-pollination fruit set

Plant(s)	Percentage of self-fertilized ovules (fruits) per head ¶
SD 1	7-37±28-86 (11)
SD 2	0-20±14-40 (6)
SD 3	0-37±30-58 (3)
SD 4	5-31±20-62 (6)
SD 5	0-22±12-33 (5)
SD 6	0-34±32-85 (11)
SD 7	0-40±24-87 (14)
SD 8	12-39±21-79 (11)
SD 9	0-36±27-77 (20)
SD 11	0-54±34-84 (5)
SD 12	0-20±25-82 (17)
SD 13	0-41±21-71 (11)
SD 14	0-43±24-70 (14)
SD 15	22-67±39-100 (2)
SD 16	0-42±29-86 (15)
SD 16*	5-47±15-83 (28)
SG 1 *	12-53±27-95 (18)
SW 3-10*	0-83±23-100 (80)
SWxSK 1 *	16-37±15-67 (16)

¶ Range with mean & SD in italics: in brackets number of heads tested.  
\* Plants isolated: in all others, heads bagged.

## 8 A

Breeding systems in *Microseris* subgenus *Monermos*

	Weakly self-incompatible (strongly self-compatible) populations	Moderately self-incompatible populations & crosses	Strongly self-incompatible populations	
			No selfing in bagged heads. Not tested with LE/LF pollen	Some selfing but only after stimulation with LE/LF pollen (Table 9)
<i>M. scapigera</i> *	SW (83%†)	SD (47%†) SG (53%†) SW x SK (37%†)	SB, SE, SF, SH, SI, SJ, SL, SN, SO, SQ, SV, SX	SA, SC, SK, SM, SP, SR
<i>M. lanceolata</i> race 1	-	-	LA	LB, LC
race 2	-	-	LD, LE, LF	-
race 3 §	-	-	-	-

\* Breeding systems of populations SS, ST & SU & crosses other than SW x SK were not investigated.  
† Average & self-fertilized ovules per head in plants grown in isolation. For number of heads counted refer to Table 8 B.  
§ Live plants were not available for study, but small florets with small anthers indicate (by analogy with pop. SW) the possibility of weak self-incompatibility.

Data on germination and pollen fertility of intra- & interspecific F<sub>1</sub> crosses in *Microseris* subgenus *Monermos*

Cross		Cross (H-) No.	No. of heads crossed	Total No. of good fruits ( ) and range per head	No. of fruits sown	% germin- ation		F <sub>1</sub> fertility	
Ovule parent	Pollen parent					F <sub>1</sub>	PS*	No. of plants tested	Average % good pollen
M. scapigera x M. scapigera									
SA	SB	109	1	( 40)	22	59		3	97
SA	SC	105	1	( 55)	22	91		3	99
SA	SD	111	3	( 55) 7-26	22	91		4	95
SA	SE	101	3	( 88) 5-50	23	22		3	99
SA	SF	107	4	(151) 10-53	22	82		3	97
SA	SH	104	2	( 76) 35-41	23	61		3	98
SA	SJ	108	2	( 30) 4-26	22	91		4	93
SA	SL	102	2	(104) 25-79	22	100		3	100
SA	SN	103	2	(107) 50-57	22	55		3	100
SA	SO	106	1	( 22)	22	36		3	97
SA	SX	110	2	( 56) 4-52	22	23		3	99
SB	SA	120	2	( 46) 21-25	21	38		4	99
SB	SC	116	1	( 44)	22	14		3	99
SB	SD	122	2	( 44) 11-33	22	27		3	99
SB	SE	112	1	( 38)	22	18		3	99
SB	SF	118	1	( 37)	23	17		3	99
SB	SH	115	3	( 94) 23-42	23	22		3	100
SB	SJ	119	1	( 32)	23	35		3	99
SB	SL	113	2	( 84) 41-43	22	45		3	99
SB	SN	114	1	( 25)	23	26		4	99
SB	SO	117	3	( 76) 19-30	22	0		-	-
SB	SX	121	1	( 31)	22	5		1	99
SC	SA	54	2	( 28) 7-21	21	24		3	82
SC	SB	55	2	( 55) 25-30	21	0		-	-
SC	SD	56	1	( 12)	12	8		1	98
SC	SE	47	2	( 28) 11-17	20	25		4	91
SC	SF	52	3	( 74) 18-30	21	0		-	-
SC	SH	50	2	( 30) 11-19	19	47		3	98
SC	SJ	53	3	( 96) 21-42	21	38		3	99
SC	SK	48	1	( 31)	20	20		2	85
SC	SN	49	3	( 99) 28-37	21	10		2	99
SC	SO	51	3	( 59) 2-29	20	10		2	97
SC	SW	177	4	( 55) 8-21	23	83		3	99
SD	SA	143	3	( 49) 13-20	23	0 + 48		-	-
SD	SB	144	2	( 30) 14-16	22	9 + 50		1	99
SD	SC	139	2	( 57) 27-30	22	0 + 59		-	-
SD	SE	135	1	( 21)	21	24 + 71		1	93
SD	SF	141	3	( 57) 18-20	23	0 + 70		-	-
SD	SH	138	3	( 76) 21-31	21	67		3	97
SD	SJ	142	1	( 28)	21	0 + 86		-	-
SD	SK	136	2	( 41) 20-21	21	81		3	98
SD	SN	137	2	( 45) 14-31	23	48 + 43		3	99
SD	SO	140	2	( 26) 12-14	14	0 + 86		-	-
SD	SX	145	2	( 43) 21-22	22	0 + 73		-	-
SE	SA	9	3	( 72) 19-28	17	47		3	99
SE	SB	10	1	( 23)	16	88		3	99
SE	SC	4	3	( 31) 0-16	15	47		3	95
SE	SD	12	3	( 37) 10-15	16	87		4	99
SE	SF	7	3	( 85) 26-30	16	25		3	91
SE	SH	3	1	( 22)	16	44		2	99
SE	SJ	8	2	( 22) 7-15	15	80		3	99
SE	SK	1	2	( 37) 14-23	16	13		2	85
SE	SN	2	3	( 43) 10-21	14	64		3	99
SE	SO	5	1	( 23)	16	6		1	100
SE	SQ	6	1	( 10)	10	0		-	-
SE	SX	11	2	( 23) 10-13	16	38		3	98
SF	SA	86	2	( 31) 11-20	25	36		2	99
SF	SB	87	2	( 47) 22-25	25	12		2	97
SF	SC	83	6	( 77) 4-22	19	42		3	99
SF	SD	89	1	( 28)	22	95		4	99
SF	SE	79	1	( 15)	15	60		4	98
SF	SH	82	5	( 41) 3-19	19	63		4	100
SF	SJ	85	1	( 31)	24	75		4	100
SF	SL	80	1	( 23)	21	95		2	99
SF	SN	81	1	( 32)	22	59		2	98
SF	SO	84	2	( 18) 0-18	18	17		3	91
SF	SX	88	2	( 33) 14-19	21	10		2	99
SG	SK	183	4	(108) 20-33	43	93		3	99
SH	SA	43	5	( 73) 0-29	22	27		3	98

2.

Cross		Cross (H-) No.	No. of heads crossed	Total No. of good fruits ( ) and range per head	No. of fruits sown	% germin- ation		F <sub>1</sub> fertility	
Ovule parent	Pollen parent					F <sub>1</sub>	PS*	No. of plants tested	Average % good pollen
M. scapigera x M. scapigera continued..									
SH	SB	44	1	( 20)	20	10		2	99
SH	SC	38	4	( 72) 6-25	21	10		2	96
SH	SD	46	2	( 44) 17-27	20	50		3	99
SH	SE	35	2	( 49) 16-33	16	13		2	96
SH	SF	41	2	( 36) 8-28	22	41		3	99
SH	SJ	42	2	( 53) 22-31	21	24		3	100
SH	SL	36	2	( 47) 17-30	23	39		4	99
SH	SN	37	1	( 15)	15	20		3	97
SH	SO	39	1	( 25)	25	8		2	98
SH	SQ	40	1	( 20)	20	15		2	99
SH	SX	45	1	( 17)	17	6		1	99
SI	SH	210	2	( 49) 24-25	24	83		3	100
SJ	SA	97	2	( 28) 12-16	24	96		3	87
SJ	SB	98	4	( 18) 0-18	18	78		3	100
SJ	SC	93	3	( 78) 22-33	22	64		3	99
SJ	SD	100	3	( 54) 14-23	20	70		2	98
SJ	SE	90	2	( 52) 26	24	96		3	94
SJ	SF	96	2	( 48) 23-25	25	36		4	99
SJ	SH	92	2	( 37) 15-22	22	55		4	99
SJ	SL	91	1	( 20)	20	5		1	98
SJ	SO	94	1	( 23)	23	0		-	-
SJ	SQ	95	2	( 23) 8-15	15	13		2	94
SJ	SX	99	4	( 56) 6-23	21	33		3	96
SK	SA	20	3	( 67) 12-29	16	69		3	99
SK	SC	16	1	( 44)	15	20		3	99
SK	SD	23	2	( 60) 22-38	15	60		4	83
SK	SE	13	1	( 37)	14	50		3	96
SK	SF	18	2	( 79) 38-41	16	38		3	99
SK	SG	180	4	( 80) 7-33	42	86		3	99
SK	SH	15	2	( 47) 13-34	15	67		4	90
SK	SJ	19	1	( 41)	15	87		3	99
SK	SN	14	1	( 33)	14	64		4	99
SK	SO	17	3	( 29) 7-12	14	57		4	94
SK	SW	175	2	( 73) 23-50	20	100		3	98
SL	SB	21	1	( 18)	15	80		3	99
SL	SX	22	1	( 9)	9	100		4	93
SM	SA	155	1	( 40)	17	82		3	92
SM	SB	156	1	( 49)	17	71		3	96
SM	SC	150	2	( 67) 29-38	17	94		3	99
SM	SD	158	2	( 66) 17-49	16	81		3	98
SM	SE	146	1	( 37)	17	88		3	99
SM	SF	153	1	( 36)	19	100		3	91
SM	SG	182	1	( 46)	20	75		3	100
SM	SH	149	2	( 35) 17-18	17	94		3	98
SM	SJ	154	2	( 70) 29-41	19	95		3	99
SM	SK	147	4	( 96) 16-38	16	100		3	99
SM	SN	148	1	( 35)	17	82		3	99
SM	SO	151	1	( 20)	19	68		3	98
SM	SQ	152	1	( 35)	17	88		3	93
SM	SW	179	3	( 23) 0-14	20	35		3	91
SM	SX	157	1	( 31)	18	56		3	98
SN	SA	31	1	( 25)	23	13		3	98
SN	SB	32	4	( 97) 20-31	22	0		-	-
SN	SC	27	2	( 55) 27-28	20	45		2	99
SN	SD	34	1	( 31)	22	18		not determined	
SN	SE	24	1	( 20)	20	35		3	99
SN	SF	29	1	( 26)	21	0		-	-
SN	SH	26	1	( 30)	20	60		3	99
SN	SJ	30	1	( 22)	22	45		3	98
SN	SL	25	1	( 23)	19	53		3	99
SN	SO	28	2	( 37) 11-26	20	0		-	-
SN	SW	176	1	( 25)	21	76		3	98
SN	SX	33	3	( 67) 16-26	22	0		-	-
SO	SA	64	2	( 34) 10-24	21	0		-	-
SO	SB	65	3	( 32) 0-23	22	5		1	99
SO	SC	61	4	( 21) 0-18	18	6		1	98
SO	SD	67	1	( 19)	18	17		3	98
SO	SE	57	1	( 19)	19	32		3	97
SO	SF	62	4	( 64) 12-20	22	5		1	100

3.

Cross		Cross (H-) No.	No. of heads crossed	Total No. of good fruits ( ) and range per head	No. of fruits sown	% germin- ation		F <sub>1</sub> fertility	
Ovule parent	Pollen parent					F <sub>1</sub>	PS*	No. of plants tested	Average % good pollen
M. scapigera x M. scapigera continued.									
SO	SH	60	2	( 28) 7-21	21	0		-	-
SO	SJ	63	3	( 34) 8-16	16	0		-	-
SO	SK	58	2	( 36) 18	21	14		3	99
SO	SN	59	4	( 54) 11-16	22	5		1	94
SO	SX	66	1	( 7)	7	14		1	99
SP	SG	181	1	( 19)	19	79		3	97
SP	SW	178	2	( 34) 16-18	23	35		3	88
SQ	SA	76	1	( 11)	11	5		4	98
SQ	SB	77	1	( 19)	19	21		3	88
SQ	SC	72	1	( 19)	19	58		2	83
SQ	SD	78	1	( 15)	15	67		4	89
SQ	SE	68	1	( 29)	21	43		4	87
SQ	SF	74	1	( 19)	19	11		2	89
SQ	SH	71	1	( 14)	14	36		2	86
SQ	SJ	75	3	( 41) 11-16	21	33		3	93
SQ	SL	69	1	( 18)	18	83		4	89
SQ	SN	70	1	( 20)	20	35		3	93
SQ	SO	73	2	( 34) 15-19	21	5		1	95
SW	SK	184	25	(379) 6-21	297	45 + 13		12	97
SX	SA	132	2	( 38) 18-20	20	0		-	-
SX	SB	133	2	( 40) 17-23	23	0		-	-
SX	SC	128	3	( 58) 16-22	22	0		-	-
SX	SD	134	3	( 61) 15-25	23	0		-	-
SX	SE	123	2	( 19) 0-19	17	0		-	-
SX	SF	130	5	( 40) 0-14	20	5		1	80
SX	SH	127	2	( 30) 12-18	12	0		-	-
SX	SJ	131	1	( 15)	15	7		1	99
SX	SK	124	2	( 37) 18-19	18	11		2	99
SX	SN	125	2	( 27) 8-19	8	0		-	-
SX	SO	129	2	( 37) 15-22	22	0		-	-
M. scapigera x M. lanceolata race 1									
SA	LA	165	1	( 26)	16	88		3	32
SB	LA	166	1	( 20)	18	83		3	31
SC	LA	162	5	( 97) 11-26	17	59		3	18
SD	LA	168	1	( 19)	18	56		3	21
SE	LA	159	1	( 24)	17	18		3	28
SJ	LA	164	2	( 52) 23-29	21	38		4	40
SK	LA	160	5	(166) 21-43	16	88		3	42
SK	LC	171	3	(135) 32-57	17	82		3	19
SM	LA	170	1	( 42)	16	38		3	9
SN	LA	161	1	( 22)	20	75		3	27
SO	LA	163	5	( 36) 0-12	20	15		3	49
SP	LA	169	10	(132) 4-21	2	100		2	19
SP	LC	173	6	( 85) 10-19	4	100		4	30
SX	LA	167	7	( 56) 0-19	19	42		4	11
M. scapigera x M. lanceolata race 2									
SA	LF	196	1	( 7)	7	0 + 14		-	-
SC	LF	195	5	( 20) 0-16	20	0 + 40		-	-
SK	LF	194	7	( 33) 1-10	32	6 + 9		2	55
SM	LF	199	3	( 12) 1-9	12	8 + 17		1	20
SP	LE	193	3	( 2) 0-2	2	0 + 50		-	-
SP	LF	197	7	( 29) 0-7	29	0 + 7		-	-
SR	LF	198	2	( 24) 9-15	24	0 + 25		-	-
M. lanceolata race 1 x M. lanceolata race 1									
LB	LC	206	5	(111) 18-25	25	40		5	96
LC	LA	172	2	( 42) 19-23	19	16		3	96
LC	LB	207	1	( 16)	16	6		not determined	
M. lanceolata race 1 x M. lanceolata race 2									
LB	LF	200	10	( 49) 0-14	49	0 + 10		-	-
LC	LF	201	12	( 43) 0-15	43	0 + 2		-	-
M. lanceolata race 1 x M. scapigera									
LC	SA	174	1	( 13)	13	31		3	32

TABLE 9

4.

Cross		Cross (H-) No.	No. of heads crossed	Total No. of good fruits ( ) and range per head	No. of fruits sown	% germination		F <sub>1</sub> fertility	
Ovule parent	Pollen parent					F <sub>1</sub>	PS*	No. of plants tested	Average % good pollen
<i>M. lanceolata</i> race 2 x <i>M. lanceolata</i> race 1									
LE	LB	191	1	( 3)	3	33		1	94
LE	LC	192	1	( 9)	9	0		-	-
LF	LB	202	3	( 2) 0-2	2	0		-	-
LF	LC	203	2	( 4) 0-4	4	0		-	-
<i>M. lanceolata</i> race 2 x <i>M. scapigera</i>									
LE	SD	208	1	( 3)	3	67		2	0§
LE	SG	209	1	( 2)	2	100		2	0§
LF	SK	204	3	( 1) 0-1	1	0		-	-

\* PS = parental selfs. § Anthers devoid of pollen.

TABLE 10

Data on germination and pollen fertility of intraspecific F<sub>2</sub> and intra- & interspecific BC<sub>1</sub> progenies in *Microseris* subgenus *Monermos*

Parents (Backcrosses: ♀ x ♂)	Cross (H-) No.	No. of heads cross- ed	Total No. of good fruits ( ) and range per head	No. of fruits sown	% germin- ation	Fertility	
						No. of plants tested	% good pollen (range)
F <sub>2</sub> PROGENIES							
<i>M. scapigera</i>							
F <sub>2</sub> of SW x SK (H184)	-	16†	(208) 5-22	208	69	30	8-99
<i>M. lanceolata</i> race 1							
F <sub>2</sub> of LC x LA (H172)	205	9	( 14) 0-7	14	50	5	84-98
BC <sub>1</sub> PROGENIES							
<i>M. scapigera</i> x <i>M. lanceolata</i> race 1							
H160 (SK x LA) x SK	186	12	( 10) 0-7	10	40	3	38-62¶
H160 (SK x LA) x LA	185	11	( 90) 0-19	89	19	15	33-89¶
<i>M. lanceolata</i> race 1 x <i>M. scapigera</i>							
H174 (LC x SA) x SA	187	8	( 45) 1-10	45	56	§	
Reciprocal of above	188	4	( 28) 0-14	28	46	§	
H174 (LC x SA) x LC	189	8	( 78) 3-14	78	35	15	20-53¶
Reciprocal of above	190	3	( 4) 0-4	4	0	-	---
<i>M. lanceolata</i> race 2 x <i>M. lanceolata</i> race 1							
H191 (LE x LB) x LF*	211	3	( 51) 15-19	51	**		

† Selfed: all heads were from a single partially self-compatible F<sub>1</sub> plant, kept in isolation during flowering.

¶ Fertility of individuals detailed in Table 11.

§ Ten plants raised to flowering (in both H187 &amp; H188) but fertility not determined.

\* Strictly a triple cross: LF was used after the failure of backcrosses (replicated) with LB &amp; LE as pollen parents.

\*\* Freshly sown at time of writing.

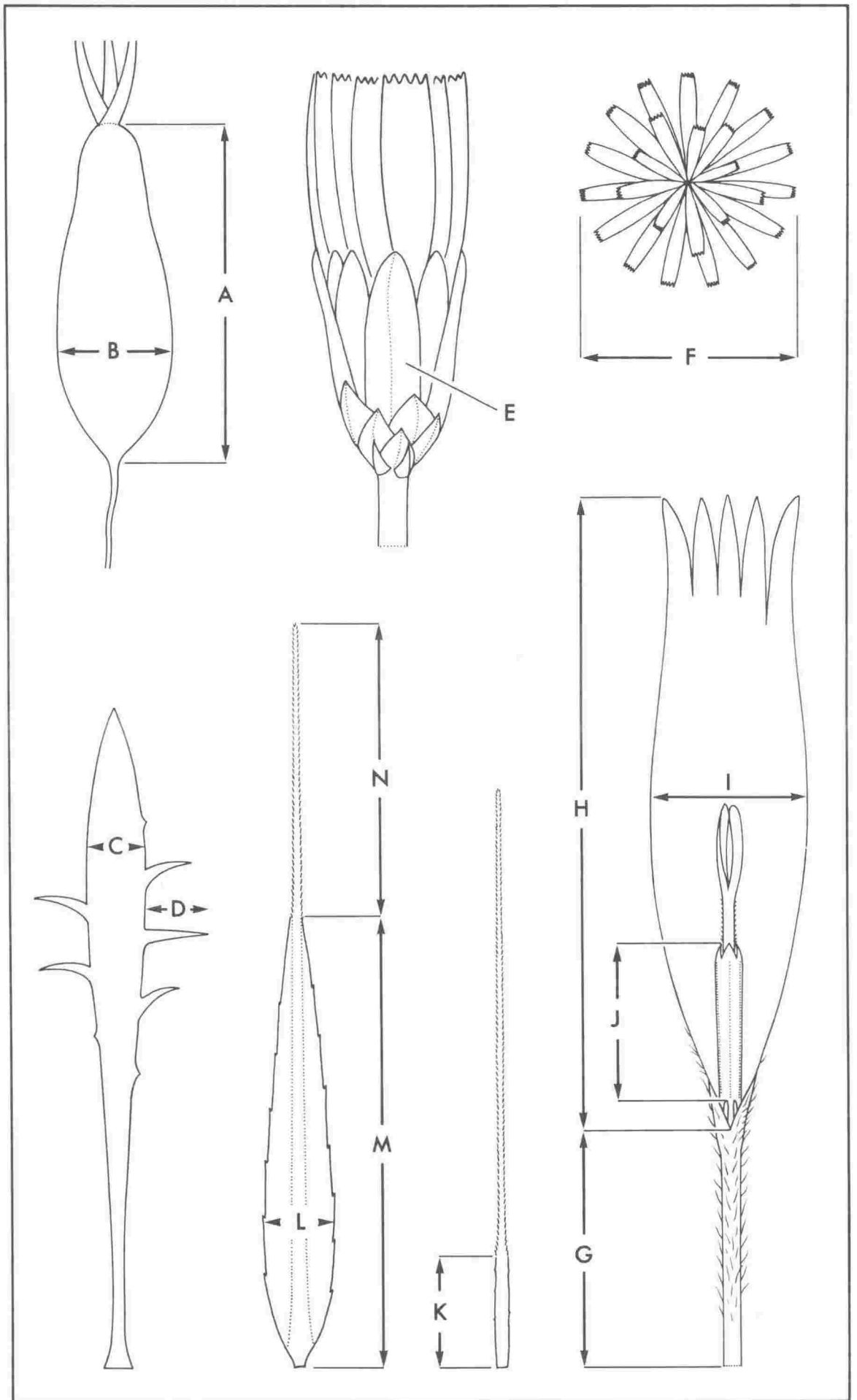


# PLATES

PLATE 1

Reference points for measurements.

- A Tuber length
- B Tuber width (widest point)
- C Leaf blade width (widest point)
- D Leaf lobe length
- E Outer phyllary isolated for measuring in cultivated material
- F Head (capitulum) diameter (fully open)
- G Corolla tube length (outer floret)
- H Ligule (corolla blade) length (outer floret)  
(Corolla length = G + H)
- I Ligule width (widest point in outer floret)
- J Anther tube length
- K Capillary pappus base length
- L Palea width (widest point)
- M Palea length
- N Awn length  
(Pappus length = M + N)



Early illustrations of *M. scapigera* and *M. lanceolata*

Fig. A *M. scapigera*

Unpublished Banks and Solander plate of *Scorsonera scapigera* drawn by Parkinson (ic.112).

Fig. B *M. lanceolata*

The artist Fitch's illustration of *M. forsteri* (plate 66) in Flora Tasmaniae, Hooker (1857).

Figure captions (with corrections in brackets):

- 1, receptacle and portion of involucre (= floret);
- 2, flower (= pappus member, from floret rather than fruit?);
- 3, stamen;
- 4, arms of style (= stamen);
- 5, achenia (= arms of style);
- 6, (no caption. = fruit).

Matching draft sketches on specimens at Kew indicate that figs 1-5 (and possibly the large plant figured) were based on the isoelectotype(?) of *Scorsonera laurencii* Hook. f. (see Plate 5 B), and similarly, that fig. 6 was based on a collection from New Norfolk (*Gum*(?) 506, 2.xi.1839). In the present treatment these two collections are placed in races 2 (*sens. lat.*) and 3 respectively. The small plant figured could not be placed.

Photographs J. Benfield



Lectotype of *Microseris scapigera* (Sol. ex A. Cunn.) Sch.-Bip.

Nova Zealandia, in collibus prope Totaranui, Banks & Solander s.n.,  
1769, BM.

The proposed lectotype seems likely to be the Banks syntype although it differs in locality and in having Solander as co-collector. The locality for the Banks specimen cited by Cunningham (1838) is "Northern Island" which, if correct, would exclude Totaranui (Queen Charlotte Sound). However, there is reason to doubt the validity of "Northern Island" since Totaranui is the only locality recorded for *Scorzonera scapigera* in Solander's MSS. Apart from the isolectotype at WELT no other specimen of Banks could be traced.

The Banks and Solander collection consists of four plants (the fifth plant on the sheet, in the top right corner, is extraneous), two with complete scapes in early fruit. None of these plants match the flowering plant figured in the unpublished Banks and Solander plate (cf. Plate 2) though two have similar (but apparently more entire) obovate-spathulate leaves.

HERB. H. F. HANCE. Repl. 1897.

Copy of Field Notes from back of sheet

Nova Zealandia, in collibus prope Totara mui

Sir J. Banks &amp; Dr Solander 1769

Nova Zealandia.  
p. 112 Dr. Hooker: 1

NEW ZEALAND 1769-70

BANKS &amp; SOLANDER

Solander Prim. Fl. N. Zel. p. 516

Parkinson Ic. 112

HERB. MUSEI BRITANNICI  
MILLIMETER

Holotype? and isotype? of *Microseris lanceolata* (Walp.) Sch.-Bip.

Fig. A Holotype?

Nova Holland(ia), *Lhotsky s.n.*, undated, KIEL.

The specimen shows close agreement with Walper's description. It consists of two plants, each with a scape (one in fruit, the other incomplete). The packets on the sheet contain the flowering head from the incomplete scape and fruits from the fruiting scape. The roots are incomplete but are long enough to be identified as non-tuberos. Labels have the following annotations:

Left hand label (Lhotsky's): "Scorzonera austral. Herbifir Alp Austr JL."

Centre label: "Lhotsky legit Nova Holland"

Right hand label: "Phyllopappus lanceolatus Walpers Nov. Genus prope Oporinia Don, Dc. Pr. VII. 108"

Fig. B Isotype?

Australia, *Lhotsky s.n.*, undated, BM.

This specimen closely matches the KIEL specimen in leaf, achene and pappus details and seems likely to be a duplicate. It consists of leaves and a fruiting scape with fertile and infertile fruits. The three detached fruits are infertile.

Lhotsky's label (top right) reads: "Scorzonera ----- Alp.(?) Austr. JL"



Lectotype and isoelectotype? of *Scorzonera (Moniermos) lawrencii* Hook. f.

Fig. A Lectotype (Sneddon, unpublished).

Tasmania, *Gunn 506, Lawrence 134 & 87, ---.1832, K.*

The three collections on this sheet show close agreement with Hooker's description (especially in leaf features). The label at the top of the sheet has the following annotation (excluding cross-outs): "1165. (*Scorzonera*) *Moniermos Lawrencii*, n. sp" (almost certainly = n.sp.). The lectotype is specified as the largest plant on the sheet, which from the position of writing nearby appears to be Gunn's collection. In the present treatment the lectotype and the right hand plant are placed in race 2 *sens. lat.*, while the small plants (top left) are referred provisionally to race 3 (pappus not seen). An additional annotation label, which was pinned across the sheet and removed for the photograph, read: "506 *Scorzonera Lawrencii*, VL(?) Very abundant in good soil. It seems very similar to a species called the "Murnong" by the aborigines of Port Phillip, the roots of which are a very favourite article of food with them."

Fig. B Isoelectotype?

Launceston, V.D. Land (= Tasmania), *Gunn 506, 11.xi.(18)44, K.*

The isoelectotype consists of two (or three) plants with flowering scapes. The roots, which are incomplete, cannot be characterised with certainty though they seem to be non-tuberos. Sketches on the sheet appear to be artist's drafts for the figures in the *M. forsteri* plate in Hooker's *Flora Tasmaniae* (cf. Plate 2 B).

Photographs J. Benfield



PLATE 6

Specimens of *M. forsteri* var. *subplumosa*, *M. teakleana*, and *M. latifolia*  
(All placed in *M. lanceolata* race 1 in the present treatment)

Fig. A      Lectotype of *M. forsteri* var. *subplumosa* Benth.

S.W. Australia, *Drummond* 366, undated, K. Three plants with  
flowering scapes. The plant on the right has an almost complete  
tuberous root.

Photograph      J. Benfield

Fig. B      Isosyntype? of *M. forsteri* var. *subplumosa* Benth.

Scotts brook, lat. 33.45, long. 122.40, entering into an inlet  
6 miles west from Cape Arid bay (*Maxwell?*), undated, MEL 64833.  
The roots are tuberous and the complete scapes are in flower  
(right) and fruit (left).

This sheet appears to be a duplicate of the Maxwell syntype  
(MEL 64832) and is in much better condition. (The syntype  
consists of six leaves or leaf fragments and one flowering scape  
with a badly insect-damaged head). The duplicate was seen by  
Bentham as indicated by his initial "B" on the back of the label.

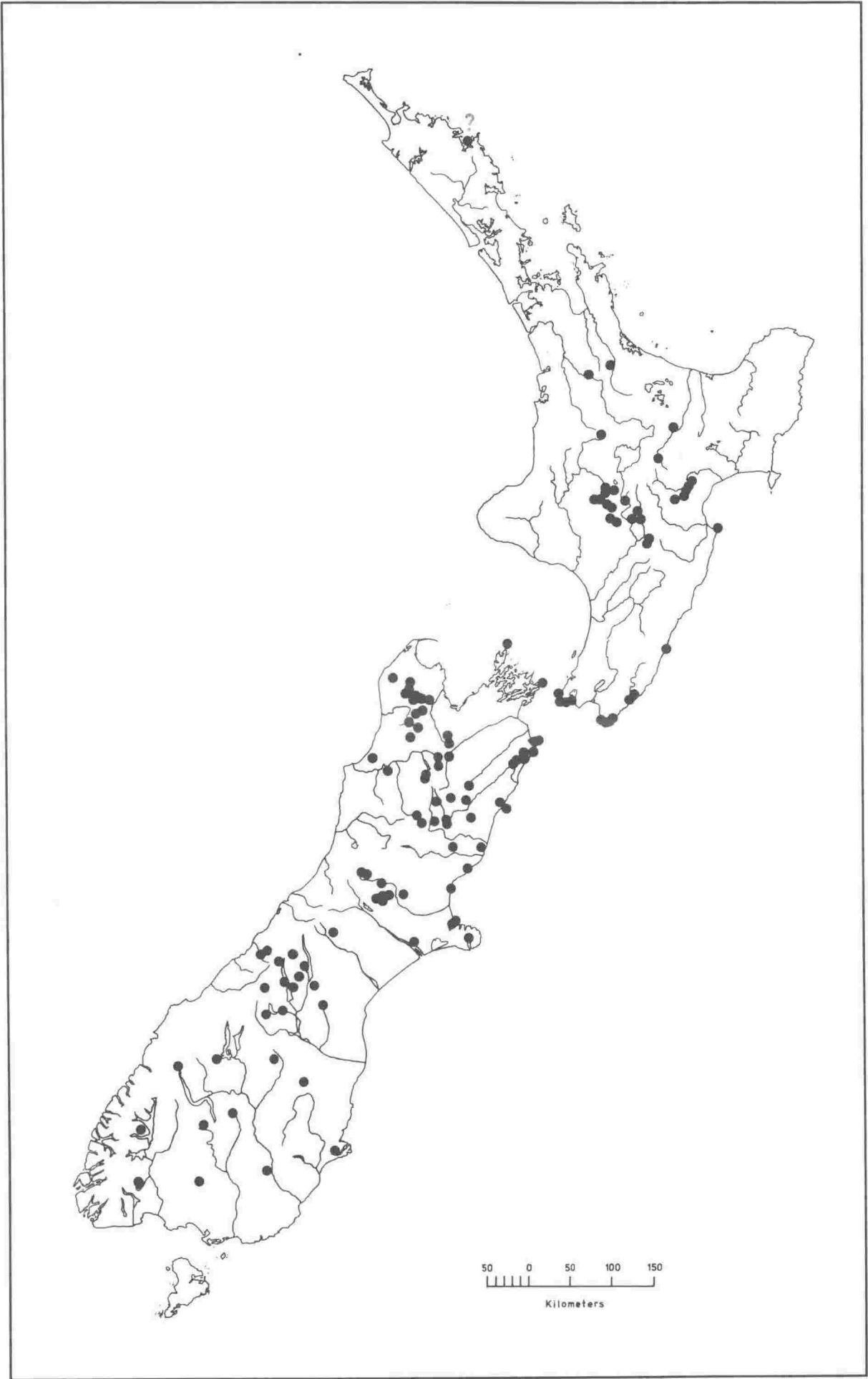
Fig. C      *M. teakleana* Gardner MS.

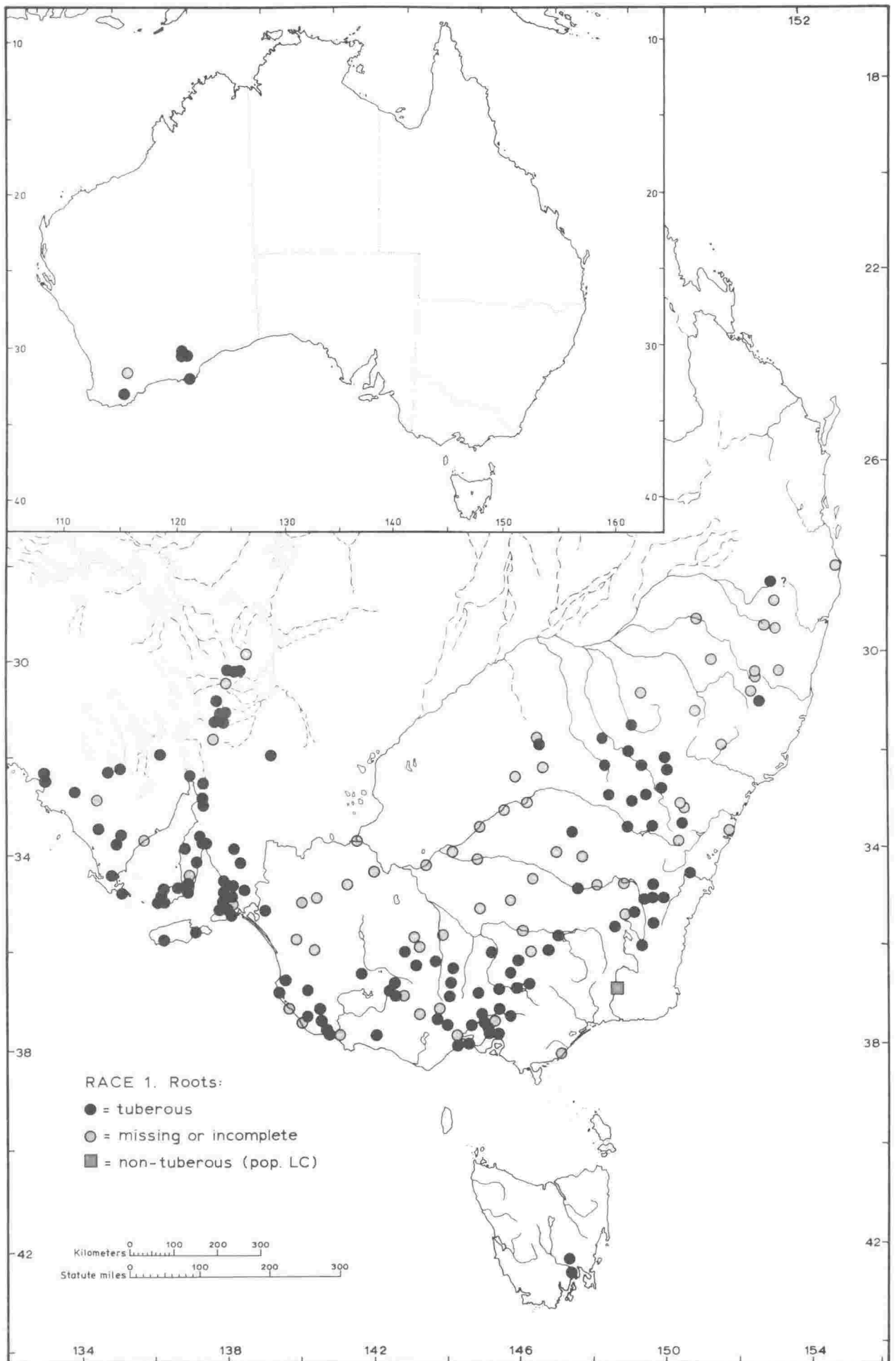
Between Lake Grace and Hyden (not "Hayden"), W.A., *Blackall* 3206,  
l.x.1933, WA. The only sheet located bearing Gardner's MS name.  
Fruits have a subplumose pappus typical of plants from Western  
Australia.

Fig. D      *M. latifolia* Gandoger MS.

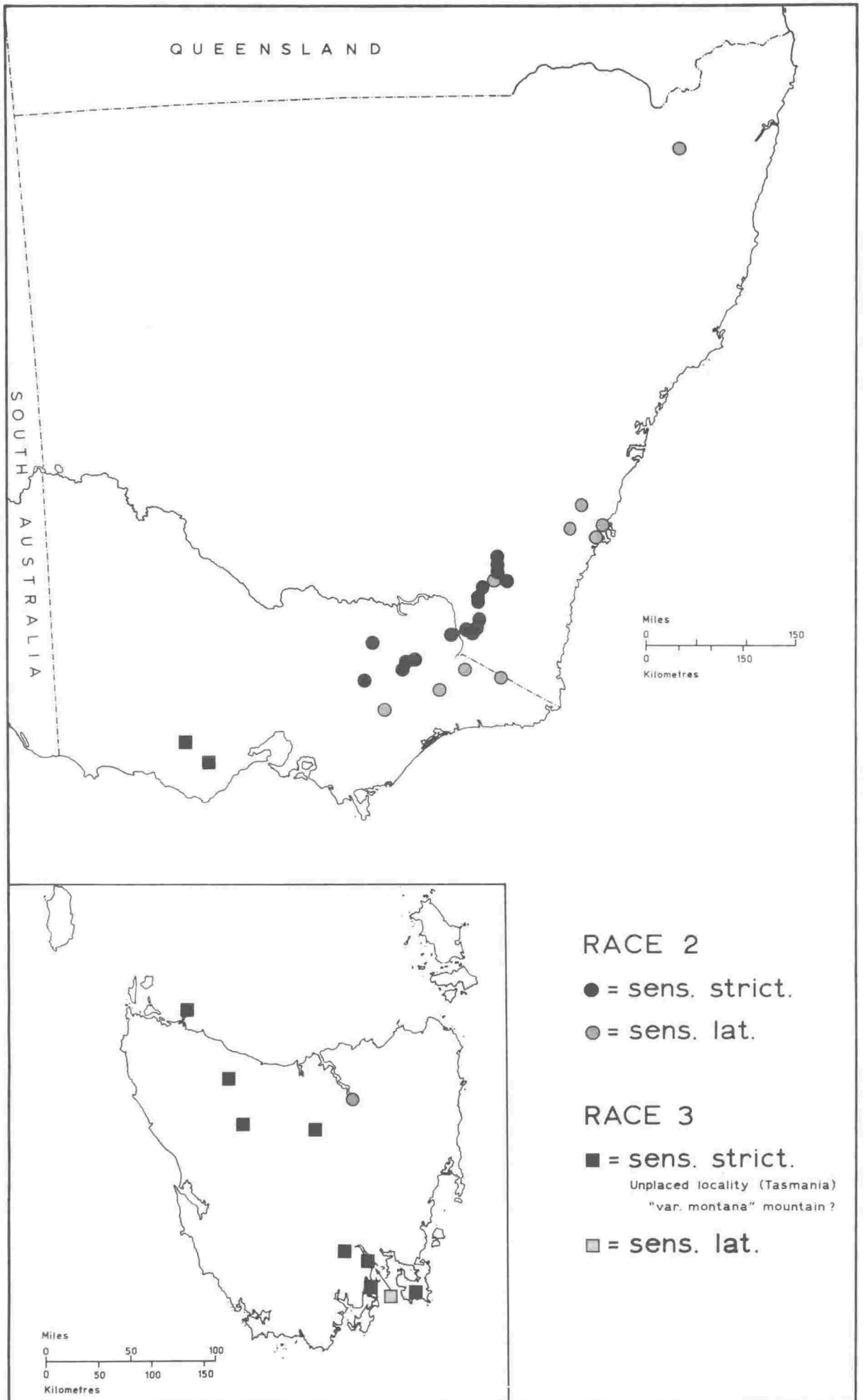
Tia Falls, N.S.W. *Forsyth* s.n., -x.1900, LY. (Isotype :  
NSW 125037). The holotype of Gandoger's unpublished name.  
The roots are unusually long and narrow for tubers but the  
older (second season) ones are shrivelled - a tuberous  
characteristic (more evident in isotype).





Distribution of *M. lanceolata* race 1

Distribution of *M. lanceolata* races 2 & 3



*M. scapigera* formae. Representative herbarium specimens to show habit.

The roots are all  $\pm$  incomplete.

Clockwise from top left:

Forma *linearis*: Lake Pukaki, S. Canterbury. Boltons Gully, Tasman Downs. (Sl00: 86-95) 1 700 ft (518 m), Macmillan & Chapman s.n., 21.xii.1970, CHR 217820. Flowering and fruiting plants.

Forma *pinnatifida*: Rotoaira Road, Waimarino, Carse 1656/2, -.i.1921, CHR. Flowering plants.

Forma *major*: Ure (= Waima) Valley, moist limestone cliffs in gorge, Simpson s.n., undated, CHR 18731. Flowering plants.

Forma *obovata*: Mt. Miro Miro, Amuri County, 5 000 ft (1 505 m), Petrie s.n., 8.ii.1914, WELT. (a & b are from duplicate sheets). Flowering and fruiting plants.



PLATE 11

*M. lanceolata* Race 1. Representative herbarium specimens to show habit. Roots are tuberous.

Clockwise from top left:

Redcliff Development Area, 25 km S of Port Augusta,  
*Chinmook* 1718, 5.ix.1974, AD. Largest specimen seen. Plant has two roots (remains of old tuber to right of current season's one) and c. 20 scapes (flowering and fruiting).

Pennington Bay near Prospect Hill, c. 25 km SE of Kingscote,  
*Eichler* 15460, 13.xi.1958, AD. Flowering and fruiting plants.

About 2 miles E of Kanya on the Kanya - St. Arnaud road,  
*Muir*, 1218, 13.ix.1960, MEL. Flowering plants.

Clover Hill, c. 11 km NE of Mt. Gambier, *Wilson* 885,  
10.x.1968, AD. Flowering plants with tubers at various stages of development and linear, mostly pinnatifid leaves.

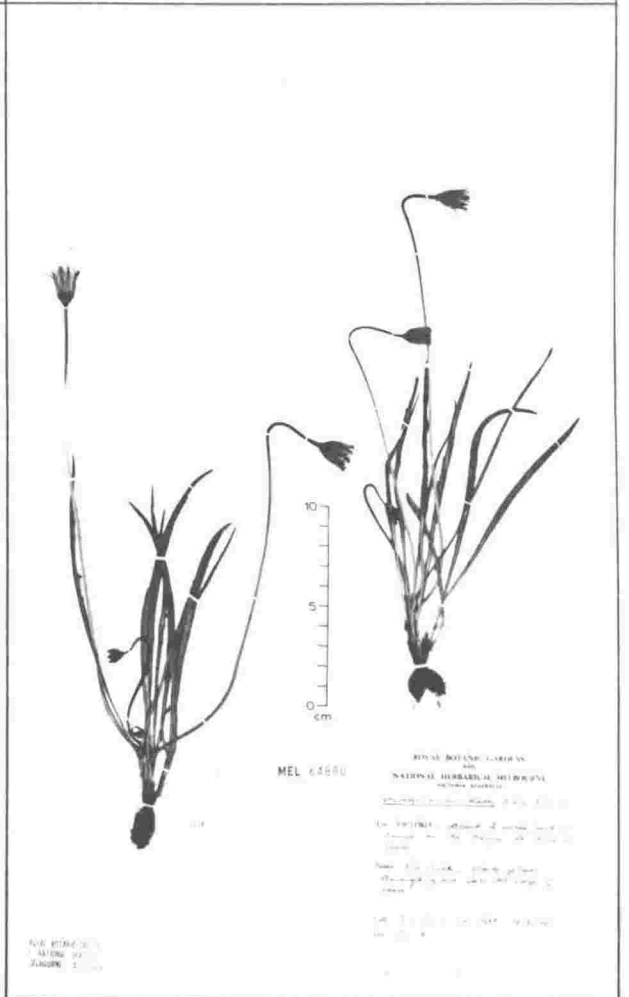
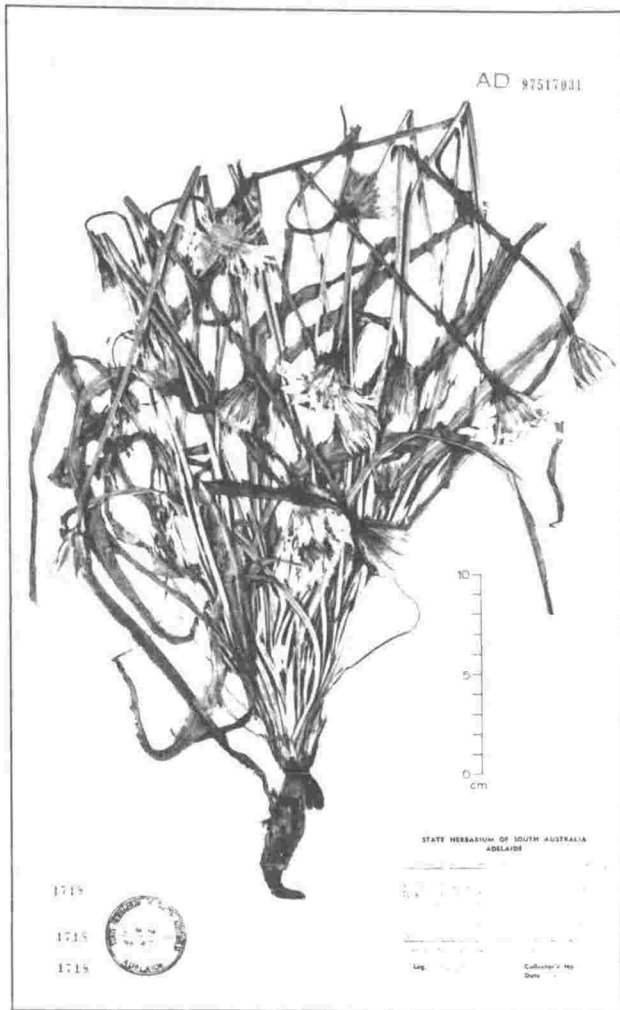


PLATE 12

*M. lanceolata* Race 2. Representative herbarium specimens to show habit. The roots (non-tuberos) are all  $\pm$  incomplete.

Clockwise from top left:

Cotter River District (A.C.T.), Snowy Flats c. 1 mile NNW of Mt. Gingera, c. 5 300 ft (1 615 m), *Adams 562*, 27.ii.1963, CANB (2 duplicates at NSW).

Summit of Mt. Bimberi (A.C.T.), c. 6 250 ft (1 905 m), *Darbyshire 121*, 17.i.1961, CANB (duplicates at NSW, K, L).

Mt. Pinnibar, Victoria (just south of Murray R., south of Mt. Kosciusko, 5 811 ft (1 771 m), *Park s.n.*, -.i.1972, WELTU 12298 (duplicate at WELTU).

Snowy Mountains near Bett's Creek, south of the Paralyser (c. 9 km ENE of Mt. Kosciusko), c. 1 750 m, *Eichler 13677*, 7.ii.1957, AD.



*M. lanceolata* Race 3. Representative herbarium specimens to show habit. The roots are non-tuberous.

Clockwise from top left:

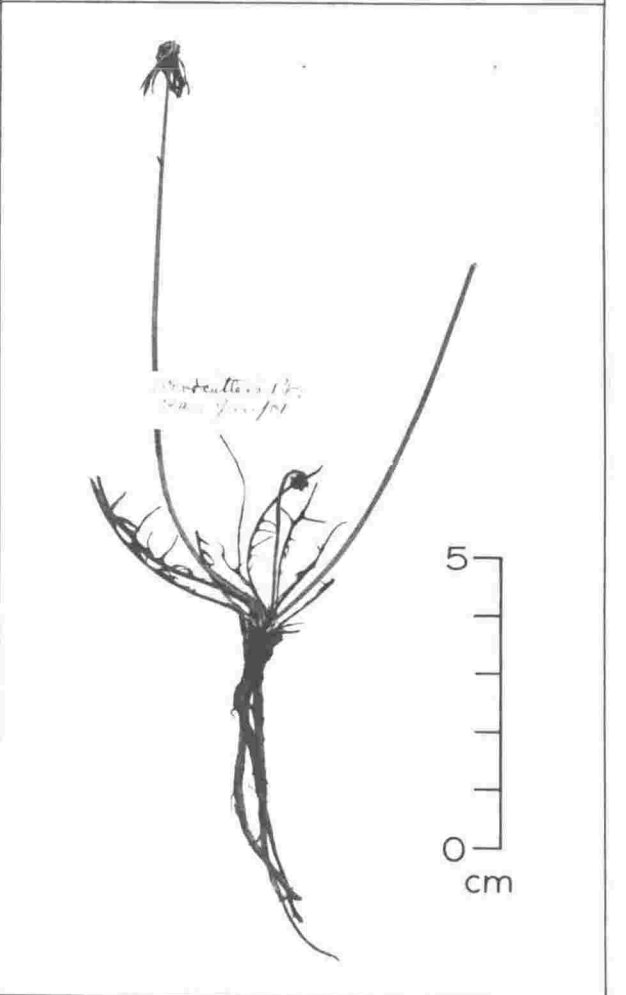
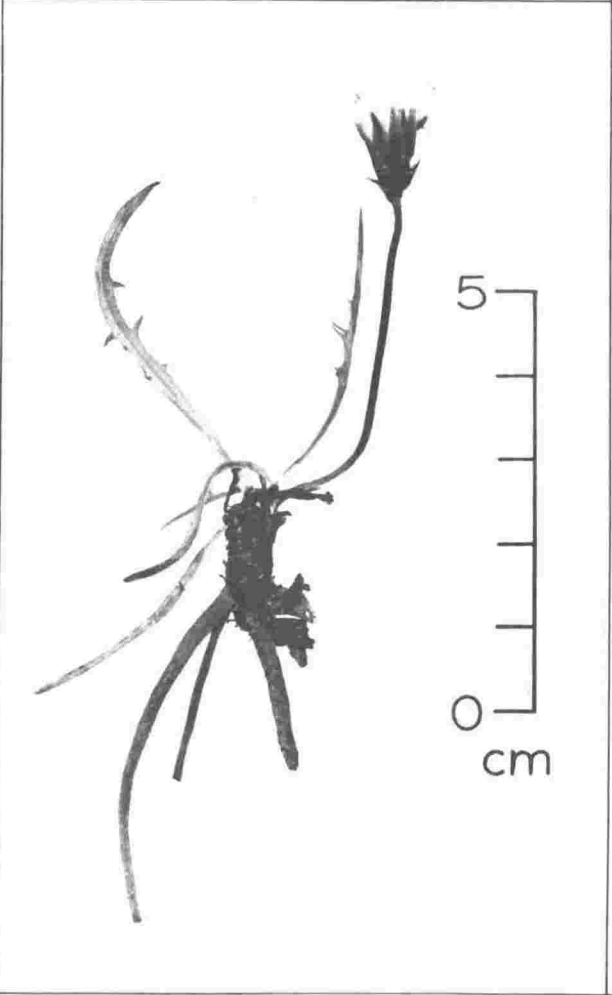
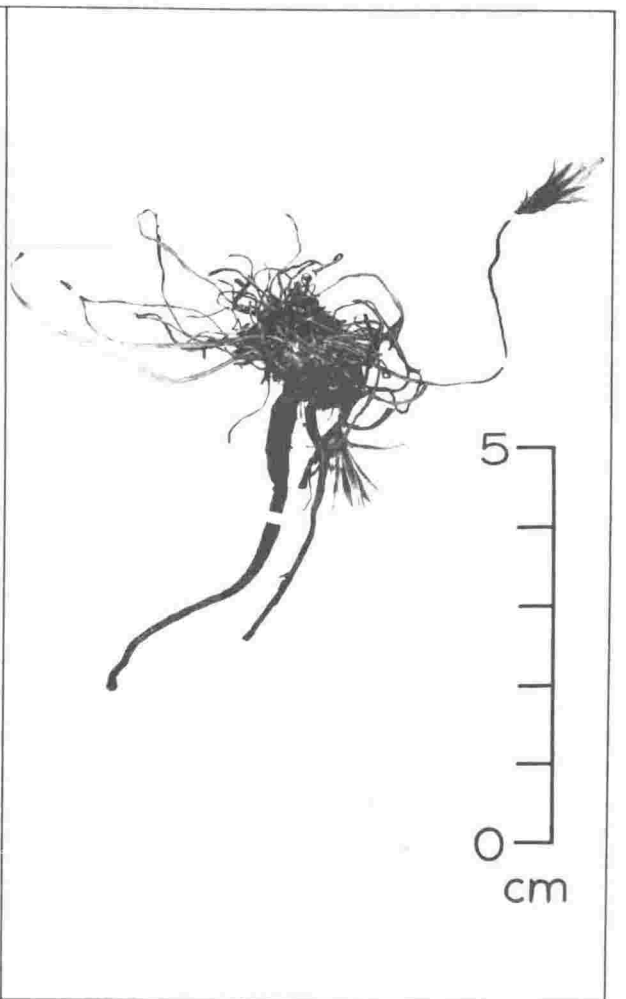
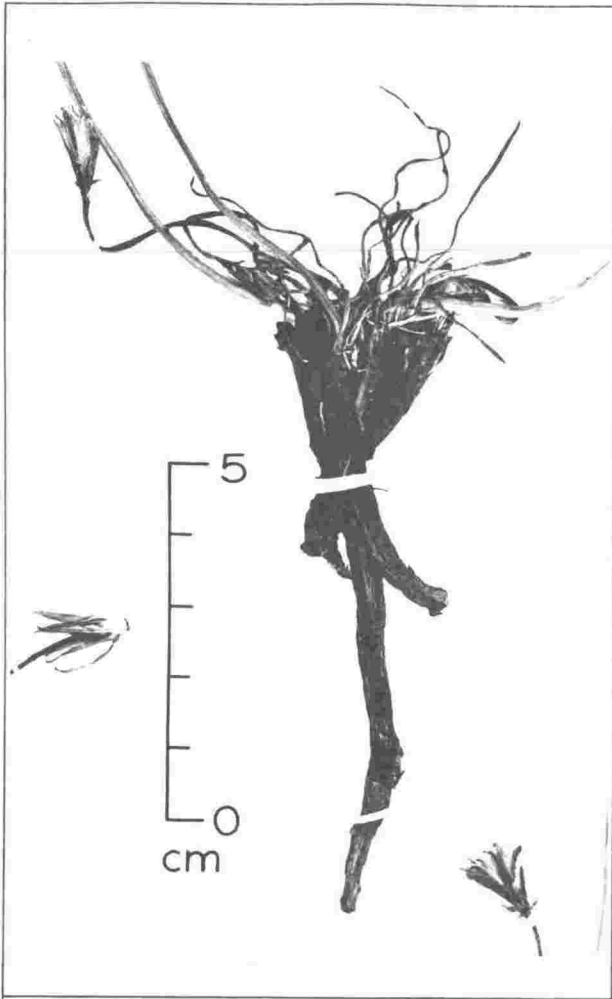
Near Lake Colac and Lake Calvert (Victoria), *Mueller s.n.*,  
-.iii.1875, MEL 64785. Plant has three roots (none complete).  
The stem, which is invested with dead leaf bases, bears filiform  
leaves, and flowering and fruiting (bases shown only) scapes,  
the latter up to 11 cm long.

Basaltic meadows near Mt. Elephant (Victoria), *Mueller (?) s.n.*,  
-.iii.1874, MEL 64790. Flowering and fruiting plant.

Woodcutter's Point (Tasmania), *Rodway 4931*, -.i.1901, NSW. Plant  
has three roots, pinnatifid filiform leaves, and scapes in bud and  
old fruit.

"Var. montana", Tasmania, *Archer s.n.*, undated, NSW 128932.

(Duplicate at HO). Plant has five roots (two obscured) and a well  
developed stem, covered with dead leaf bases.



ROOTS AND STEMS I. *M. scapigera*: cultivated plants. Dead leaf bases have been removed from the stems. All plants shown were grown from seed except SM (fig. H). All horizontal scales = 1 cm.

Fig. A Pop. SH Ten-month old plant. Unbranched root on left shows gradually tapering form typical in *M. scapigera*.

Fig. B Pop. SH Ten-month old plant with some branches and living leaves removed to show stem. The branched primary root (centre) is not the dominant root.

Fig. C Pop. SK Ten-month old plant (at flowering). Roots branch at tips.

Fig. D Pop. SK Twenty-month old plant after one flowering season (at 10 - 12 months). Note absence of shrivelling in old root (arrow).

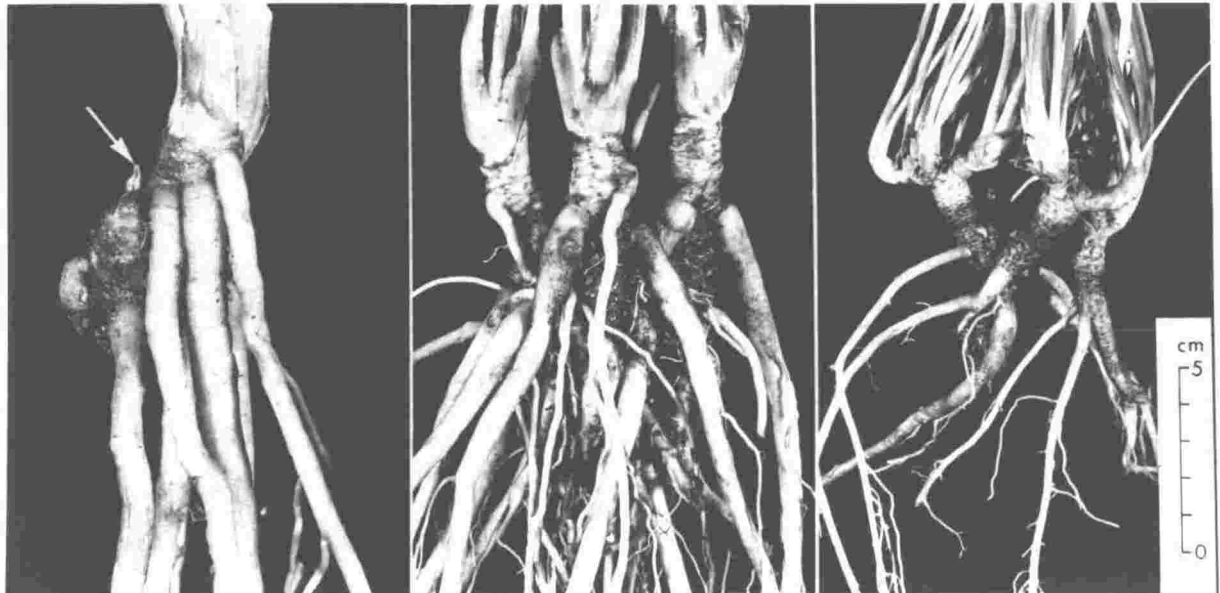
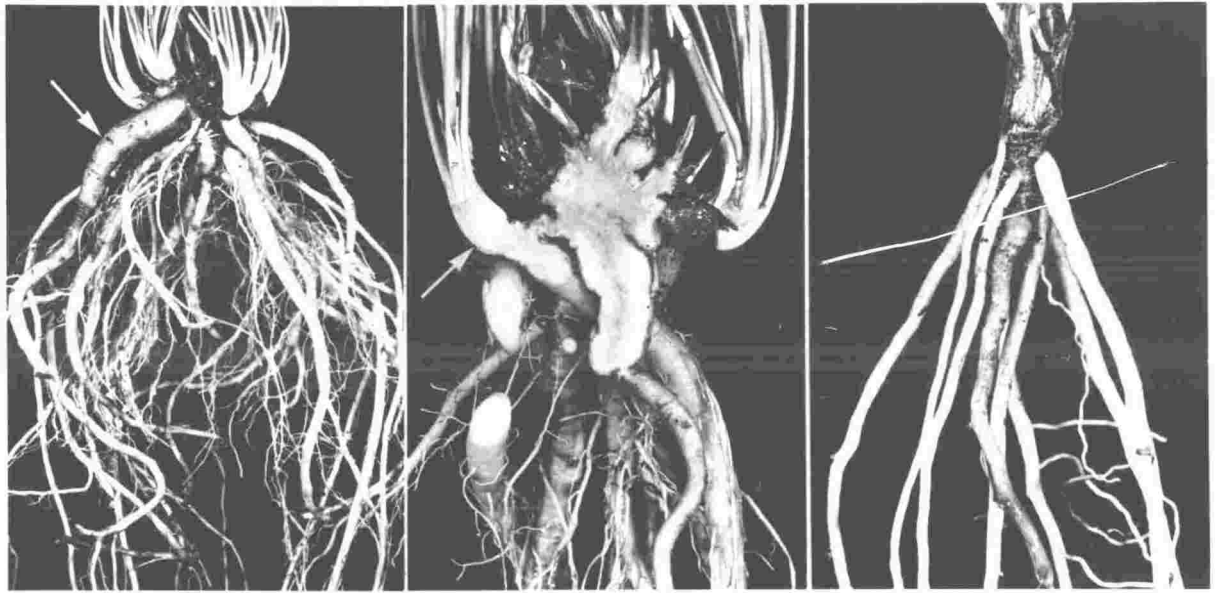
Fig. E Pop. SK Near median L.S. of plant in D (at right angle to plane of D) Primary root (centre) is incomplete. Older branches (e.g. arrow) each have a well developed root but are still firmly connected to the caudex (section through connection is non-median).

Fig. F Pop. SW Unbranched stem axis showing roots of various ages.

Fig. G Pop. SW Several-year old plant showing sympodial branching. Arrow points to remains of scape terminating the lower-order axis.

Fig. H Pop. SM Branches of a cloned transplant, showing root development.

Fig. I Pop. SA Several-year old plant. Branches have become independent plants through disintegration of connecting tissue (branch at right is not in its original position).



ROOTS AND STEMS II. *M. lanceolata* race 1: cultivated plants. Dead leaf bases have been removed from the stems. Plants in figs. A & F were raised from seed, and the remainder clone propagated. All scales = 1 cm.

*Roots tuberous*

- Fig. A Pop. LA One-year old plant after flowering. The caudex is much larger than in wild plants.
- Fig. B Pop. LA Several-year old plant showing shrivelled tuber of previous season (arrow) and fleshy tubers of the current season.
- Fig. C Pop. LA Several-year old cluster of tubers at different stages of development, all originating from a single tuber. In cultivation tubers (with their associated shoots) often became independent at an early age - at which stage they could be clone propagated.
- Fig. D Pop. LB Two-year old tuber clone showing shrivelled tuber of first season (arrow) and fleshy tuber of current season.
- Fig. E Pop. LB Several-year old cluster of tubers showing different stages of development.

*Roots non-tuberous*

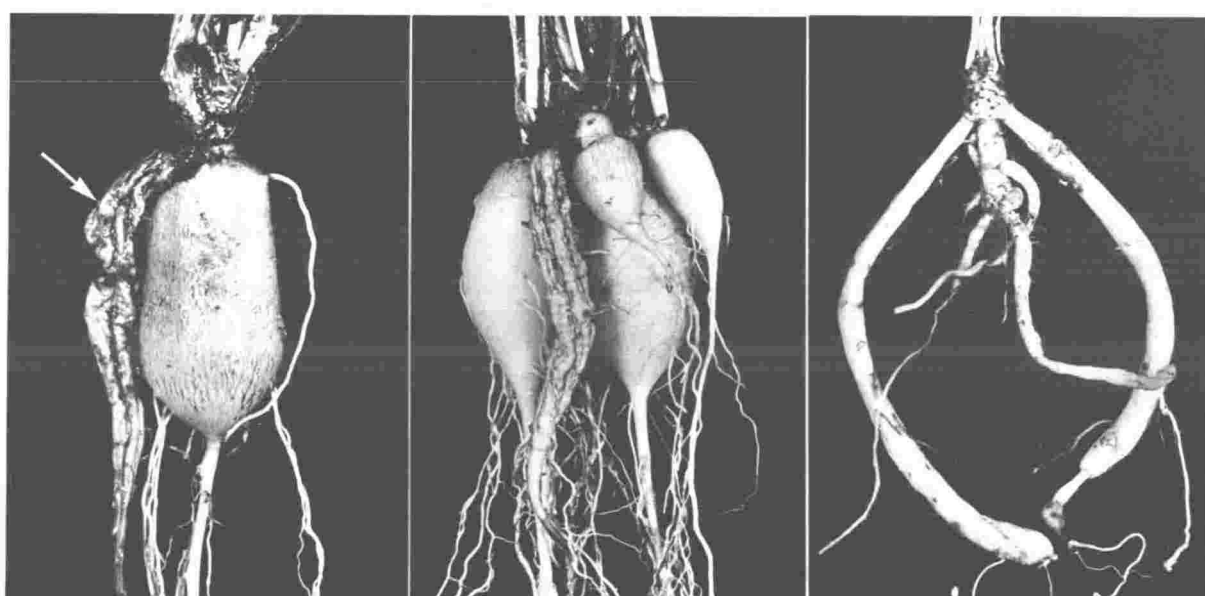
- Fig. F Pop. LC One-year old plant (after flowering) showing branched primary root and more strongly developed secondary roots.
- Fig. G Pop. LC Two-year old plant grown in a small pot. Roots have swollen through being confined by the pot.
- Fig. H Pop. LC Several-year old plant from large pot. Roots are long and cylindrical when unconfined.
- Fig. I Pop. LC Fusiform roots of three suckers grown in fine sand. The dead tissue visible is the remains of the suckers' parent root.



A

B

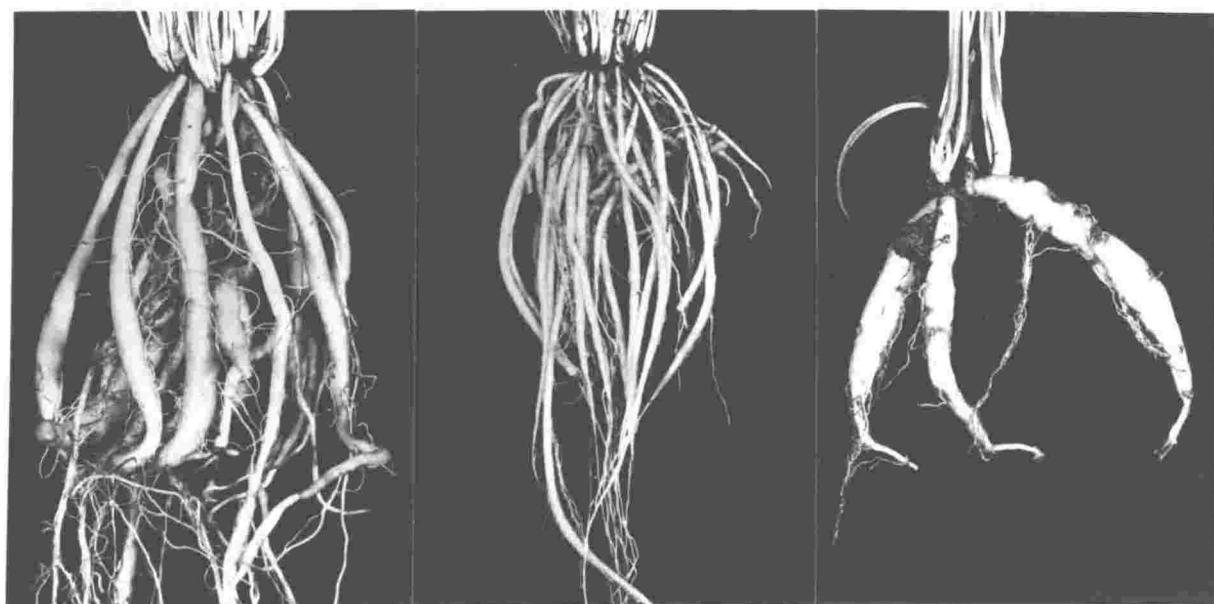
C



D

E

F



G

H

I

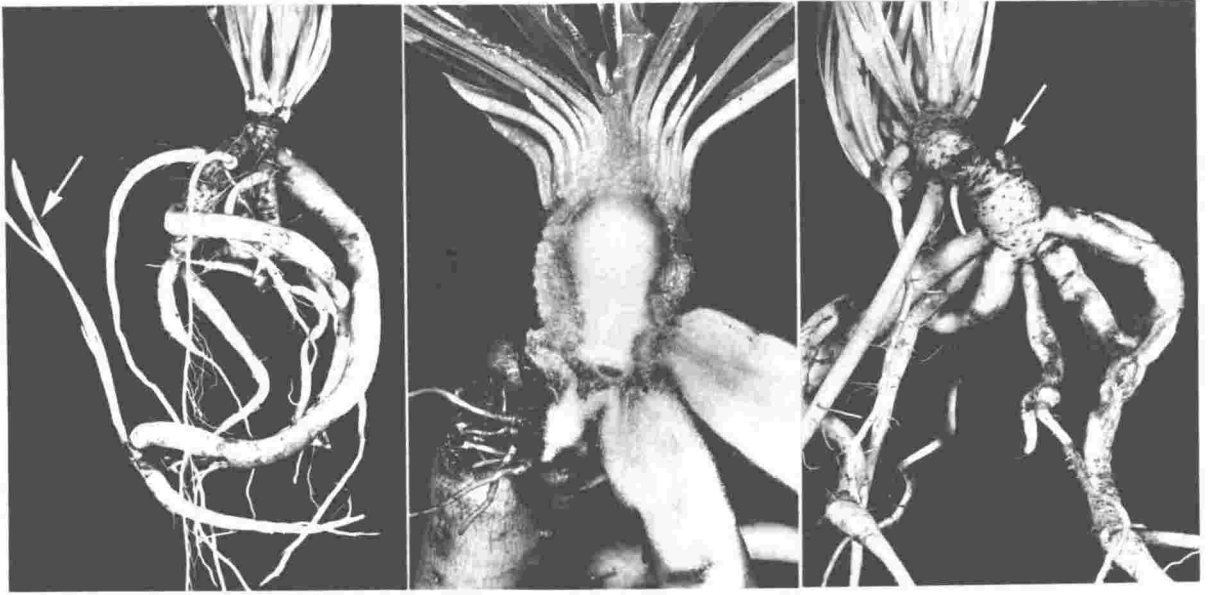
ROOTS AND STEMS III. *M. lanceolata* race 2, *M. lanceolata* intraspecific and interspecific hybrids: cultivated plants. Dead leaf bases have been removed from the stems. Plants in figs. A - E raised from root suckers, those in figs. F - I from seed. All scales = 1 cm.

*M. lanceolata* race 2

- Fig. A Pop. LE Twelve-month old plant before flowering. Arrow points to leaves of adventitious sucker growing on root.
- Fig. B Pop. LE L.S. of plant in fig A showing unbranched caudex.
- Fig. C Pop. LE Twenty-two month old plant (after flowering at 12 months) showing sympodial branching. Arrow points to remains of scape terminating the original axis. The secondary axis bears the current crown of leaves.
- Fig. D Pop. LE Twenty-two month old plant showing two orders of stems with their respective roots.
- Fig. E Pop. LF Twenty-two month old plant. Arrow points to adventitious sucker - one of several present.

*M. lanceolata* hybrids

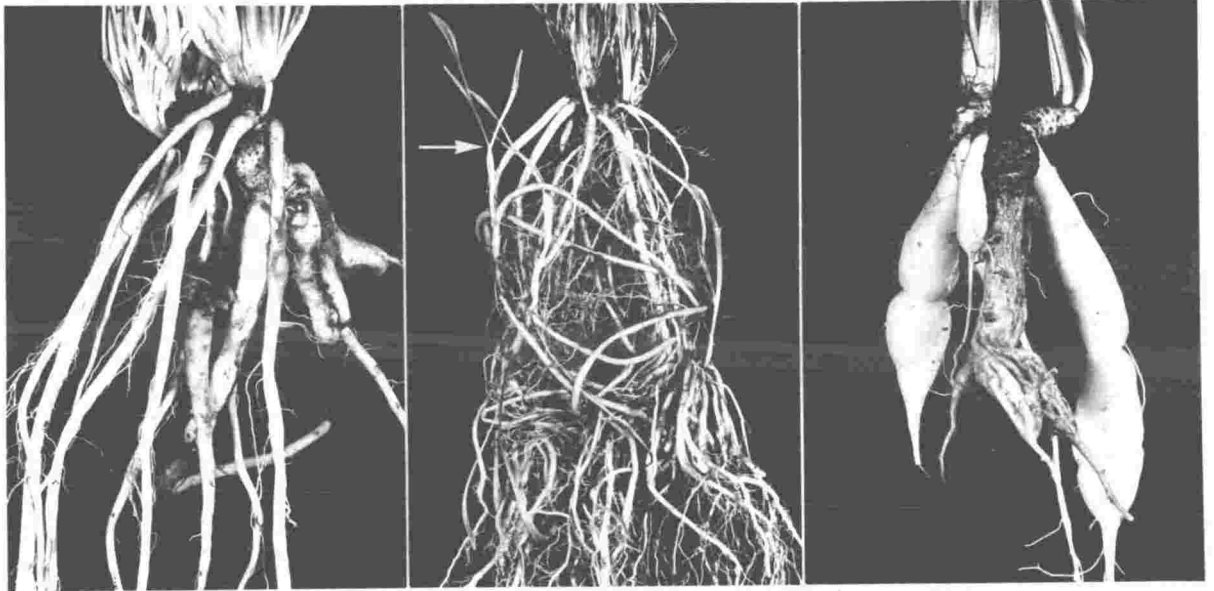
- Fig. F LB x LC (H206) *M. lanceolata* race 1, intraracial hybrid (tuberous x non-tuberous parents). Several-year old plant showing roots of tuberous character.
- Fig. G LE x LB (H191) *M. lanceolata* race 2 x race 1 (non-tuberous x tuberous parents). Twenty-month old plant (first flowering at 17 months). Roots are slightly tuberous. (Note new roots developing beneath leaf crown).
- Fig. H SK x LA (H160) *M. scapigera* x *M. lanceolata* race 1 (non-tuberous x tuberous parents). Roots are semi-tuberous (older roots in background show some shrivelling).
- Fig. I SO x LA (H163) *M. scapigera* x *M. lanceolata* race 1 (non-tuberous x tuberous parents). Roots are semi-tuberous (small size reflects SO parent).



A

B

C



D

E

F



G

H

I

PLATE 17

*M. lanceolata* Adventitious suckers on roots.

(Figs. A - C all race 2, population LE)

Fig. A      Adventitious suckers growing from roots laid on the soil surface.

At this stage most suckers had their own roots (as in Fig. C) and could be separated from the parent root for potting as independent plants. By this method large numbers of plants were cloned.

Fig. B      Potted plant (itself originally a sucker) showing a sucker developing on its root. Sucker development could occur at any point along the length of roots. ( $\times \frac{1}{2}$ ).

Fig. C      Close-up view of sucker at later stage than Fig. B, showing development of the sucker root system. The sucker is still connected to the parent root (running horizontally across picture) but at a later stage the connection breaks down leaving the sucker as an independent plant. ( $\times 2$ ).



Fig. A



Fig. B

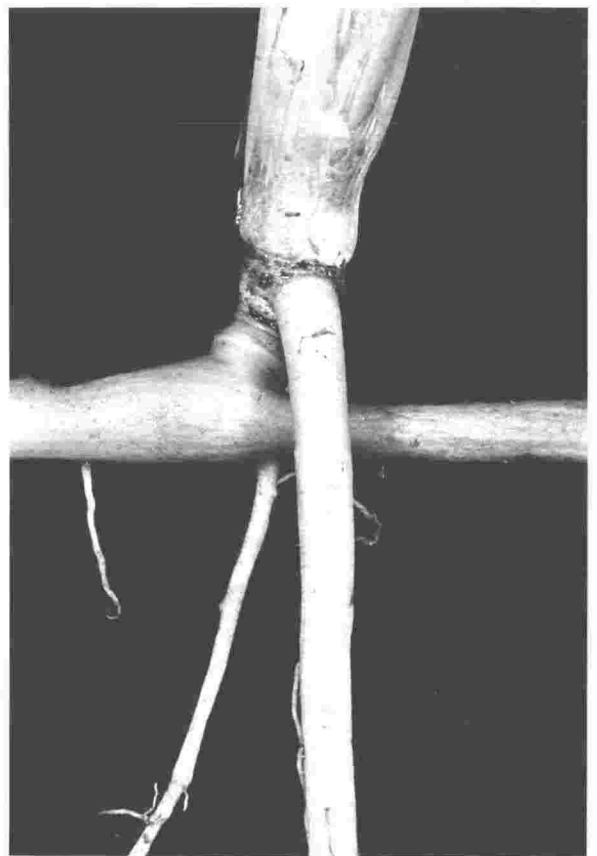


Fig. C

PLATE 18

LEAF FORM I. Silhouettes of leaves from glasshouse-cultivated plants to show seasonal extremes in size.

Small leaves (bottom) picked August - September

Large leaves (top) picked December - January.

Fig. A *M. scapigera* SC Large and small leaves from entire-dentate-leaved plant (left) and pinnatifid-leaved plant (right).

Fig. B *M. scapigera* SD Leaves from the same plant. Note the difference in lobing.

Fig. C *M. scapigera* SK Small leaves from entire-dentate-leaved plant (left) and dentate-lobed-leaved plant (right). Large leaf is from another dentate-lobed-leaved plant.

Fig. D *M. scapigera* SM Leaves from the same plant.

Fig. E *M. scapigera* SW Leaves from the same plant.

Fig. F *M. lanceolata* LE (race 2). Leaves from two plants cloned from the same genotype.

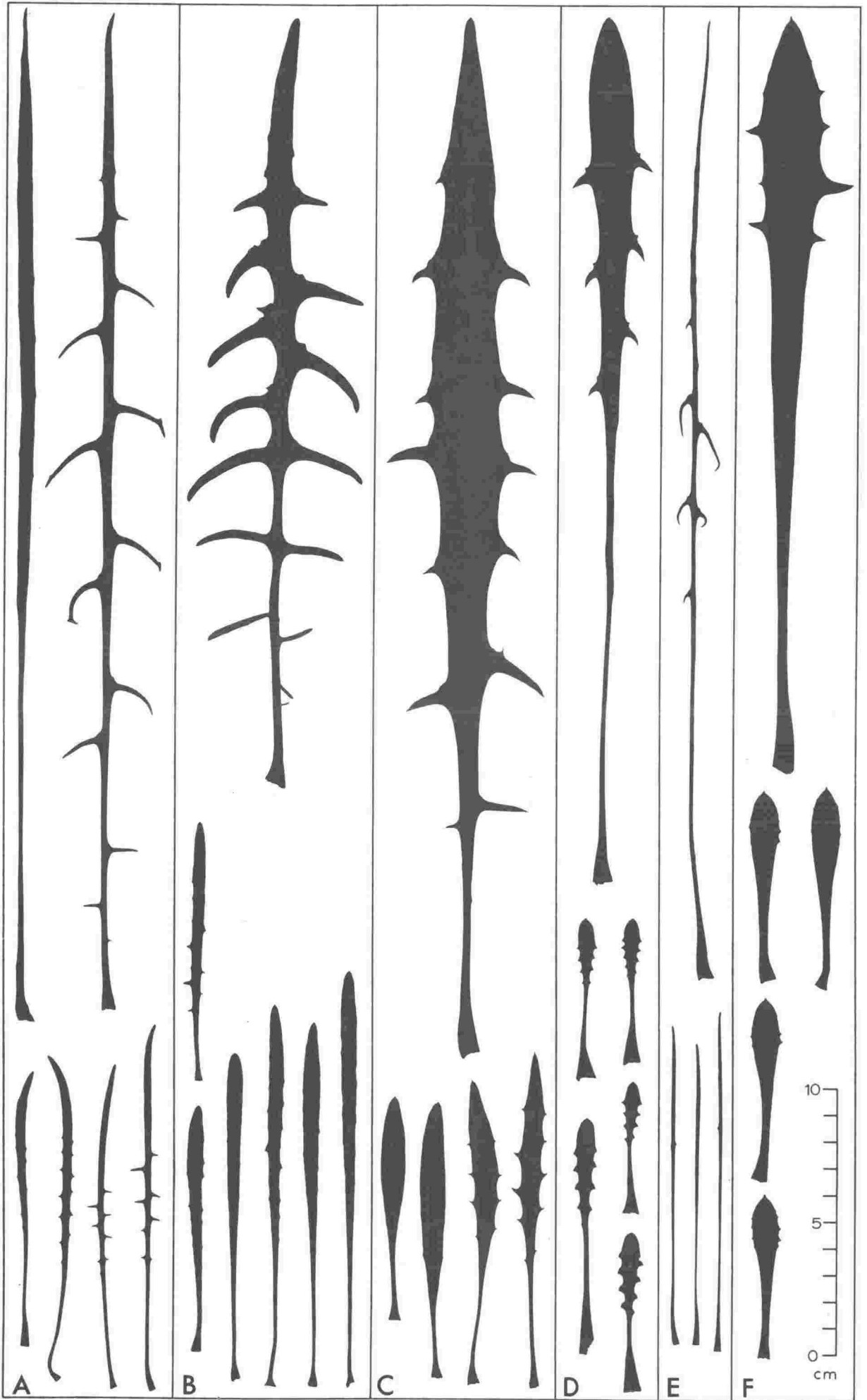


PLATE 19

LEAF FORM II. *M. scapigera*: silhouettes of leaves from glasshouse-cultivated plants picked in mid-summer (at near maximum length).

Fig. A Pop. SB

Fig. B Pop. SC

Fig. C Pop. SA Leaves from two plants

Fig. D Pop. SD Leaves from two plants

Fig. E Pop. SE Leaves from one plant

Fig. F Pop. SF Leaves from entire- and pinnatifid-leaved plants.

Leaf margin division (entire or lobed) was constant in both plants.

Fig. G Pop. SG Leaves from two plants. Leaf margin division varied in both plants (dentate to lobed).

Fig. H Pop. SI Leaves from one plant

Fig. I Pop. SH

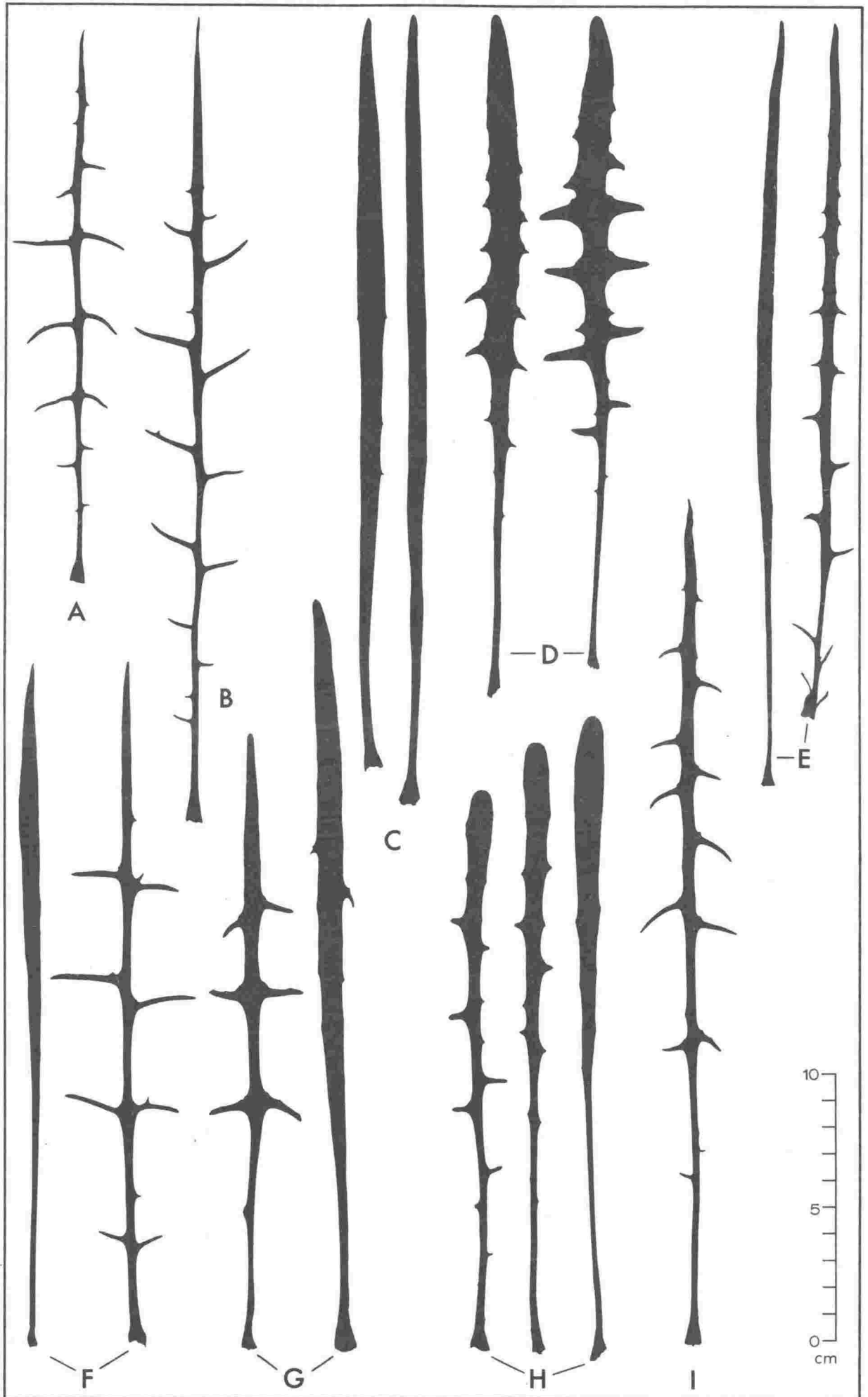
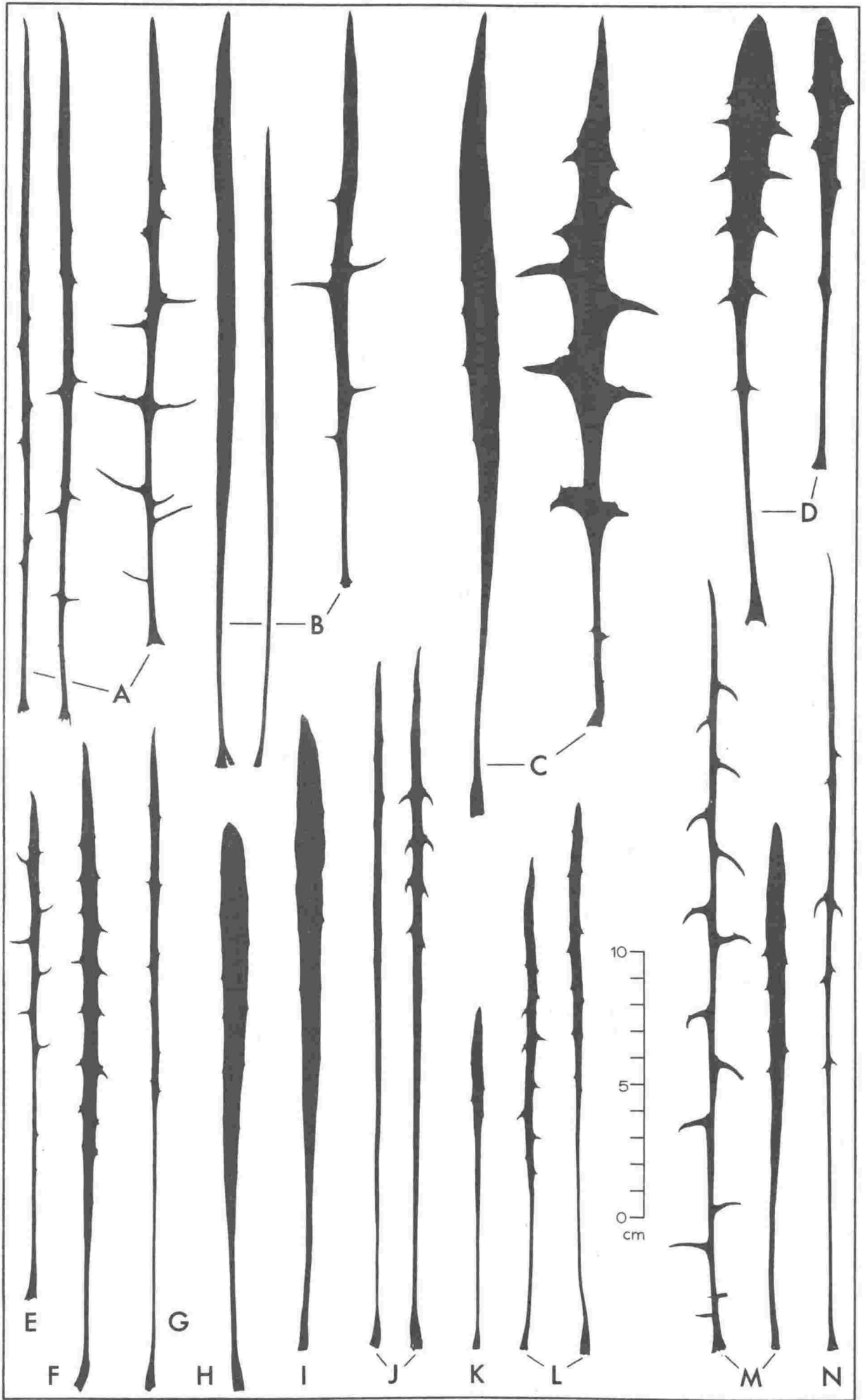


PLATE 20

LEAF FORM III. *M. scapigera*: silhouettes of leaves from glasshouse-cultivated plants picked in mid-summer (at near maximum length).

- |        |         |                              |
|--------|---------|------------------------------|
| Fig. A | Pop. SJ | Leaves from one plant        |
| Fig. B | Pop. SN | Leaves from three plants     |
| Fig. C | Pop. SK | Leaves from different plants |
| Fig. D | Pop. SM | Leaves from different plants |
| Fig. E | Pop. SQ |                              |
| Fig. F | Pop. SP |                              |
| Fig. G | Pop. SR |                              |
| Fig. H | Pop. ST |                              |
| Fig. I | Pop. SS |                              |
| Fig. J | Pop. SO | Leaves from different plants |
| Fig. K | Pop. SU |                              |
| Fig. L | Pop. SX | Leaves from different plants |
| Fig. M | Pop. SV | Leaves from different plants |
| Fig. N | Pop. SW |                              |



LEAF FORM IV. *M. lanceolata*: silhouettes of leaves from glasshouse-cultivated plants (with one exception noted), picked in mid-summer (at near maximum length).

Fig. A Pop. LA (race 1) Leaves from different plants

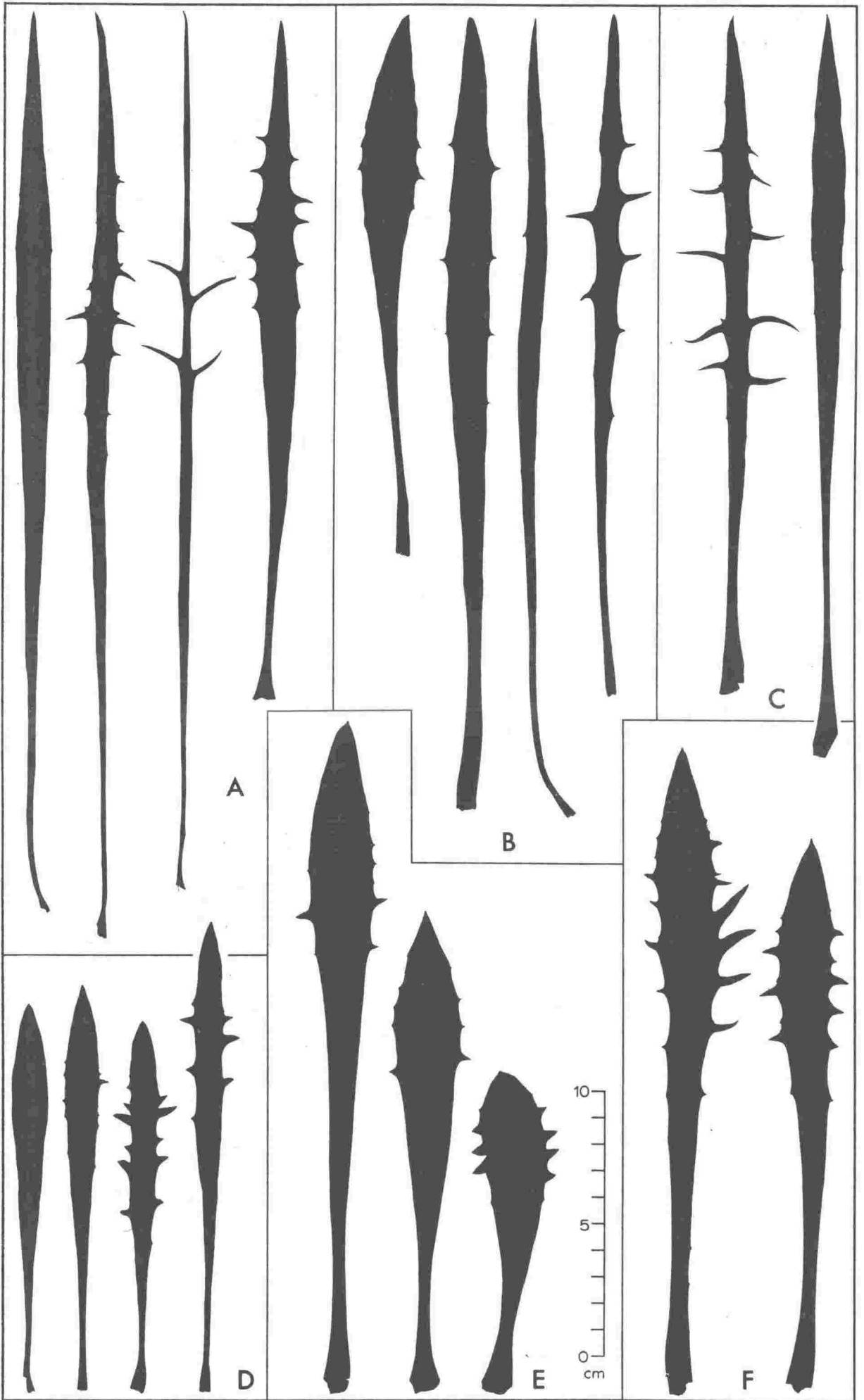
Fig. B Pop. LC (race 1) Leaves from different plants. Not shown: linear-pinnatifid leaf form

Fig. C Pop. LF (race 2) Leaves from two plants cloned from the same genotype

Fig. D Pop. LB (race 1) Leaves from two plants

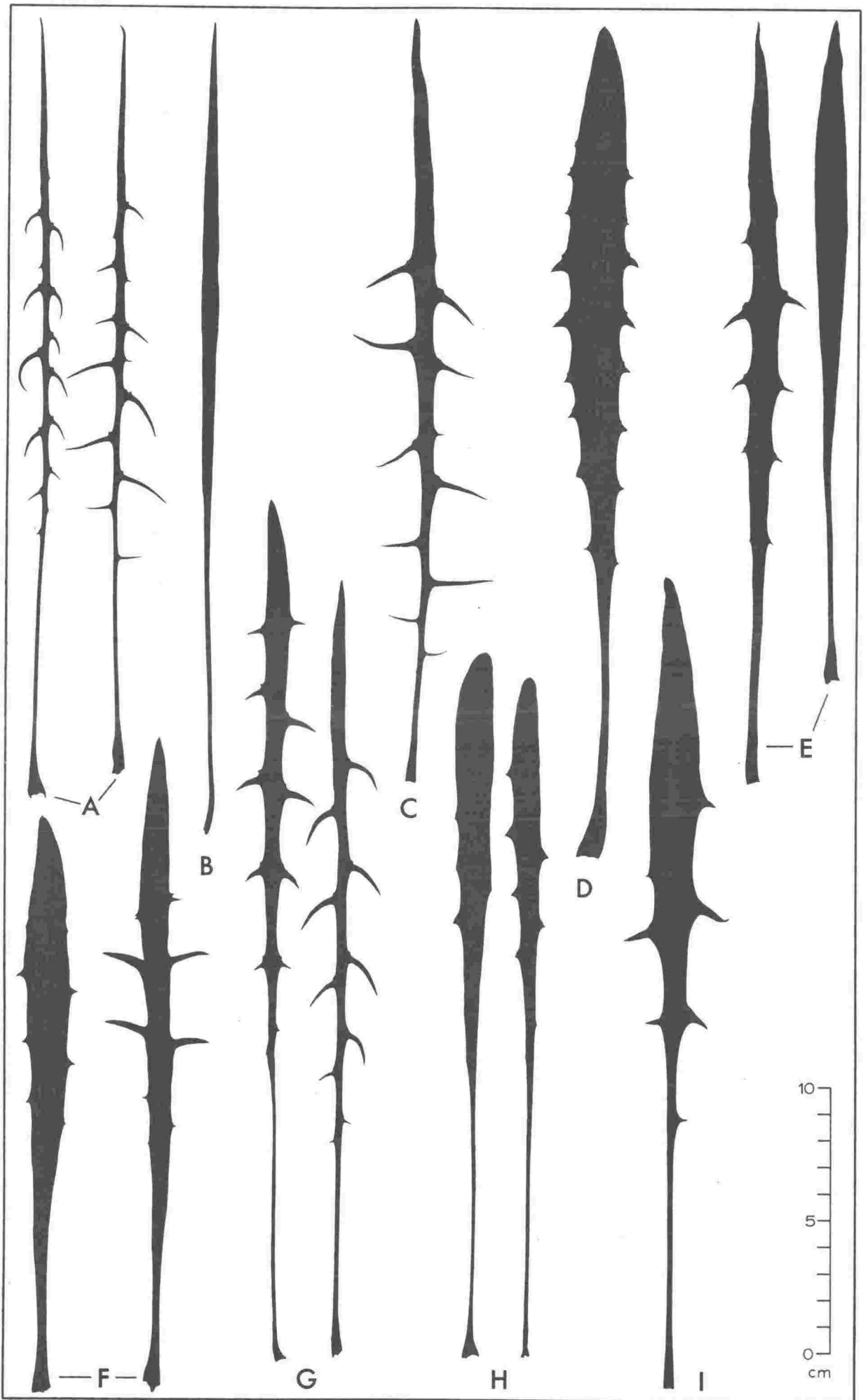
Fig. E Pop. LE (race 2) Leaves from plants cloned from the same genotype. The small leaf is from a plant grown outdoors.

Fig. F Pop. LD (race 2) Leaves from one plant.



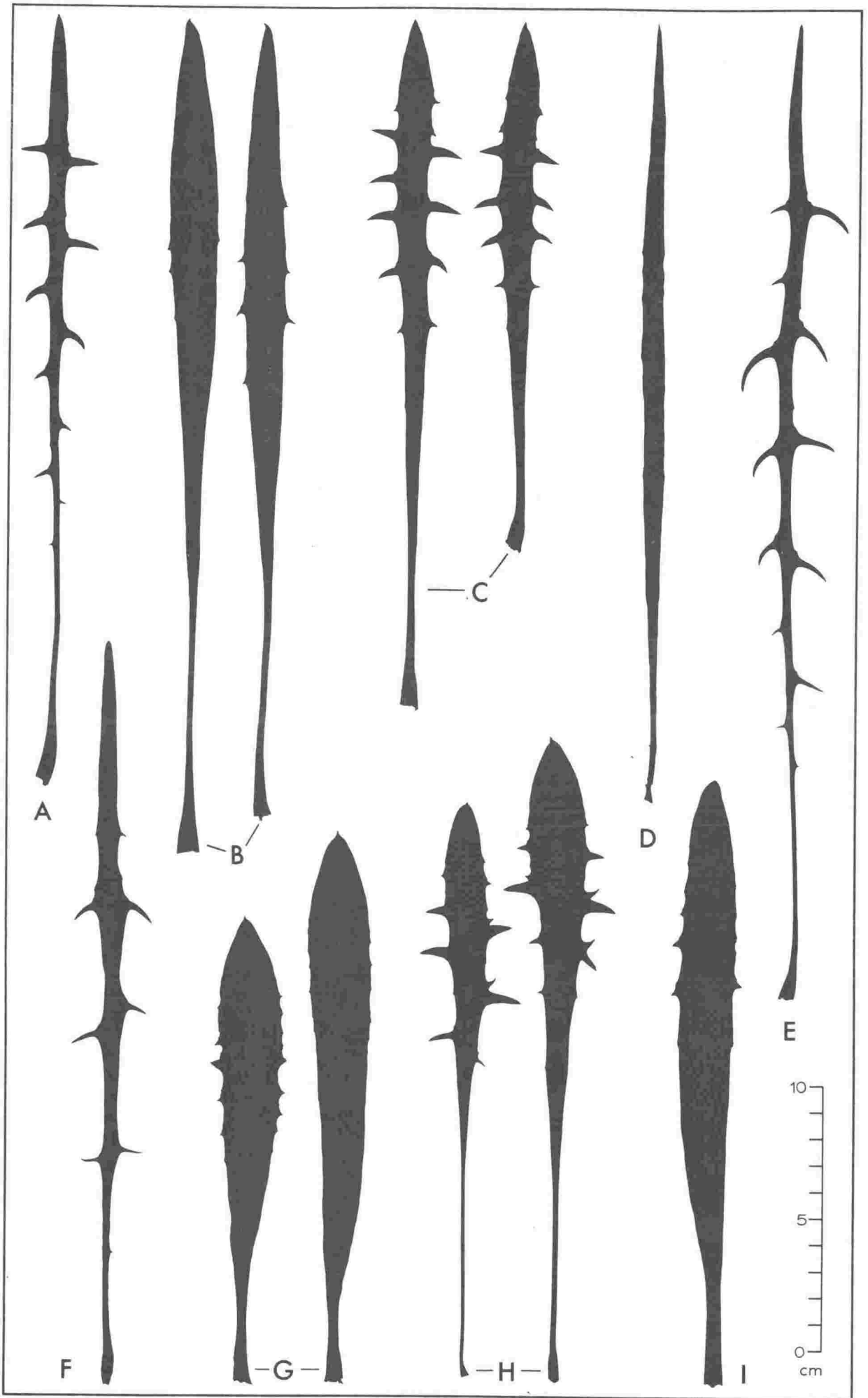
LEAF FORM V. *M. scapigera* and *M. lanceolata* - selected intraspecific and interspecific hybrids: silhouettes of leaves from glasshouse-cultivated plants picked in mid-summer (at near maximum length).

- Fig. A SC x SW (H177) *M. scapigera* intraspecific cross  
(pinnatifid x narrow-linear-leaved parents)
- Fig. B SC x LA (H162) *M. scapigera* x *M. lanceolata* race 1  
(pinnatifid x lanceolate-entire-leaved parents)
- Fig. C SK x SC (H16) *M. scapigera* intraspecific cross  
(broad-lanceolate x pinnatifid-leaved parents)
- Fig. D SK x SG (H180) *M. scapigera* intraspecific cross  
(broad-lanceolate x narrow-lanceolate-leaved parents)
- Fig. E SK x LA (H160) *M. scapigera* x *M. lanceolata* race 1  
(broad-lanceolate x lanceolate-leaved parents)
- Fig. F SK x LF (H194) *M. scapigera* x *M. lanceolata* race 2  
(broad-lanceolate x lanceolate-leaved parents)
- Fig. G SM x SC (H150) *M. scapigera* intraspecific cross  
(obovate-spathulate x pinnatifid-leaved parents)
- Fig. H SM x SJ (H154) *M. scapigera* intraspecific cross  
(obovate-spathulate x linear-leaved parents)
- Fig. I SM x SK (H147) *M. scapigera* intraspecific cross  
(obovate-spathulate x broad-lanceolate-parents)



LEAF FORM VI. *M. scapigera* and *M. lanceolata* - selected intraspecific and interspecific hybrids: silhouettes of leaves from glasshouse-cultivated plants picked in mid-summer (at near maximum length).

- Fig. A SM x SW (H179) *M. scapigera* intraspecific cross  
(obovate-spathulate x narrow-linear-leaved parents)
- Fig. B SM x LA (H170) *M. scapigera* x *M. lanceolata* race 1  
(obovate-spathulate x lanceolate-leaved parents)
- Fig. C SM x LF (H199) *M. scapigera* x *M. lanceolata* race 2  
(obovate-spathulate x lanceolate-leaved parents)
- Fig. D SO x LA (H163) *M. scapigera* x *M. lanceolata* race 1  
(linear x lanceolate-leaved parents)
- Fig. E SW x SK (H184) *M. scapigera* intraspecific cross  
(narrow-linear x broad-lanceolate-leaved parents)
- Fig. F LC x SA (H174) *M. lanceolata* race 1 x *M. scapigera*  
(lanceolate x linear-lanceolate-leaved parents)
- Fig. G LE x LB (H191) *M. lanceolata* race 2 x race 1  
(obovate-spathulate x lanceolate-leaved parents)
- Fig. H LE x SD (H208) *M. lanceolata* race 2 x *M. scapigera*  
(obovate-spathulate x lanc-obovate-leaved parents)
- Fig. I LE x SG (H209) *M. lanceolata* race 2 x *M. scapigera*  
(obovate-spathulate x lancolate-leaved parents)



LEAF SURFACES. *M. lanceolata* and *M. scapigera*:

adaxial surface (top) and abaxial surface (bottom) of fresh leaves  
from cultivated plants.

*M. lanceolata* race 2

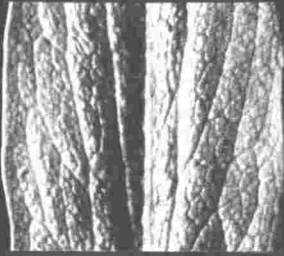
Fig. A	Pop. LD	)	
		)	Adaxial surface rugulose (veins sunken);
Fig. B	Pop. LE	)	
		)	abaxial surface with prominent lateral veins
Fig. C	Pop. LF	)	

*M. lanceolata* race 1

Fig. D	Pop. LB	)	
		)	Adaxial surface smooth to subrugulose;
Fig. E	Pop. LA	)	
		)	abaxial surface with ± prominent lateral
Fig. F	Pop. LC	)	veins

*M. scapigera*

Fig. G	Pop. SA	)	
		)	Adaxial surface ± smooth;
Fig. H	Pop. SK	)	
		)	abaxial surface with ± inconspicuous
Fig. I	Pop. SM	)	lateral veins



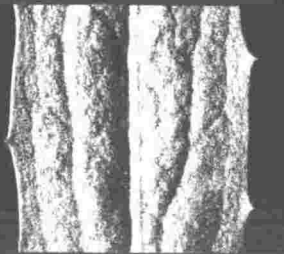
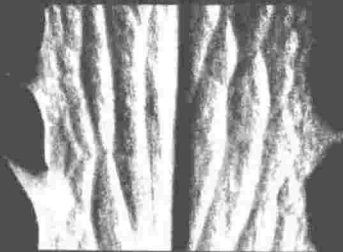
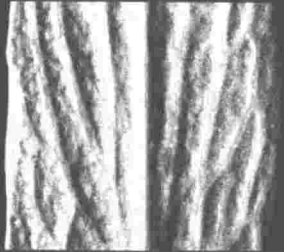
A



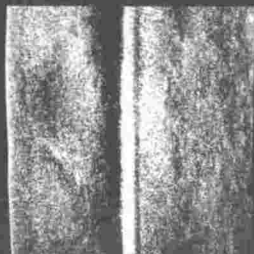
B



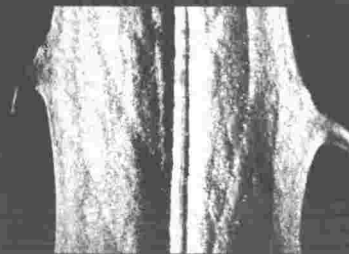
C



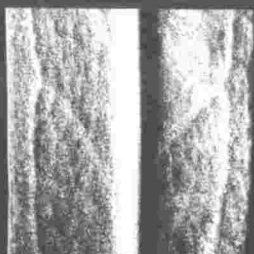
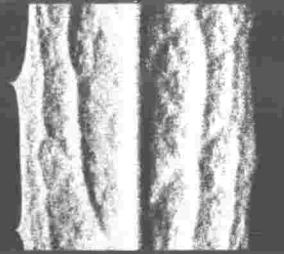
D



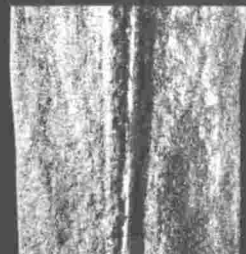
E



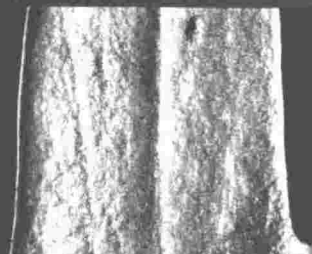
F



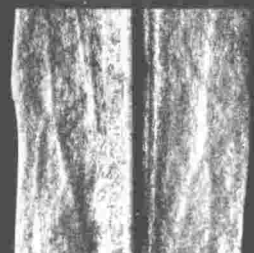
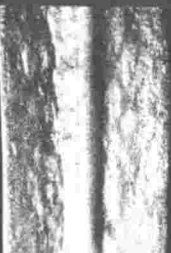
G



H



I



1 cm

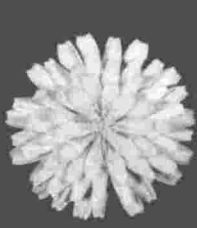
CAPITULA VIEWED FROM ABOVE. *M. scapigera* and *M. lanceolata*:  
examples of capitula from glasshouse-cultivated plants, with all  
(or nearly all) florets opened.  
All capitula figured are in the maximum diameter range of their  
respective populations, except L and Q which are of average  
diameter.

*M. scapigera*

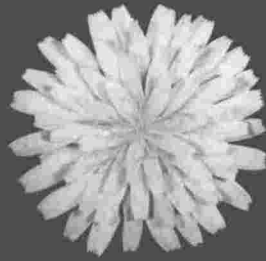
Fig. A	Pop.	SC
Fig. B	"	SA
Fig. C	"	SD
Fig. D	"	SF
Fig. E	"	SG
Fig. F	"	SH
Fig. G	"	SK
Fig. H	"	SM
Fig. I	"	SP
Fig. J	"	SO
Fig. K	"	SV
Fig. L	"	SW

*M. lanceolata*

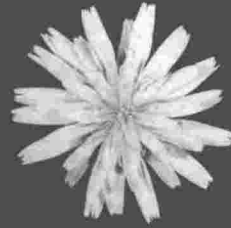
Fig. M	Pop.	LA	(race 1)	
Fig. N	"	LB	"	
Fig. O	"	LC	"	{ capitula from different plants }
Fig. P	"	LC	"	
Fig. Q	"	LD	(race 2)	
Fig. R	"	LE	"	
Fig. S	"	LF	"	



A



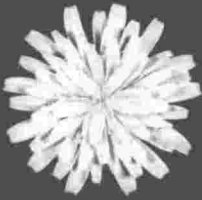
B



C



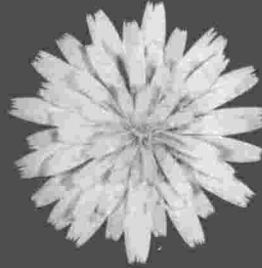
D



E



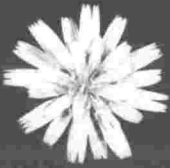
F



G



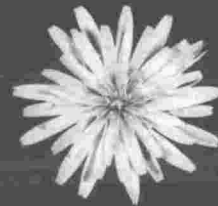
H



I



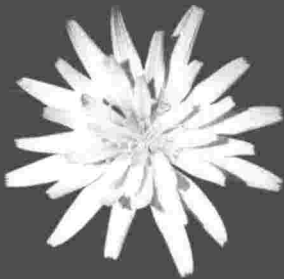
J



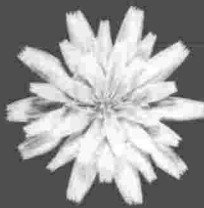
K



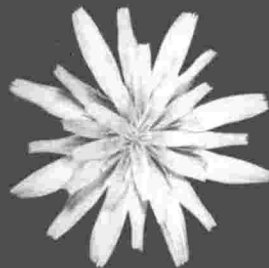
L



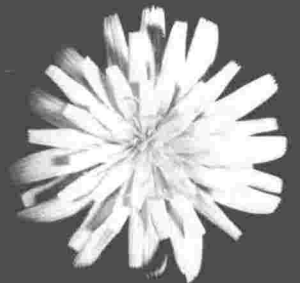
M



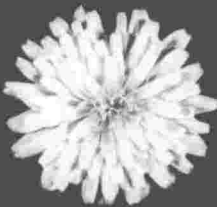
N



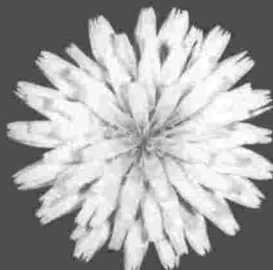
O



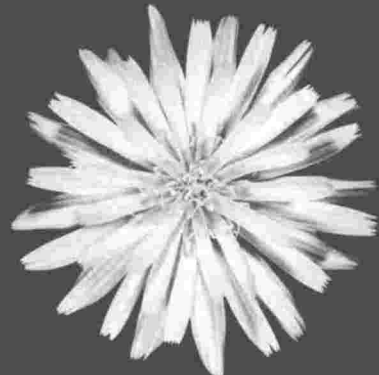
P



Q



R

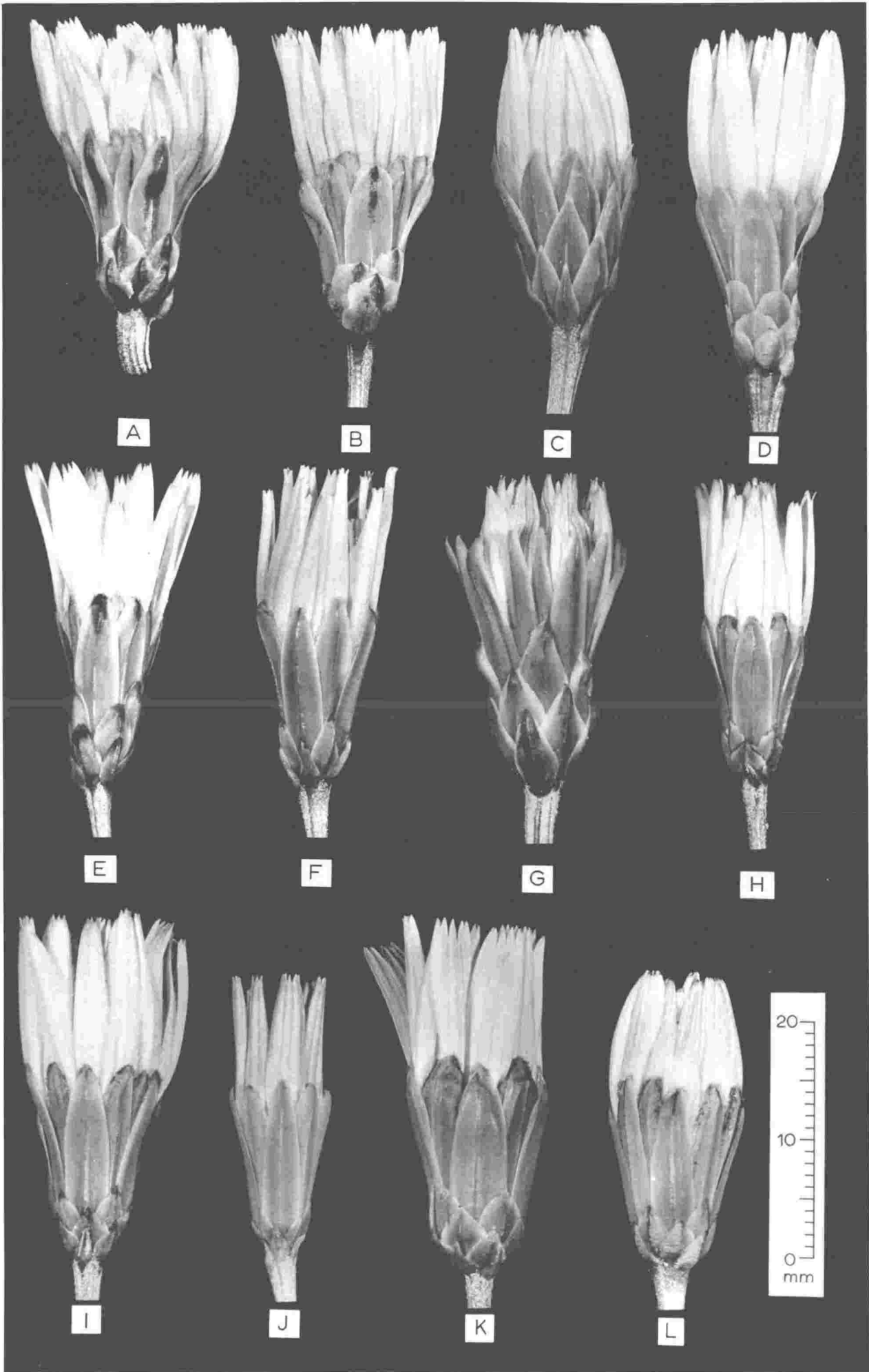


S



CAPITULA FORM I. *M. scapigera*: examples of capitula from glasshouse-cultivated populations, viewed from the side (with florets in nocturnal position). Capitula are not necessarily average size.

Fig. A	Pop.	SB	Maungaharuru Range
Fig. B	"	SC	Mt. Tongariro
Fig. C	"	SA	Cape Kidnappers
Fig. D	"	SD	Castlepoint
Fig. E	"	SE	Pahaoa River
Fig. F	"	SF	Cape Palliser
Fig. G	"	SG	Red Rocks
Fig. H	"	SH	Marfells Beach
Fig. I	"	SJ	N. of Ward Beach
Fig. J.	"	SN	Kaikoura Peninsula
Fig. K	"	SK	Isolation Creek
Fig. L	"	SM	Mt. Fyffe



CAPITULA FORM II. *M. scapigera*: examples of capitula from glasshouse-cultivated populations (figs. A - J, with florets in nocturnal position), and from wild plant herbarium specimens (figs. K and L).

Fig. A	Pop.	SP	Lake Sylvester
Fig. B	"	SQ	Between L. Cobb and Cobb Peak
Fig. C	"	SR	N. Arthur Range
Fig. D	"	SS	S. Arthur Range
Fig. E	"	ST	Owen Range
Fig. F	"	SO	Richmond Range
Fig. G	"	SU	Travers Range
Fig. H	"	SX	Hopkins Valley
Fig. I	"	SV	Ben Ohau Range
Fig. J	"	SW	Ben Ohau Range
Fig. K	-	-	Upper Craigieburn Valley, Moore s.n., CHR 189680
Fig. L	-	-	Hakataramea Pass, Ward-Hammond 68151, CANU

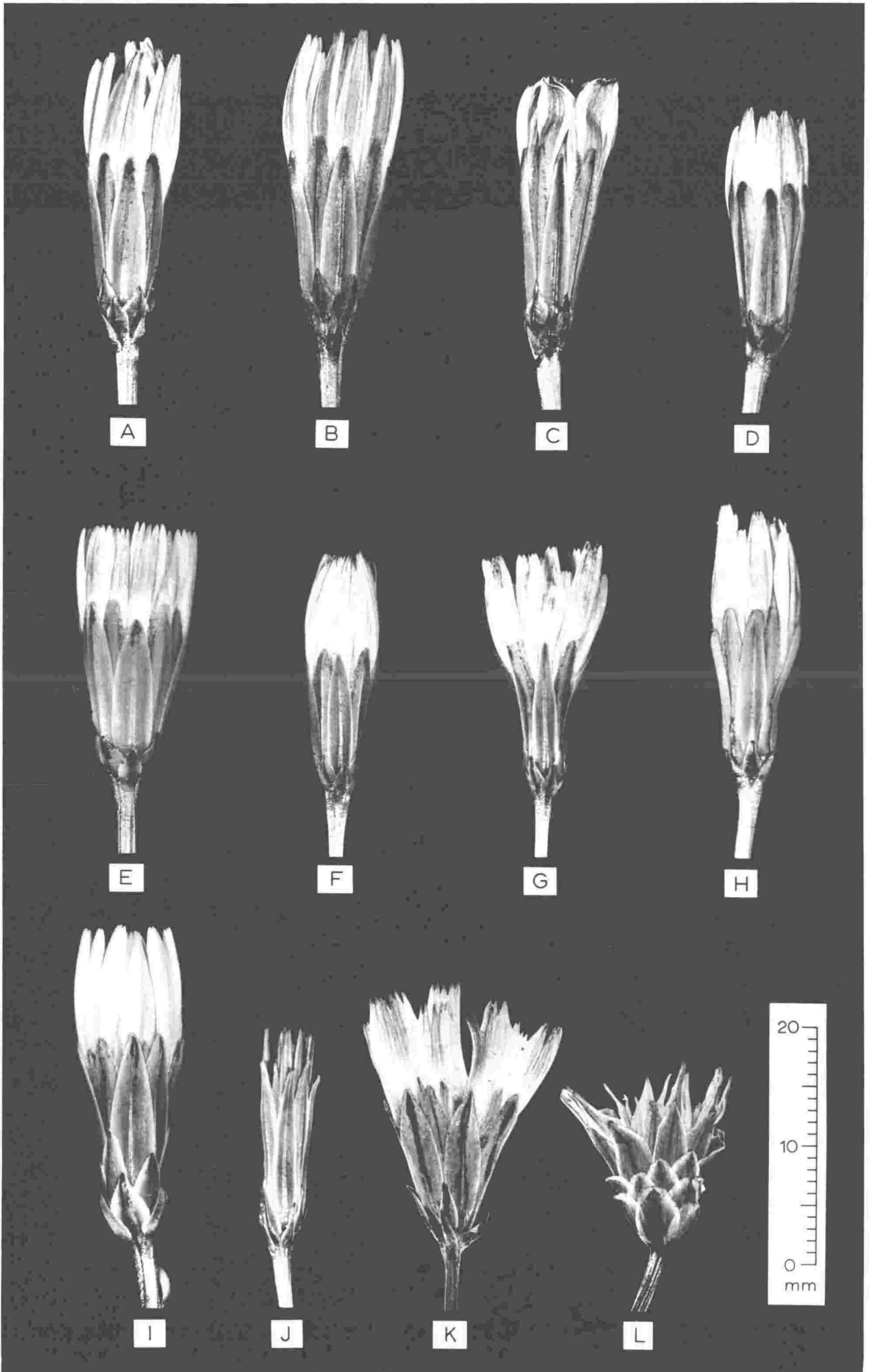
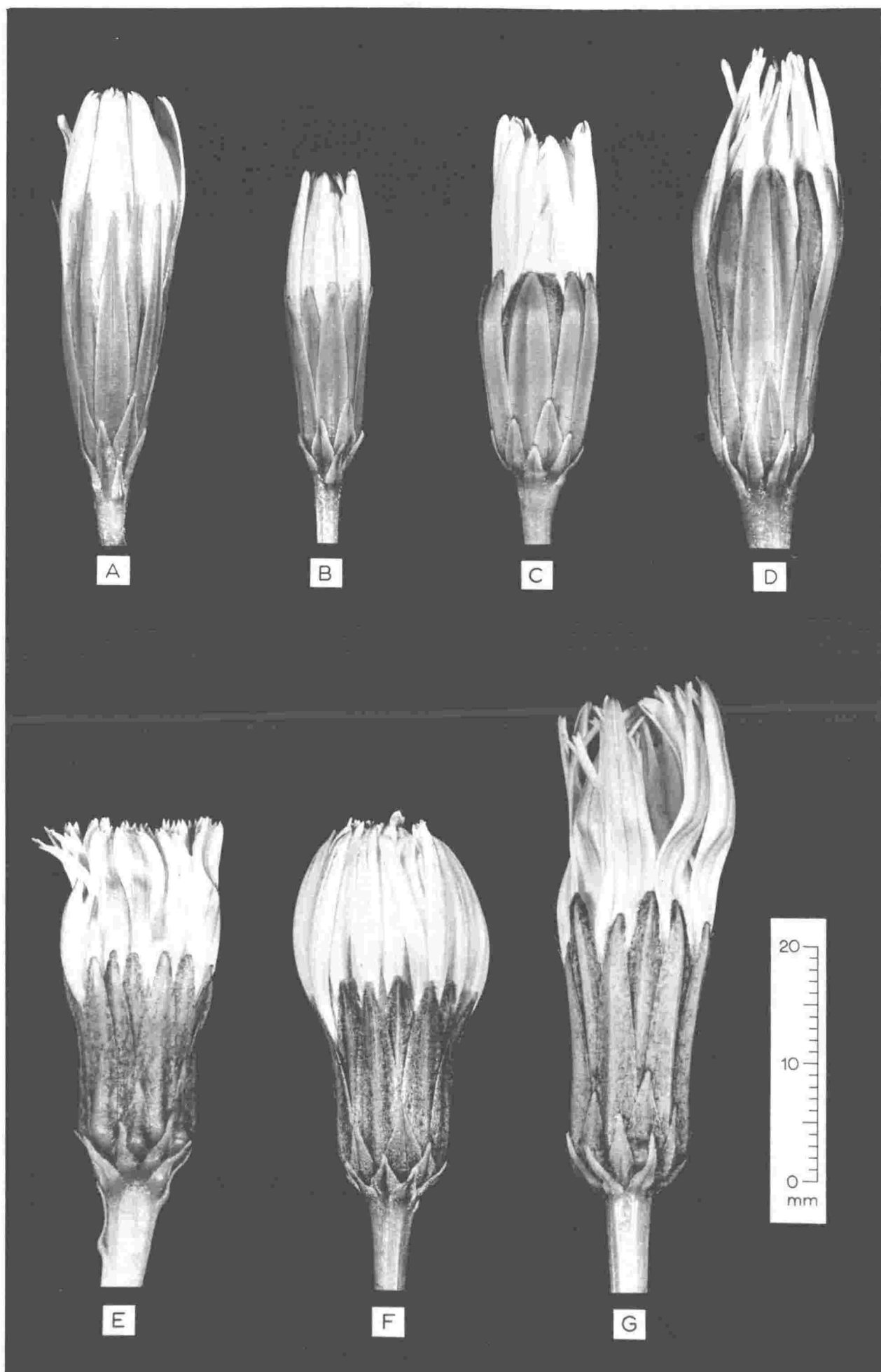


PLATE 28

CAPITULA FORM III. *M. lanceolata*: examples of capitula from glasshouse-cultivated populations, viewed from the side (with florets in nocturnal position). Capitula are not necessarily average size.

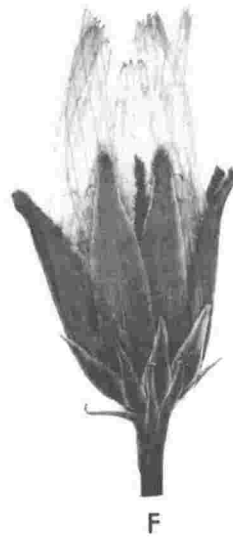
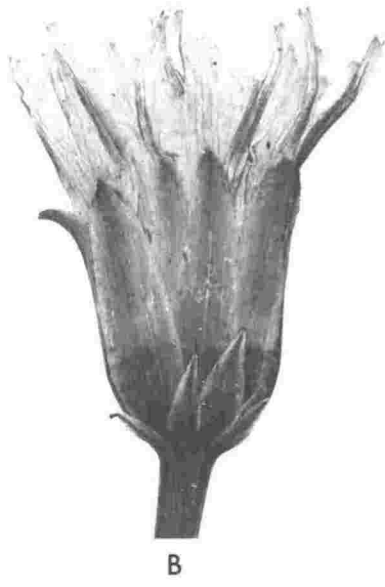
Fig. A	Pop.	LA	(race 1)	
Fig. B	"	LB	"	
Fig. C	"	LC	"	( extremes to show variation)
Fig. D	"	LC	"	( in involucre )
Fig. E	"	LD	(race 2)	
Fig. F	"	LE	"	
Fig. G	"	LF	"	



CAPITULA FORM IV. *M. lanceolata* race 1: examples of pressed capitula from wild plant herbarium specimens. (All at anthesis)



- (A) South Hills Station, Fraser Range, *Beard* 6293, 12.ix.1970, NSW
- (B) Corunna Hill, Corunna North, *Chinmook* 1904, 7.ix.1973, AD
- (C) Gammon Ranges (northern Flinders Range), *Eichler* 12742, 19.ix.1956, AD
- (D) Kangaroo Island, Pennington Bay nr Prospect Hill, *Eichler* 15460, 13.xi.1958, AD
- (E) Wattle Park in Burwood (Melbourne), *Muir* 532, 19.x.1958, MEL
- (F) Two miles SW of Highlands on the Yea road, *Muir* 3512, 27.x.1964, MEL
- (G) Strathbogie Ranges, in the Euroa district, 9 miles (14.5 km) from Strathbogie on the Merton road, *Muir* 1437, 13.x.1960, MEL
- (H) Black Mountain (A.C.T.), 600m, *McKee* 11603, 14.ix.1964, CANB
- (I) Monument Hill, Albury, *McBarron* 1942, 4.ix.-48, NSW
- (J) Lachlan District, Eremeran and other Stations, *Duff* 91, ---.1893, MEL



CAPITULA FORM V. *M. lanceolata* races 1-3: examples of pressed capitula from wild plant herbarium specimens. (Head stages: C, pre-anthesis; D & K, fruiting; remainder, flowering to early fruiting).



Race 1

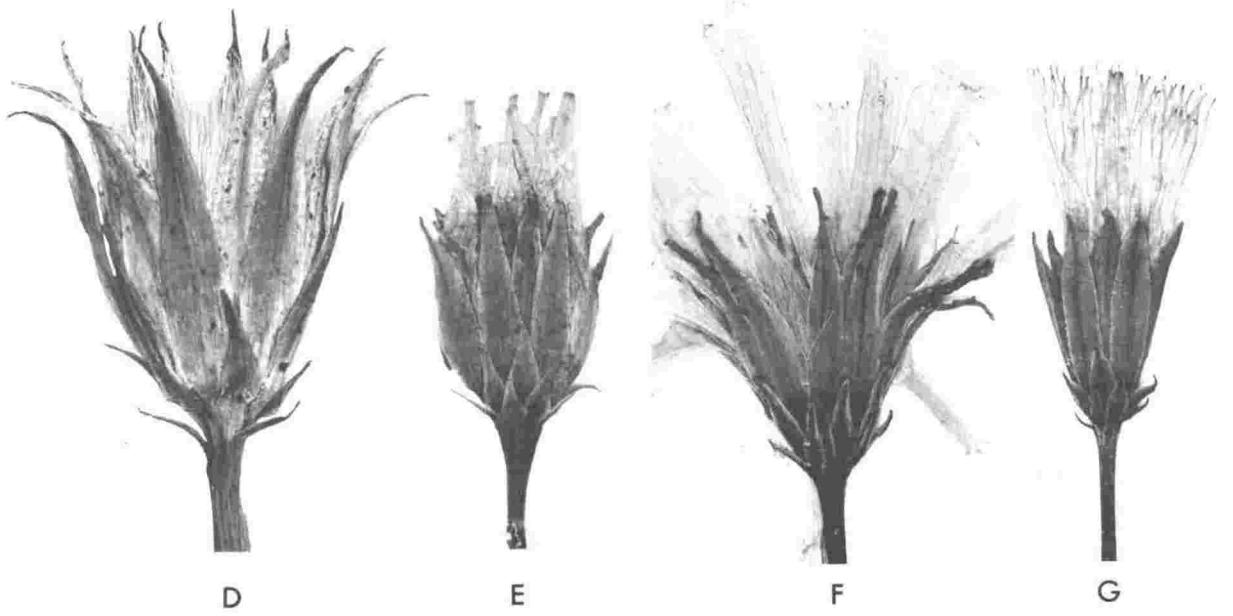
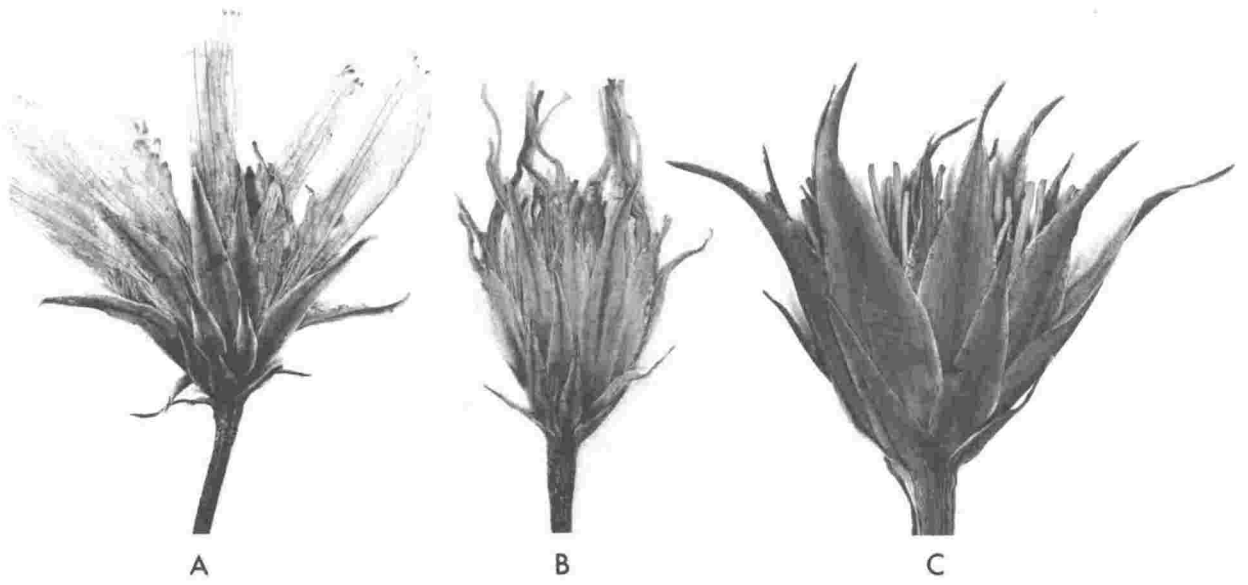
- (A) Tia falls, *Forsyth & Cheel s.n.*, -.x.1900, NSW 125037
- (B) Chiswick, 10 miles S of Armidale, *Gray 1757*, 23.x.1952, CANB
- (C) Pimpara creek, between Maude & Oxley, *Jacobs 1043*, 8.ix.1973, NSW
- (D) Redcliff Development Area, 25 km S of Port Augusta, *Chinnock 1718*, 5.ix.1974, AD
- (E) Van Diemen's Land (Tasmania), *Mossman s.n.*, undated, K
- (F) Mt. Knocklofty, 1 000 ft (305 m), *Olsen s.n.*, 30.xi.1936, HO
- (G) Macquarie Pl. (Plains), *M.B. (or W.B.?) 506*, 19.xi.1842, NSW

Race 3

- (H) Near Mt. Elephant, *Mueller(?) s.n.*, -.iii.1874, MEL 64790
- (I) Hampshire Hills, *Milligan 1026*, 4.iv.1841, K
- (J) Projection Bluff, 3 900 ft (1 189 m), *Burns 299*, 20.i.1960, K

Race 2

- (K) Tasmania, *Hooker s.n.*, 1839-1843, MEL 64821



CAPITULA FORM VI. *M. lanceolata* race 2: examples of pressed capitula from wild plant herbarium specimens (Head stages: F, late flowering; remainder at anthesis).



- (A) W side of Murray's Gap, Bimberi Range, A.C.T. border, 1 500 m,  
*Rodd 995*, 29.iii.1970, NSW
- (B) Mt. Pinnibar, *Park s.n.*, -.i.1972, WELTU 12298
- (C) Ginini Flats (A.C.T.), alpine woodland, *Solling 146*, 24.iii.1972,  
NSW
- (D) Snowy Mountains nr Bett's Creek, S of the Paralyser (c. 9 km ENE  
of Mt. Kosciusko), c. 1 750 m, *Eichler 13677*, 7.ii.1957, AD
- (E) Mt. Kosciusko, *R.H. s.n.*, -.ii.1893, NSW 128919
- (F) Mt. Hotham nr Diamantina Hut, c. 5 600 ft (1 707 m), *Craven*  
*1549*, 2.ii.1969, MEL
- (G) Summit of Mt. Bimberi (A.C.T.), c. 6 250 ft (1 905 m), *Darbyshire*  
*121*, 17.i.1961, CANB
- (H) Summit area of Mt. Gingera, Cotter River District, c. 6 000 ft  
(1 829 m), *Hoogland 8472*, 28.ii.1962, NSW

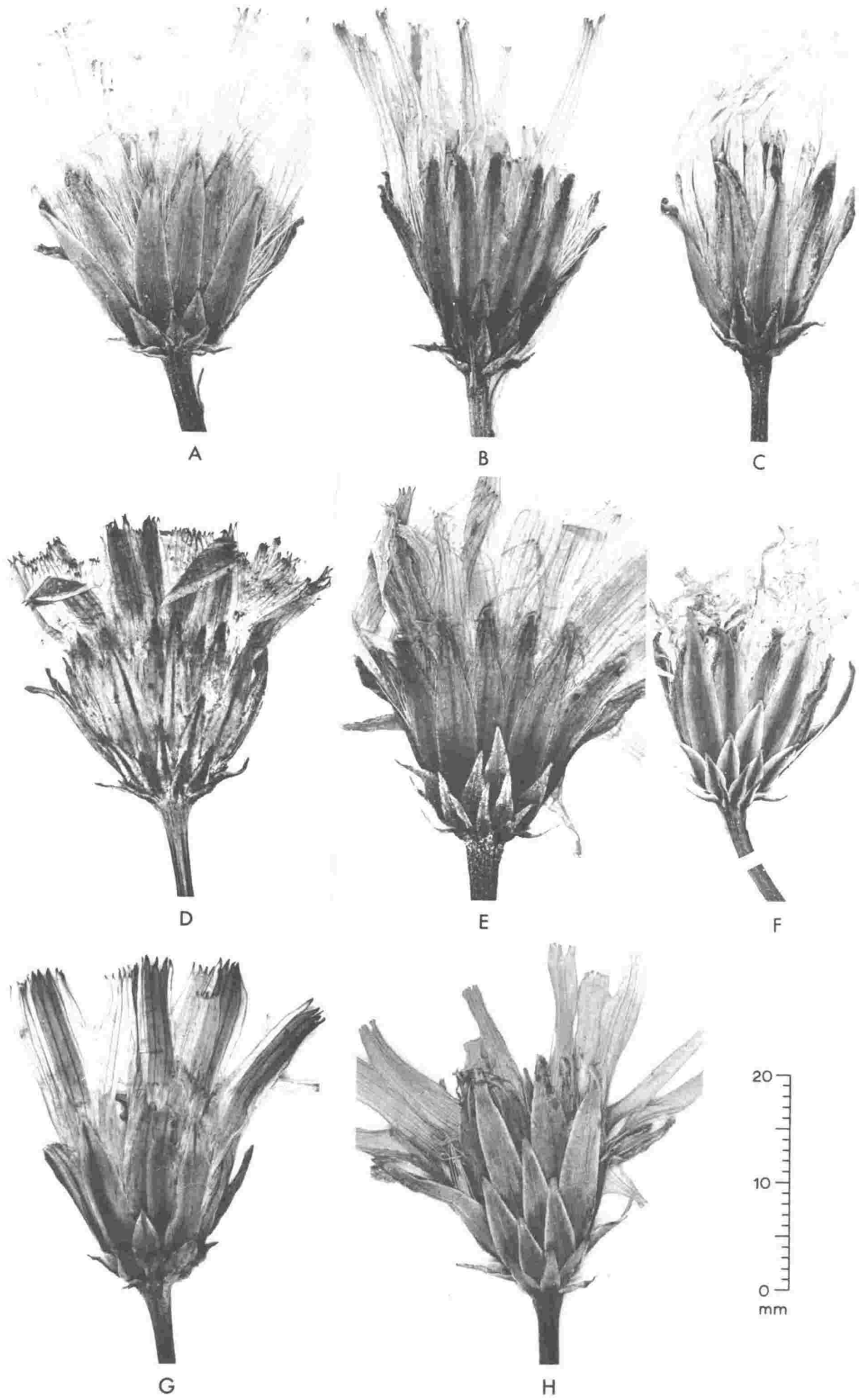
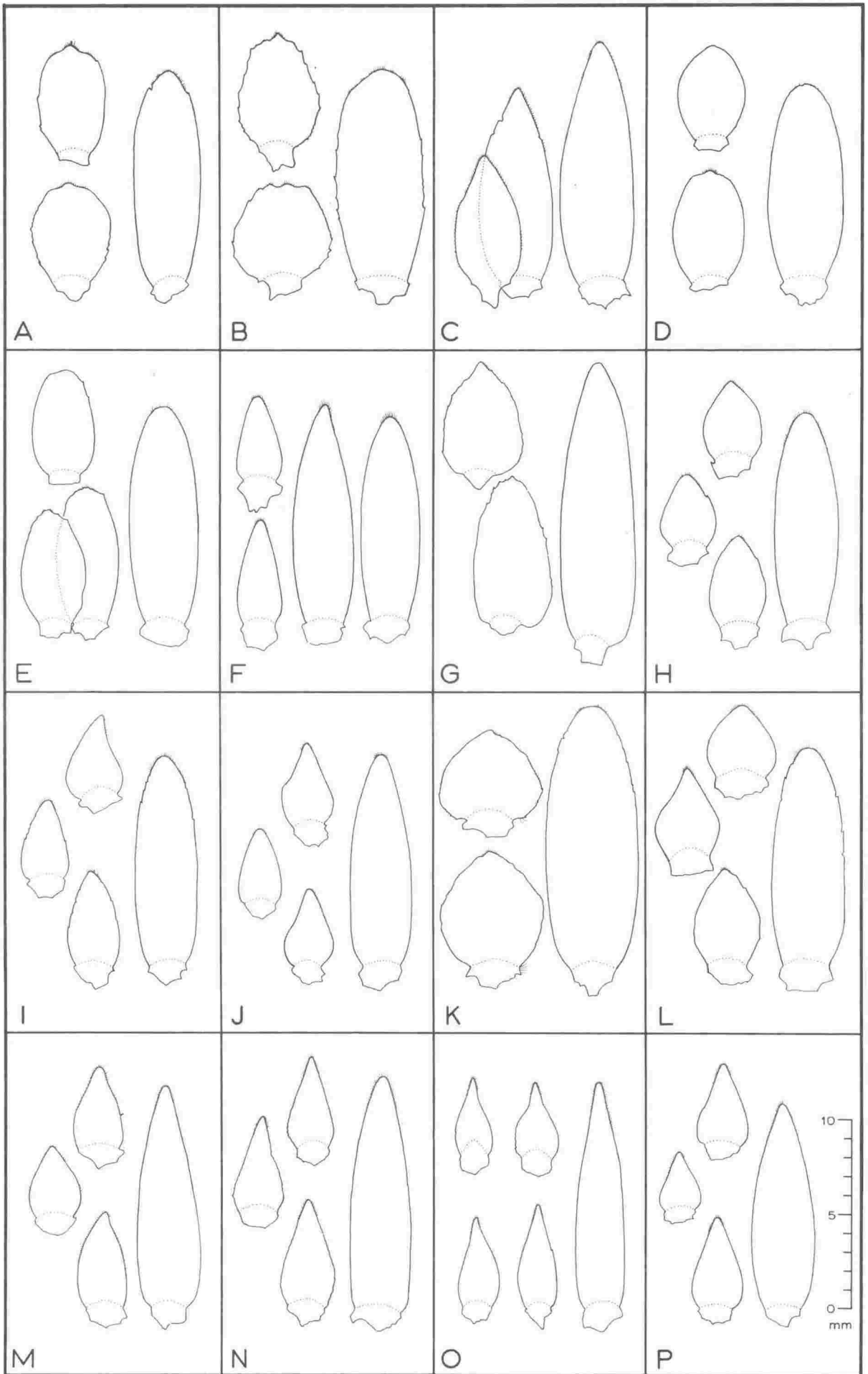


PLATE 32

INVOLUCRE PART FORM I. *M. scapigera*: outlines of isolated, flattened larger bracteoles (to left), and an outer phyllary (two in Fig. F) from glasshouse-cultivated populations.

Fig. A	Pop.	SB	Maungaharuru Range
Fig. B	"	SC	Mt. Tongariro
Fig. C	"	SA	Cape Kidnappers
Fig. D	"	SD	Castlepoint
Fig. E	"	SE	Pahaoa River
Fig. F	"	SF	Cape Palliser
Fig. G	"	SG	Red Rocks
Fig. H	"	SH	Marfells Beach
Fig. I	"	SJ	N. of Ward Beach
Fig. J	"	SN	Kaikoura Peninsula
Fig. K	"	SK	Isolation Creek
Fig. L	"	SM	Mt. Fyffe
Fig. M	"	SP	Lake Sylvester
Fig. N	"	SQ	Between L. Cobb and Cobb Peak
Fig. O	"	SR	N. Arthur Range
Fig. P	"	SS	S. Arthur Range



INVOLUCRE PART FORM II. *M. scapigera* and *M. lanceolata*:

outlines of isolated, flattened larger bracteoles (to left) and  
an outer phyllary from glasshouse-cultivated populations.

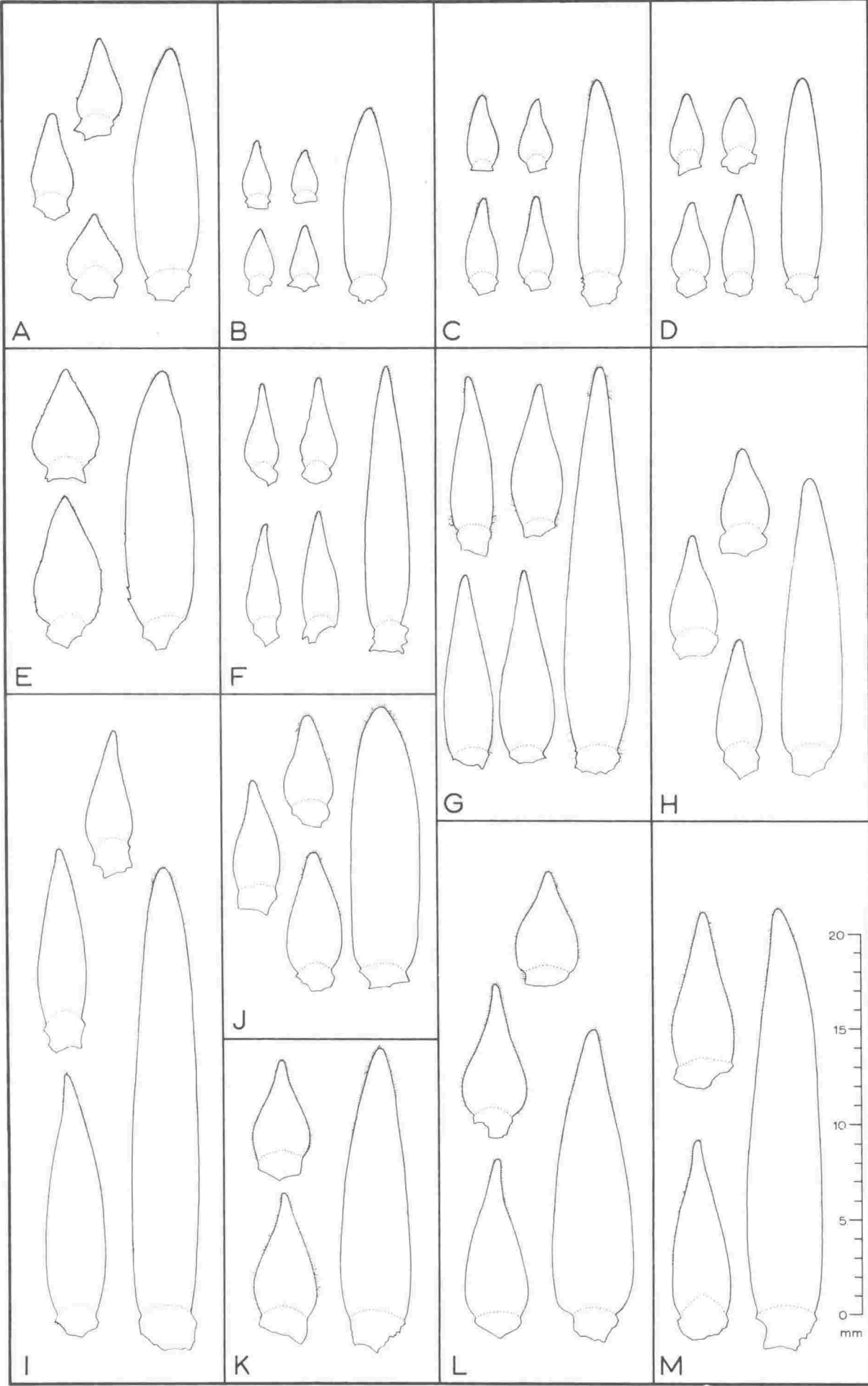
*M. scapigera*

Fig. A	Pop.	ST	Owen Range
Fig. B	"	SO	Richmond Range
Fig. C	"	SU	Travers Range
Fig. D	"	SX	Hopkins Valley
Fig. E	"	SV	Ben Ohau Range
Fig. F	"	SW	" " "

*M. lanceolata*

Fig. G	Pop.	LA	(race 1)	South Australia
Fig. H	"	LB	"	New South Wales
Fig. I*	"	LC	"	Victoria
Fig. J*	"	LC	"	"
Fig. K	"	LD	(race 2)	"
Fig. L	"	LE	"	"
Fig. M	"	LF	"	"

\* Long (I) and short (J) involucre parts from the two capitula  
forms illustrated in Plate 28.



*Microseris* subgenus *Monermos*: trichome types and pappus awn silhouettes.

Fig. 1 Trichome types:

- (A) furfuraceous trichome from scape apex (pop. SJ) - similar (but shorter) trichomes occur on leaf surfaces;
- (B) furfuraceous trichome from leaf margin (pop. LA);
- (C) bracteole trichomes (pop. SP) - C1 (villous) and C2 (villous-furfuraceous intermediate) from apex, C3 (short-tomentose) and C4 (furfuraceous) from lower margin;
- (D) strigulose trichomes from achene (pop. LC) - as in Plate 37 E;
- (E) villous trichome from achene (pop. SP).

The surface of the terminal cells of A, B, C4 and the single-celled trichomes of D are minutely papillose.

Trichomes not illustrated: scaberulous trichome from achene (unicellular?);

villous trichomes from corolla tube, leaf and scape bases, and long-tomentose trichomes from involucre (all multicellular and uniseriate).

Fig. 2 Silhouettes of awns (for clarity only the laterally inserted bristles have been drawn):

- (A) *M. scapigera* (pop. SK);
- (B) *M. scapigera* (pop. SW);
- (C) *M. lanceolata* race 2, A.C.T., W side of Murray's Gap, Rodd 995, NSW;
- (D) *M. lanceolata* race 1 (pop. LA);
- (E) *M. lanceolata* race 1, West Australia, Southern Hills in Fraser Range, Gardner 2851, WA;
- (F) *M. lanceolata* race 3 Tasmania, Archer s.n., NSW 128934;
- (G) *M. lanceolata* race 3, Victoria, nr Lake Colac and Lake Calvert, Mueller s.n., MEL 64785.

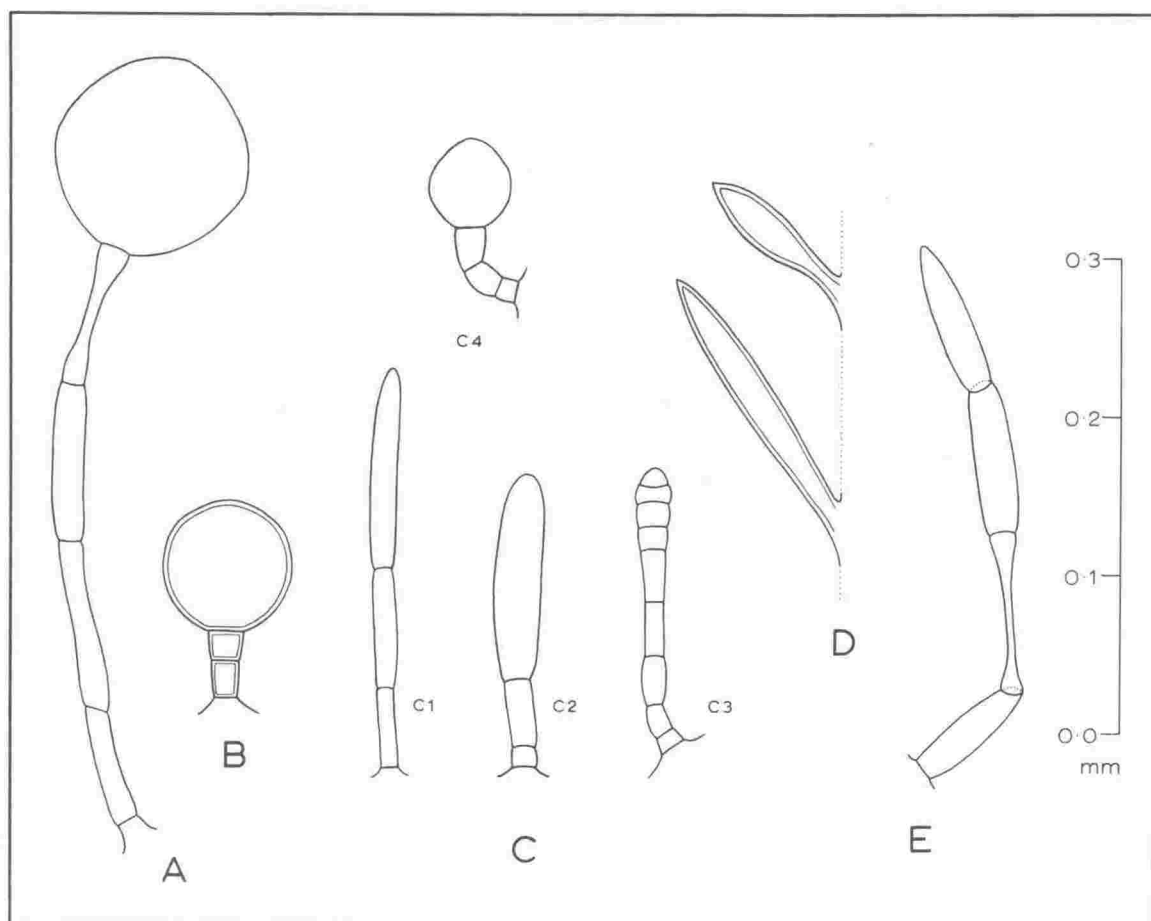


Fig. 1

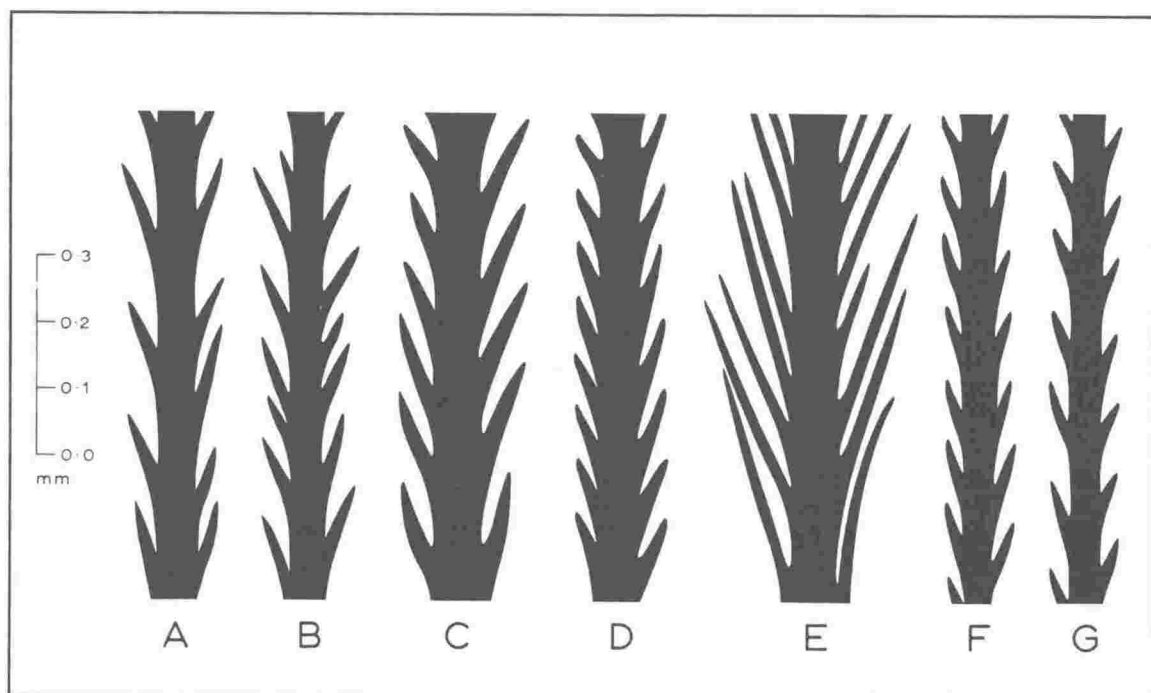


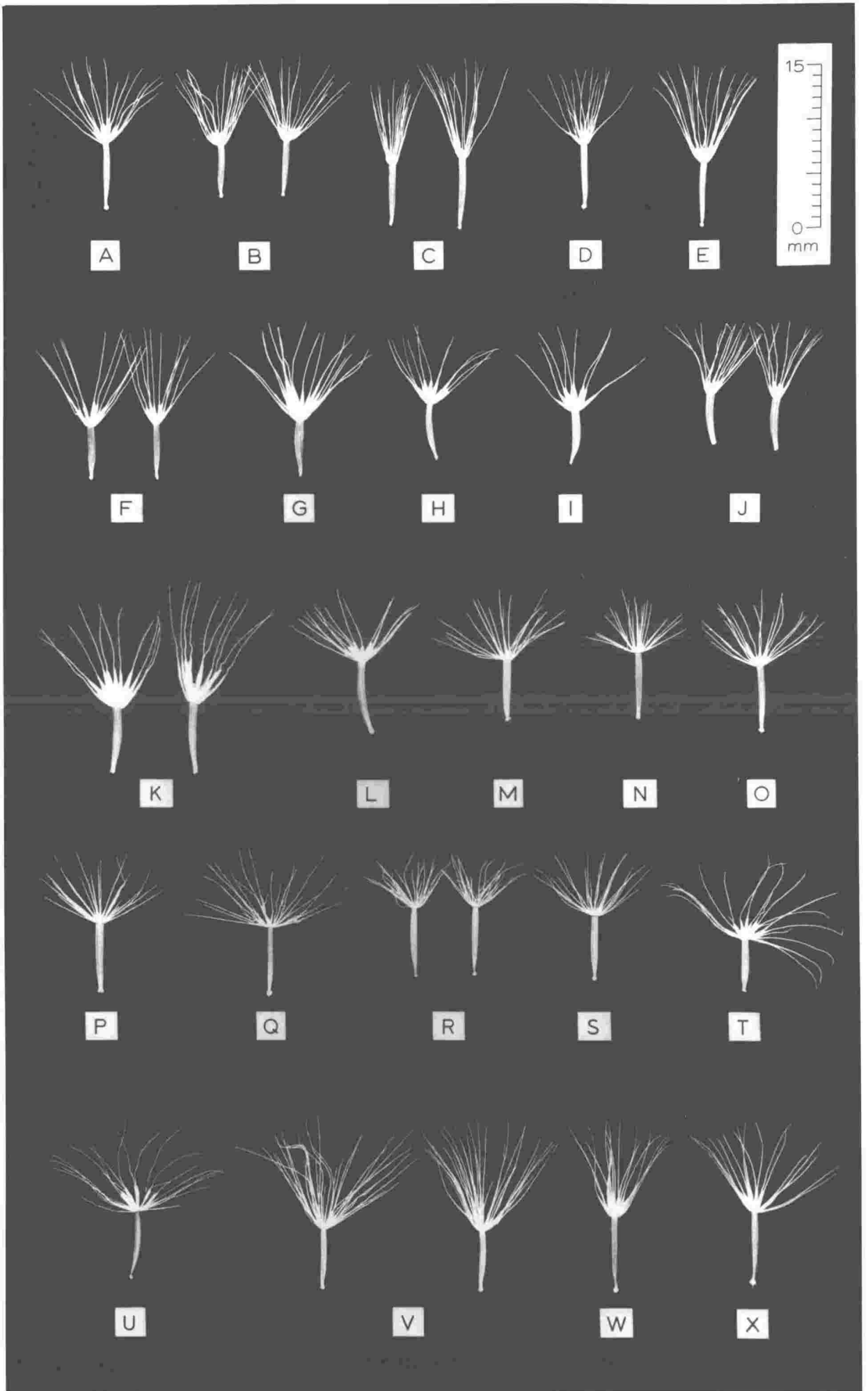
Fig. 2

FORM OF ACHENES AND PAPPUS I. *M. scapigera* - Fig. U from wild plant herbarium specimen, remainder from cultivated plants.

(Figs. B, C, F, J, K, R and V with two fruits)

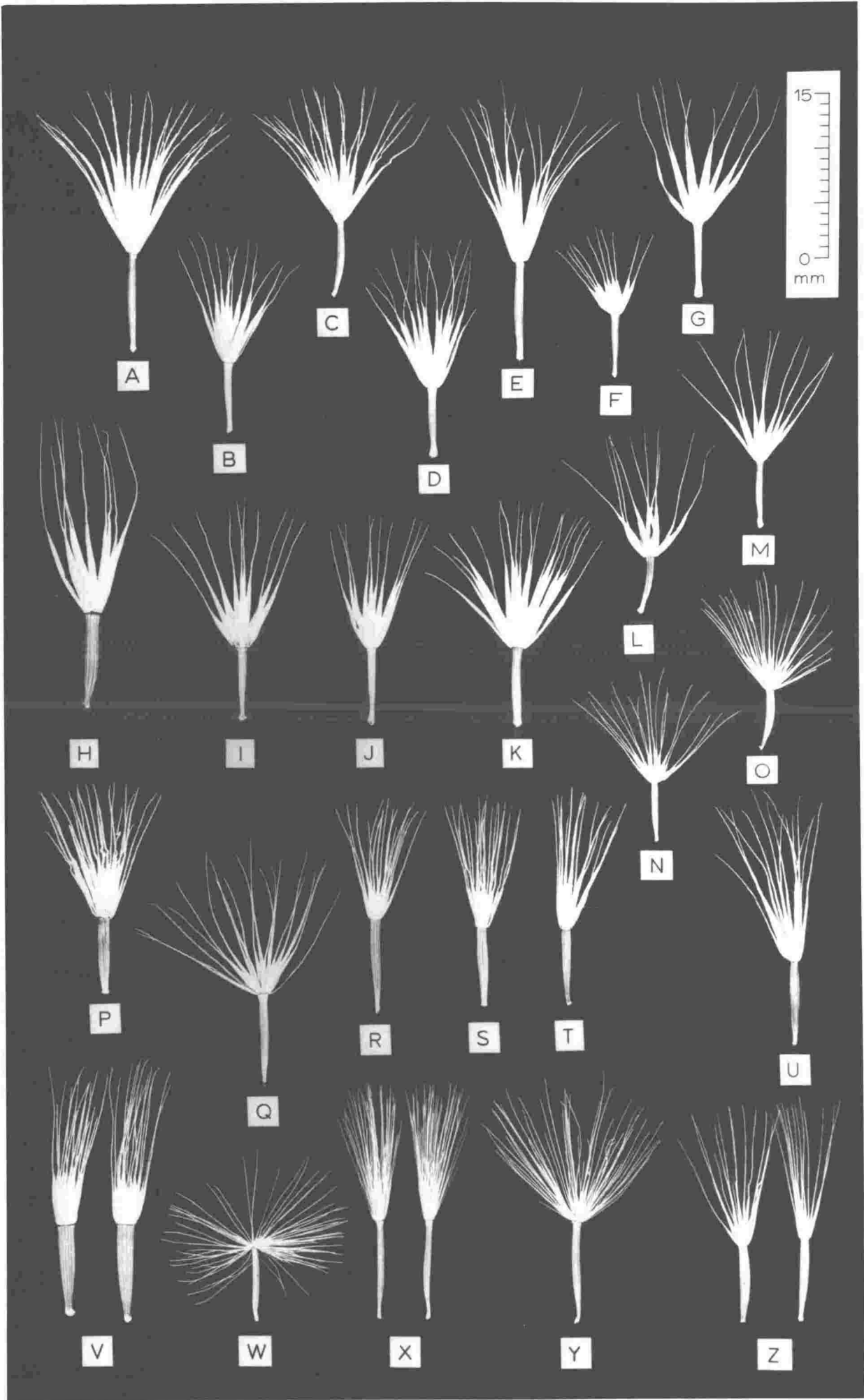
Fig. A	Pop.	SB	Maungaharuru Range
Fig. B	"	SC	Mt. Tongariro
Fig. C	"	SA	Cape Kidnappers
Fig. D	"	SD	Castlepoint
Fig. E	"	SE	Pahaoa River
Fig. F	"	SF	Cape Palliser
Fig. G	"	SG	Red Rocks
Fig. H	"	SH	Marfells Beach
Fig. I	"	SJ	N of Ward Beach
Fig. J	"	SN	Kaikoura Peninsula
Fig. K	"	SK	Isolation Creek
Fig. L	"	SM	Mt. Fyffe
Fig. M	"	SP	Lake Sylvester
Fig. N	"	SQ	Between L. Cobb and Cobb Peak
Fig. O	"	SR	N. Arthur Range
Fig. P	"	SS	S. Arthur Range
Fig. Q	"	ST	Owen Range
Fig. R	"	SO	Richmond Range
Fig. S	"	SU	Travers Range
Fig. T	"	SX	Hopkins Valley
Fig. U	-	-	Hakataramea Pass, Ward-Hammond 68151, CANU
Fig. V	Pop.	SW	Ben Ohau Range
Fig. W*	"	SV	" " "
Fig. X*	"	SV	" " "

\* Fruits from narrow-obovate-leaved (W) and pinnatifid-leaved (X) plants (leaves illustrated in Plate 20 Fig. M).



FORM OF ACHENES AND PAPPUS II. *M. lanceolata* - Figs. H, M and Q from cultivated plants, remainder from wild plant herbarium specimens. (Figs. V, X and Z with two fruits).

- |        |                          |   |
|--------|--------------------------|---|
| Fig. A | Race 1                   | 79 miles E of Norseman, <i>Demaree</i> 4626, WA                             |
| Fig. B | "                        | Jerilderie, <i>Dwyer</i> 1194, NSW  |
| Fig. C | "                        | Scotts Brook, <i>Maxwell?</i> s.n., MEL 64833                               |
| Fig. D | "                        | Eulomogo nr Dubbo, <i>Abrahams</i> 556 NSW                                  |
| Fig. E | "                        | N Flinders Range, <i>Lothian</i> 957, AD                                    |
| Fig. F | "                        | Kangaroo Island, <i>Eichler</i> 15460, AD                                   |
| Fig. G | "                        | Belair Nat. Park, (pop. LA)   |
| Fig. H | "                        | Mt. Wheeler, (pop. LC)  |
| Fig. I | "                        | Two miles SE of Stawell, <i>Muir</i> 2679, MEL                              |
| Fig. J | "                        | Five miles SW of Benalla, <i>Muir</i> 3605, MEL                             |
| Fig. K | "                        | Trangie, <i>Morris</i> 1210, NSW  |
| Fig. L | "                        | Tatura, <i>Gauba</i> s.n., NE 022489  |
| Fig. M | "                        | Smokers Gap (pop. LB)   |
| Fig. N | Race 2                   | Gudgenby, A.C.T., <i>Cambage</i> 3405, NSW                                  |
| Fig. O | "                        | Barbers Creek, <i>Rumsey</i> s.n., NSW 128908                               |
| Fig. P | "                        | Dainers Gap, Mt Kosciusko Nat. Park, <i>Ashby</i> 1764, AD                  |
| Fig. Q | "                        | Mt. Cope (pop. LE)  |
| Fig. R | "                        | Mt. Hotham, <i>Park</i> s.n., WELTU 12298                                   |
| Fig. S | "                        | Mt. Hotham, <i>Craven</i> 1549, CANB  |
| Fig. T | "                        | Mt. Gingera, <i>Hoogland</i> 8472, CANB                                     |
| Fig. U | "                        | Below Gungahran, Kosciusko region, <i>Phillips</i> s.n.,<br>AD 97011119     |
| Fig. V | "                        | W side of Murray's Gap, A.C.T., <i>Rodd</i> 995, NSW                        |
| Fig. W | Race 3                   | Nr L. Colac and L. Calvert, <i>Mueller</i> s.n., MEL 64785                  |
| Fig. X | "                        | Tasmania, <i>Archer</i> s.n., HO  |
| Fig. Y | "                        | Tasmania, <i>Archer</i> s.n., NSW 128934                                    |
| Fig. Z | Race uncertain - 1 or 2? | Tasmania, <i>Archer</i> s.n., HO - from<br>incomplete plant mixed with (X). |



ACHENE AND PAPPUS MEMBER DETAIL

Figs. A - D from cultivated plants;

Figs. E - I from wild plant herbarium specimens

*Microseris scapigera*

Fig. A Pop. SB Maungaharuru Range

Fig. B Pop. SK Isolation Creek. Achene is scaberulous on some ribs

Fig. C Pop. SM Mt. Fyffe. Achene is scaberulous on some ribs

Fig. D Pop. SW Ben Ohau Range

*Microseris lanceolata*

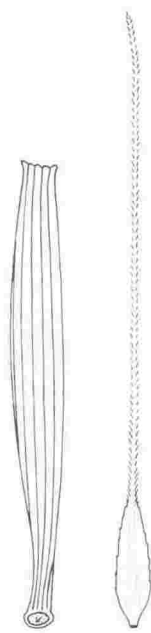
Fig. E Race 2 New South Wales (A.C.T.), W side of Murray's Gap, Rodd 995, NSW. Achene is strigulose-pubescent.

Fig. F Race 1 West Australia, Scotts Brook, Maxwell? s.n., MEL 64833

Fig. G Race 1 South Australia, Redcliff development area, Chinnock 1718, AD

Fig. H Race 1 New South Wales, Trangie, Morris 1210, NSW

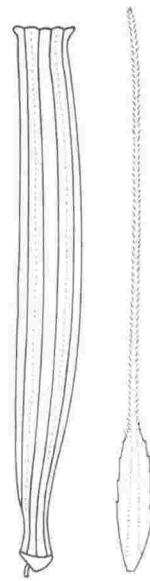
Fig. I Race 3 Victoria, nr L. Colac and L. Calvert, Mueller s.n., MEL 64785



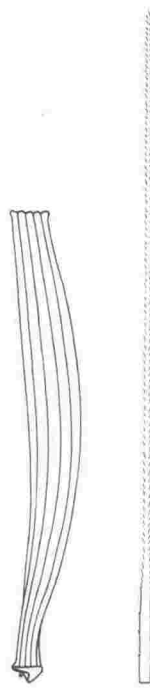
A



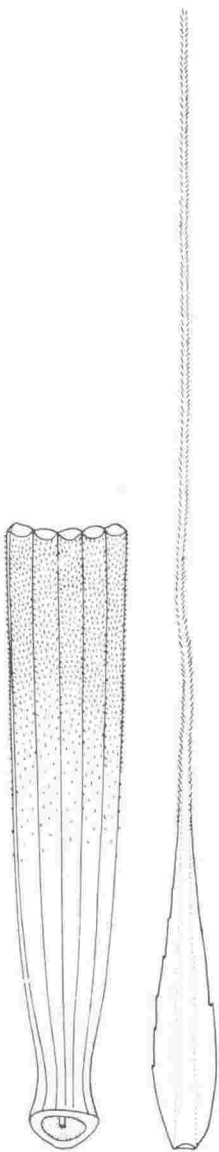
B



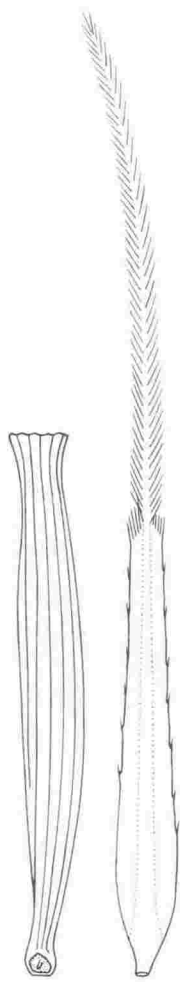
C



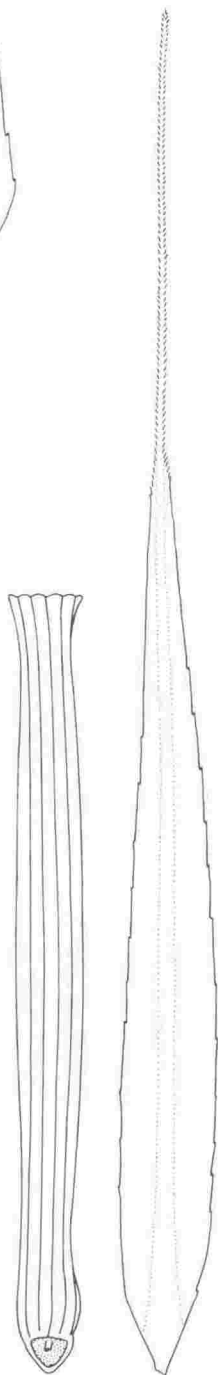
D



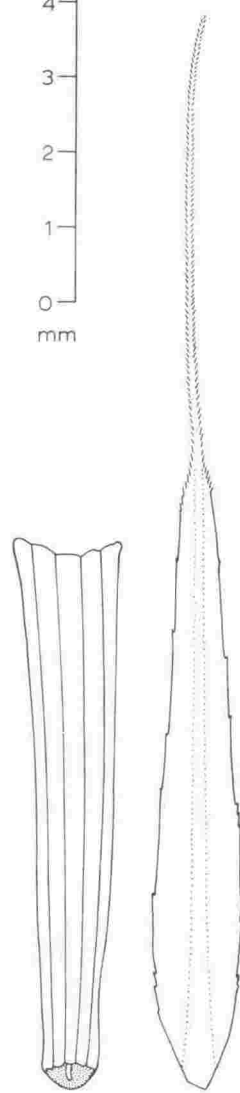
E



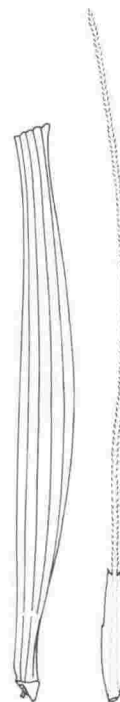
F



G

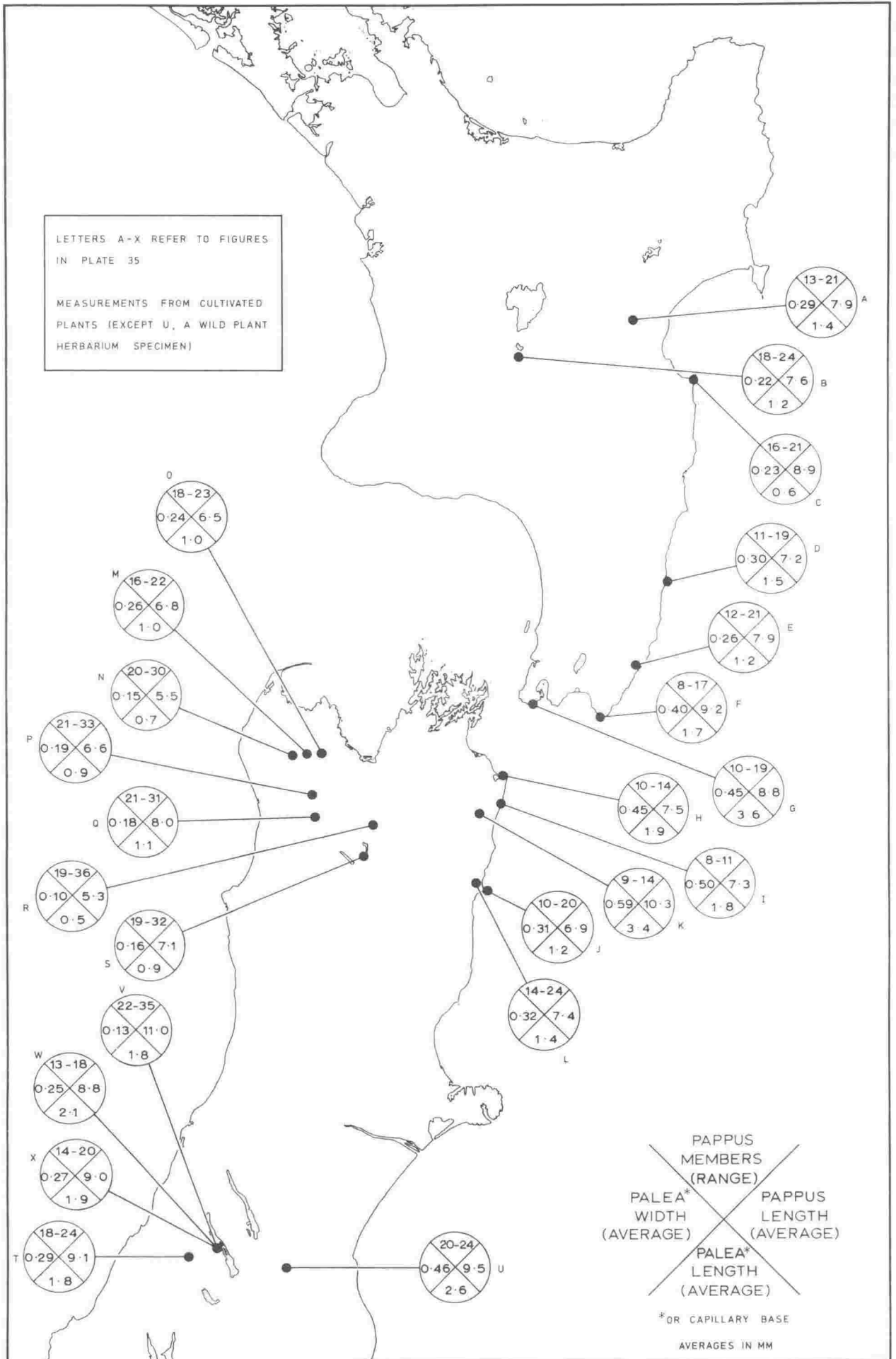


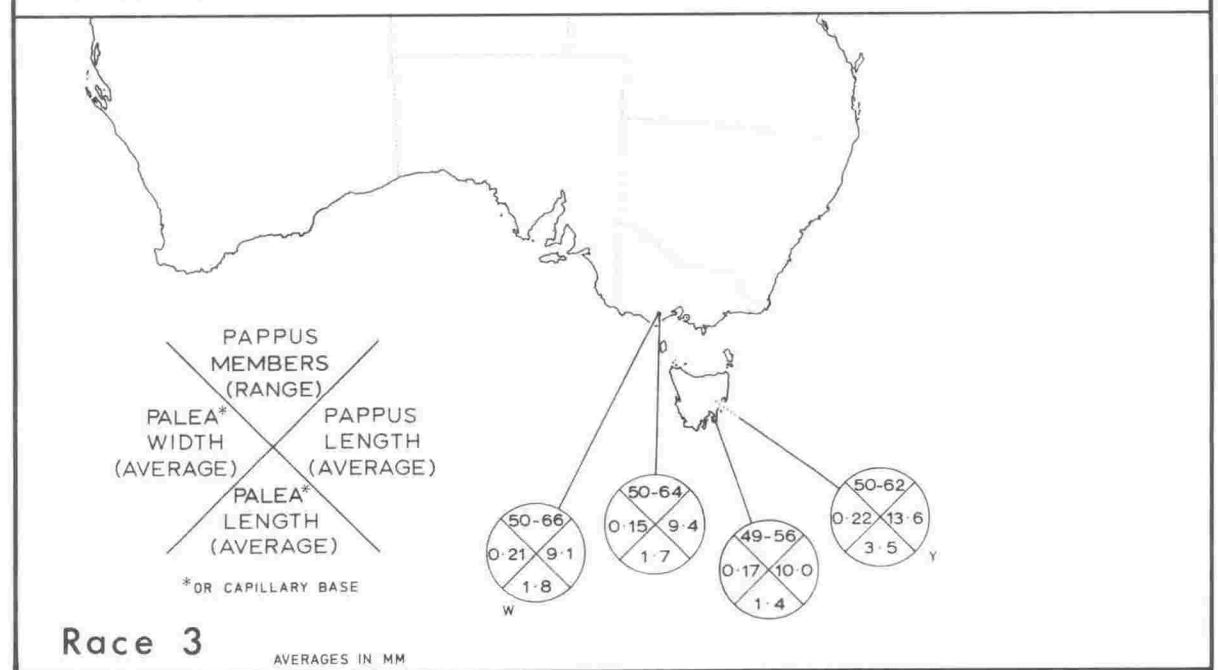
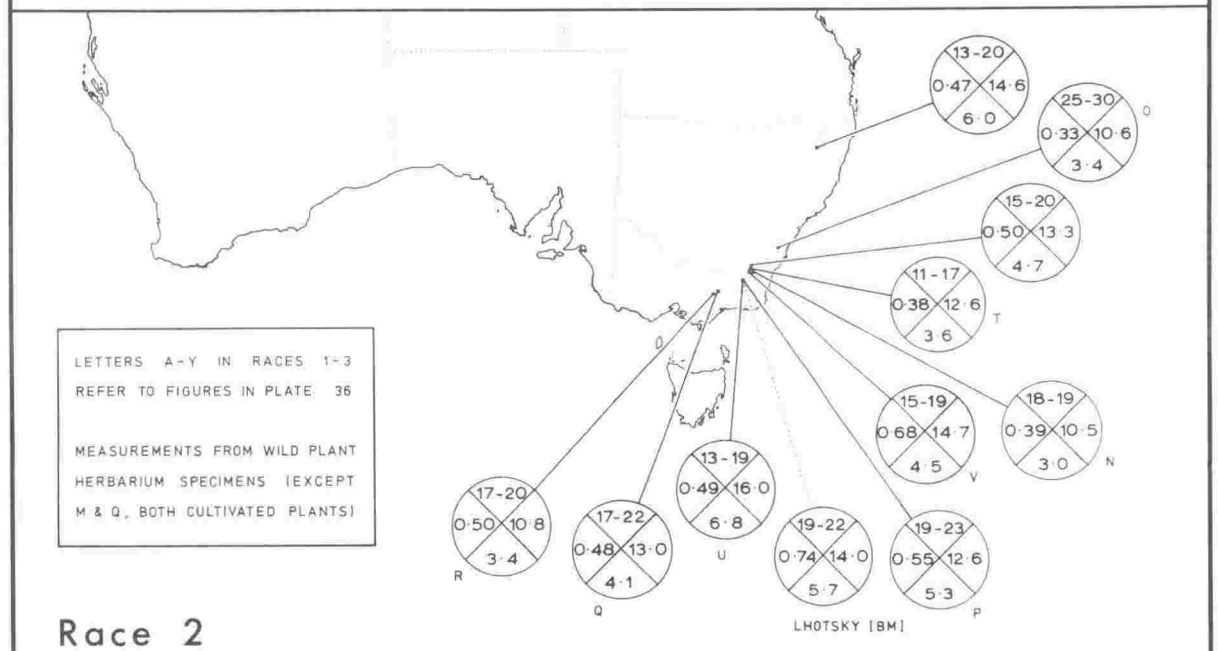
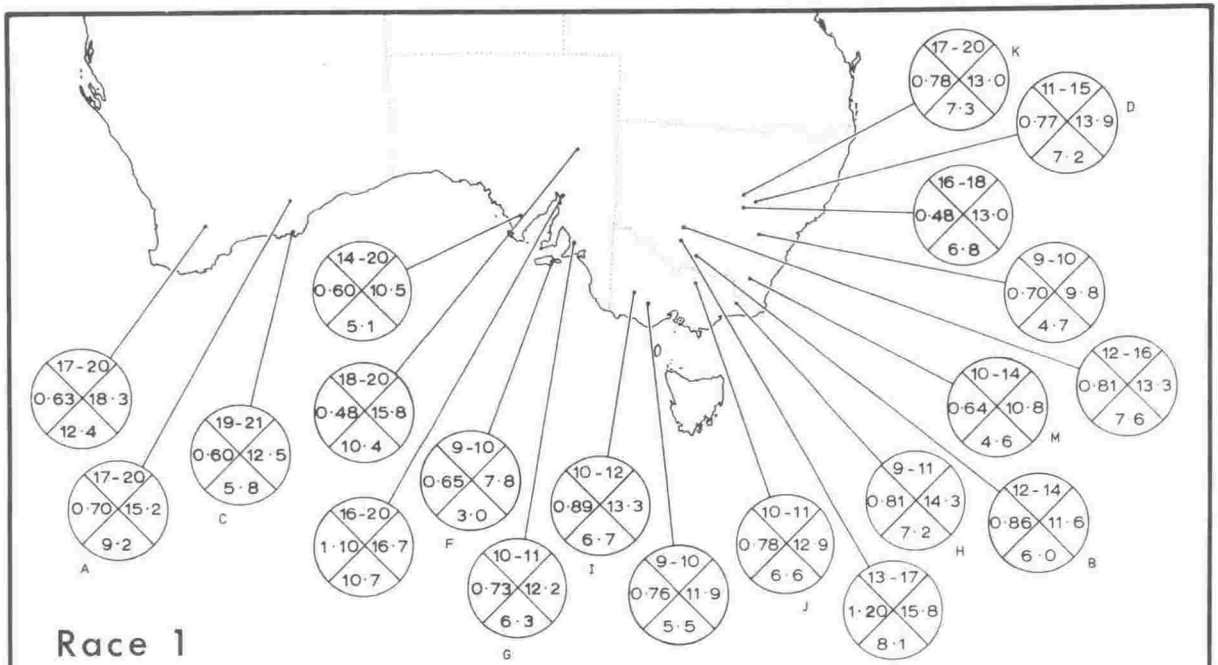
H



I

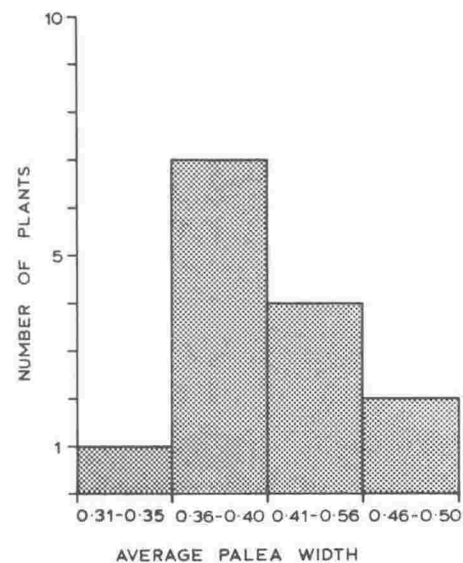
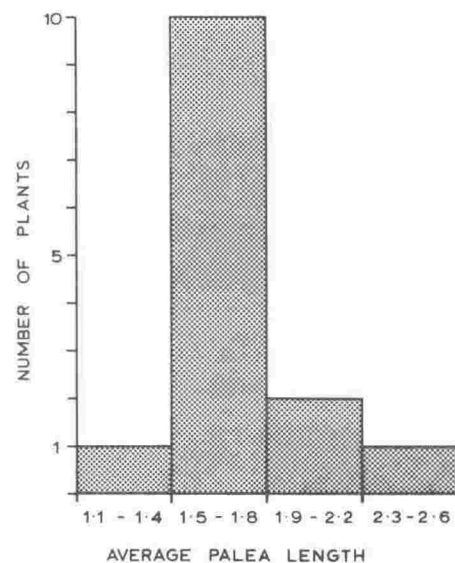
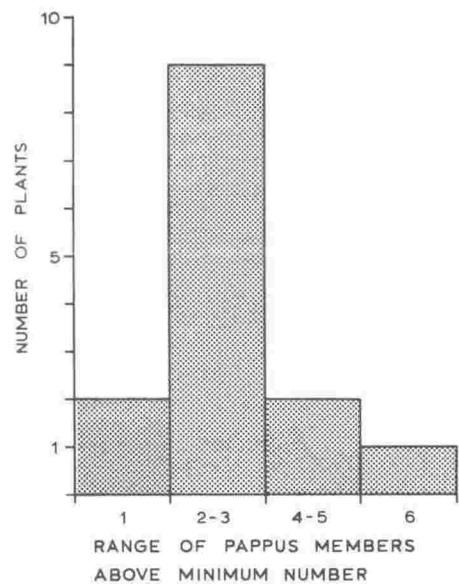
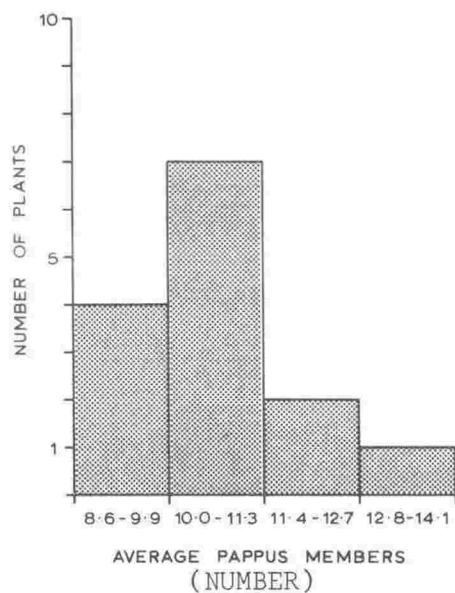
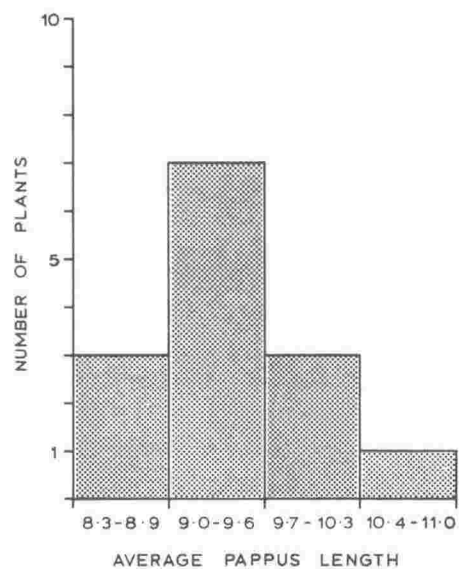
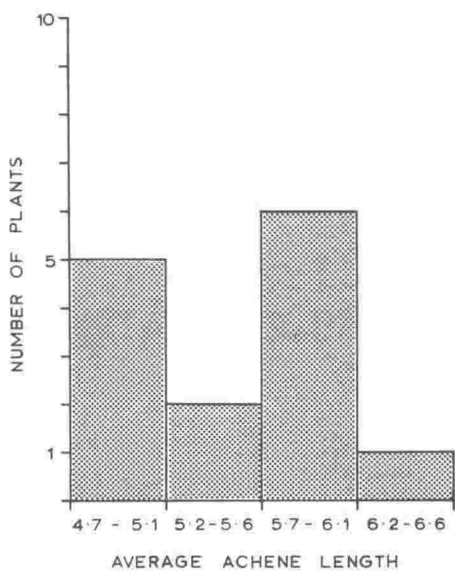
Map indicating pappus measurements in *M. scapigera*



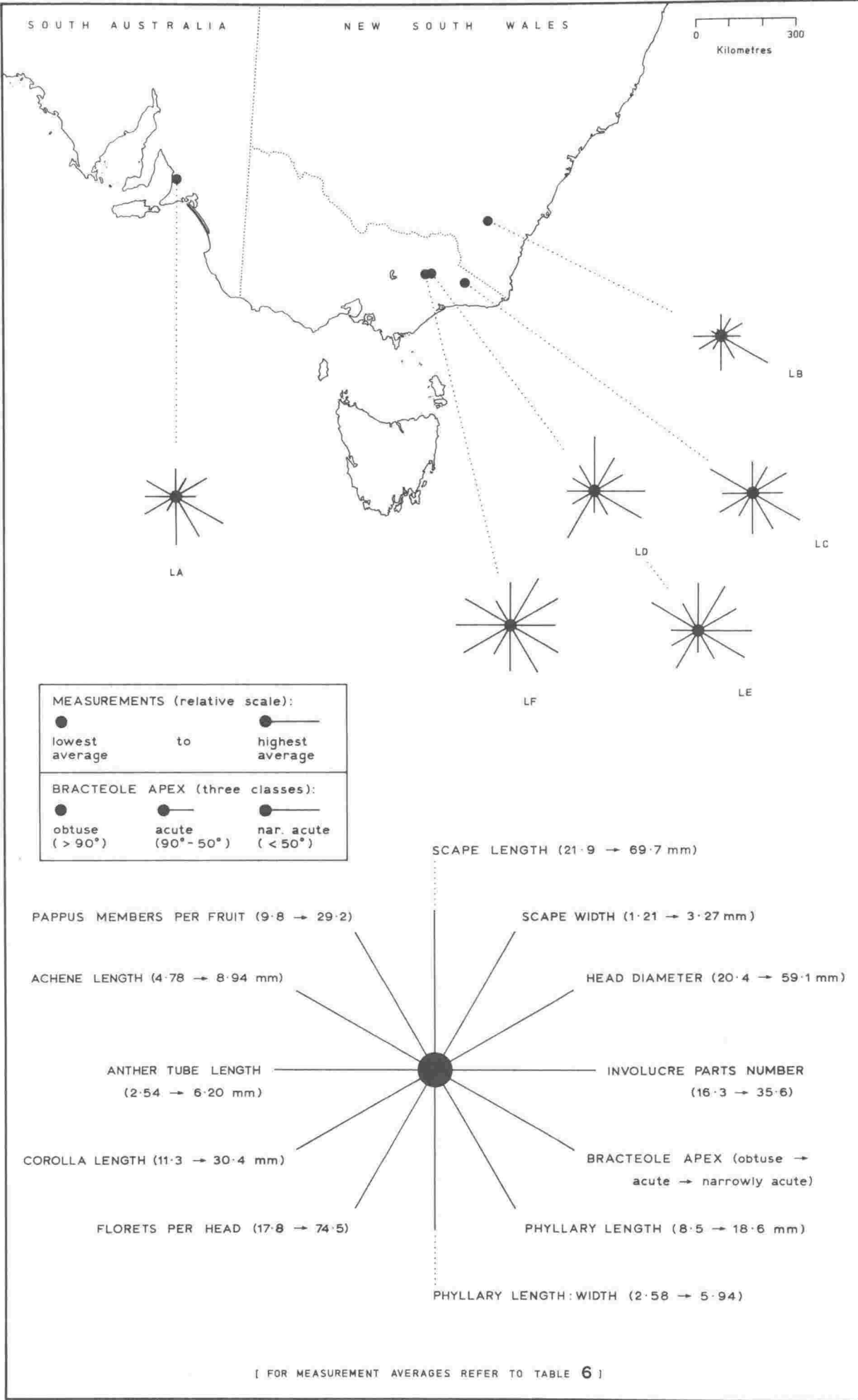


Achene and pappus variation in *Microseris scapigera* population SF.

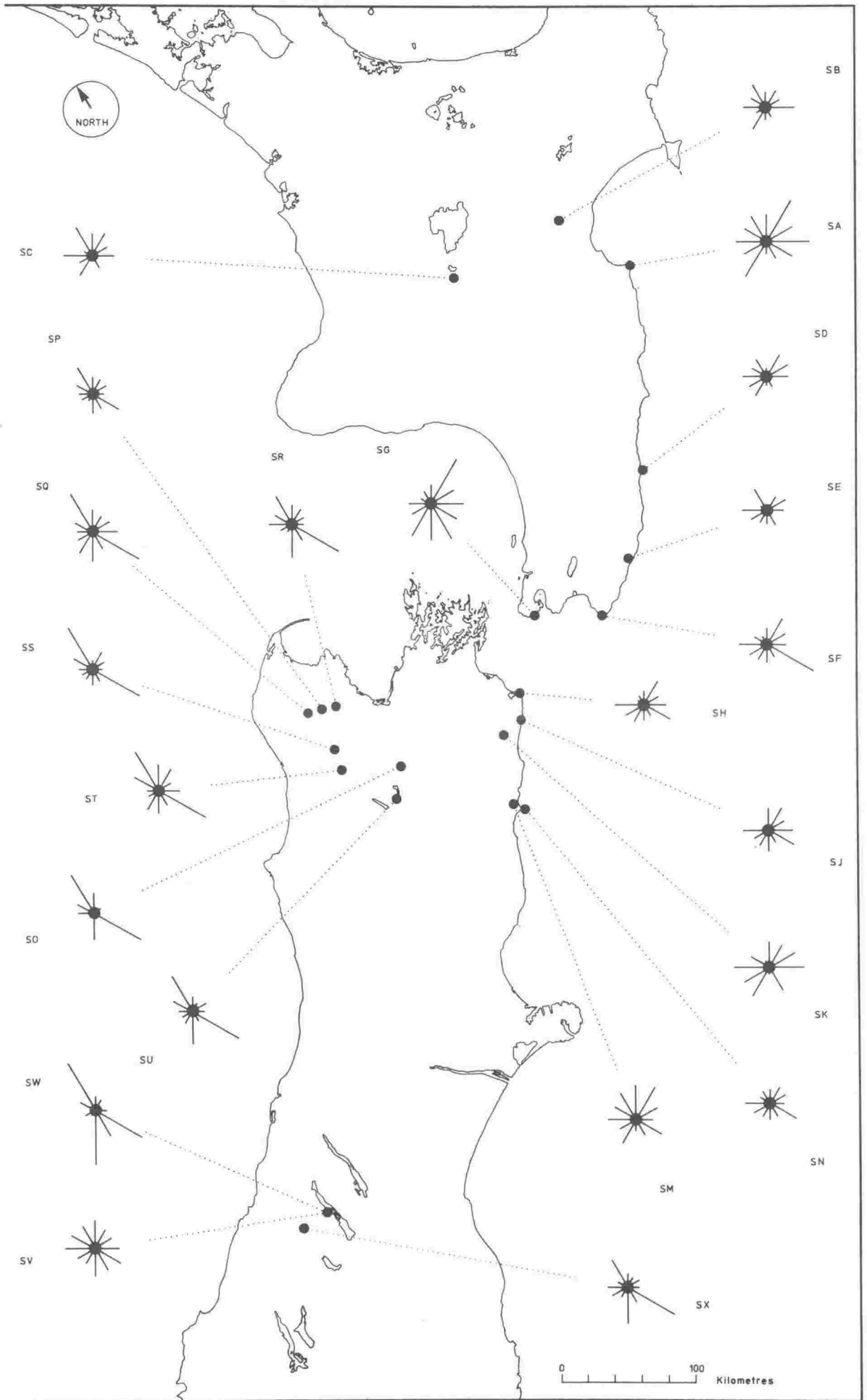
SAMPLE SIZE: 14 PLANTS, 10 SEEDS PER PLANT.



Map indicating average states of 12 reproductive characters in population



samples of *M. lanceolata* (opposite) and *M. scapigera* (below).



CHROMOSOMES. *M. scapigera*, *M. lanceolata*, and interspecific hybrids.

(Figs. A-E, metaphase of mitosis; Fig. F, diakinesis of meiosis).

Fig. A *M. scapigera*. Isolation Creek, Marlborough (pop. SK).

$2n = 36$ . Centre and right-hand arrows point to groups of two and three chromosomes respectively. Magnification 1600.

Fig. B *M. lanceolata* race 1. Smokers Gap, A.C.T. (pop. LB).

$2n = 36$ . Arrow points to two overlapping chromosomes. Magnification 1900.

Fig. C *M. lanceolata* race 2. Mt. Cope, Victoria (pop. LE).

$2n = 36$ . Magnification 1800.

Fig. D *M. lanceolata* race 2. Mt. Hotham, Victoria (pop. LF).

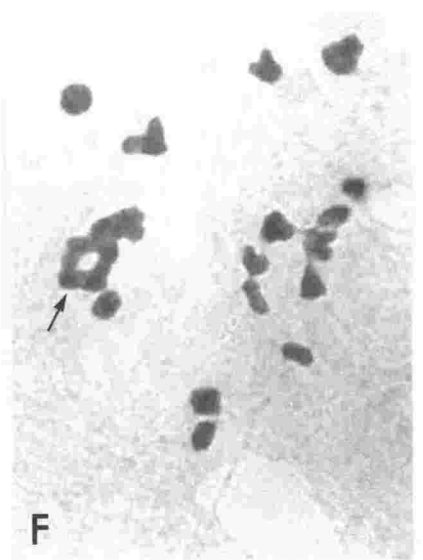
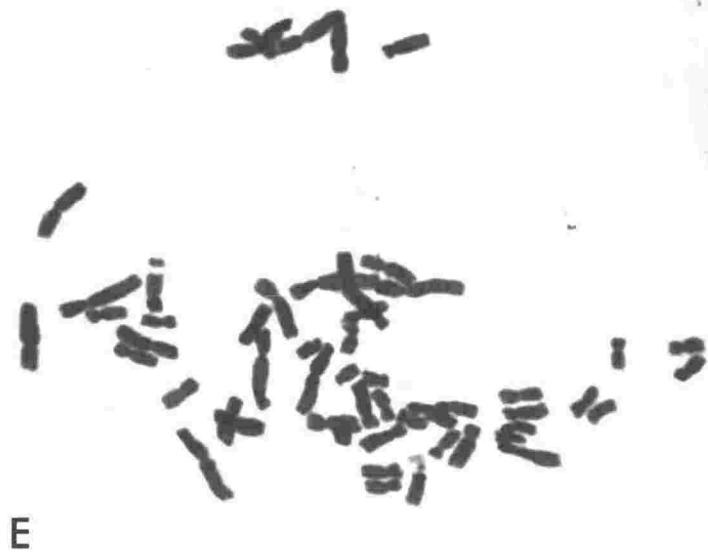
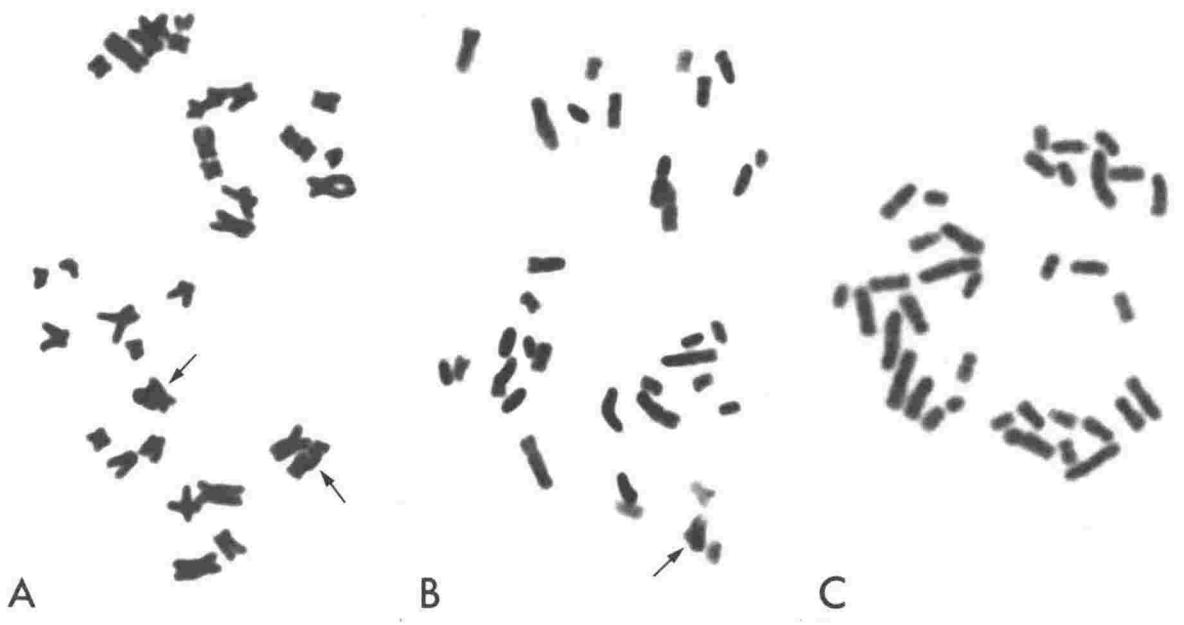
$2n = 72$ . Horizontal arm of 'cross' (arrow) consists of two chromosomes. Magnification 2600.

Fig. E SK x LF (H194). *M. scapigera* x *M. lanceolata* race 2.

$2n = 54$ . Magnification 1800.

Fig. F LC x SA (H174). *M. lanceolata* race 1 x *M. scapigera*.

$n = 18$  ( $16_{II} + 1_{IV}$ ). Arrow points to ring quadrivalent (overlapped by a bivalent). Magnification 2000.



---

CROSSING DETAILS

- Fig. A     Bagging apparatus (cellophane bags placed over wire loops and sealed with paper clips). Heads were bagged in experimental crosses and breeding system tests.
- Fig. B     Seedling tray. Fruits from experimental crosses were planted in horizontal rows across the tray (one cross per row). The fruits were fixed in position with a layer of finely-sieved soil, and mist-watered through germination until seedlings were large enough for transplanting to pots. Seedlings shown are at transplanting age.
- Fig. C     Outdoor plunge bed used for growing potted hybrids. Three to six plants per cross (or fewer depending on the number of seedlings raised) were plunged to examine intermediacy, pollen fertility, and fruit-set.

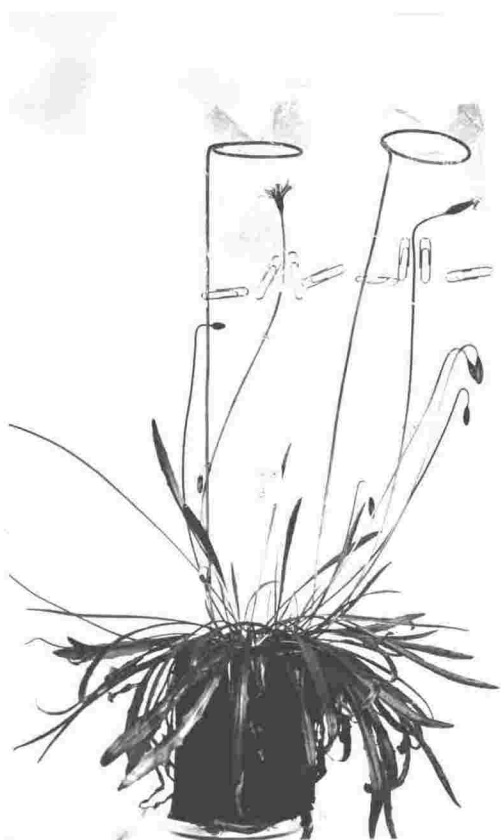


Fig. A



Fig. B

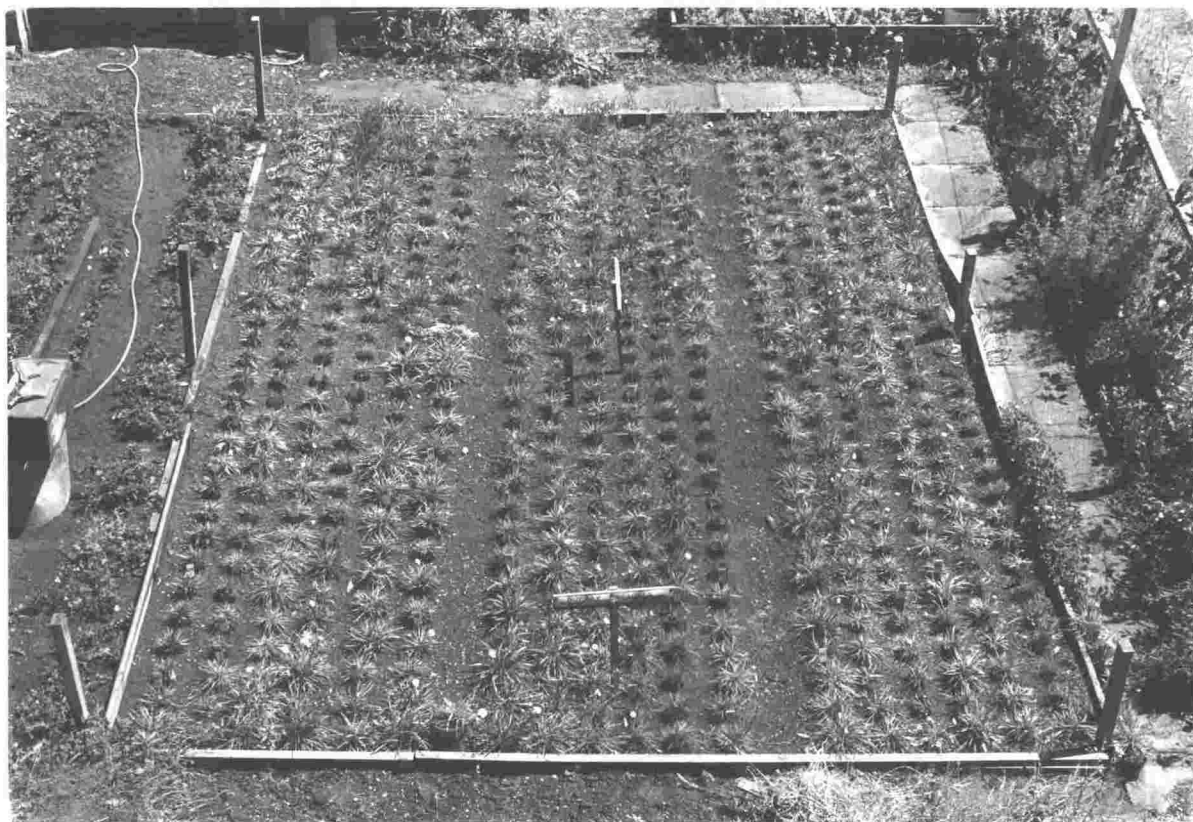


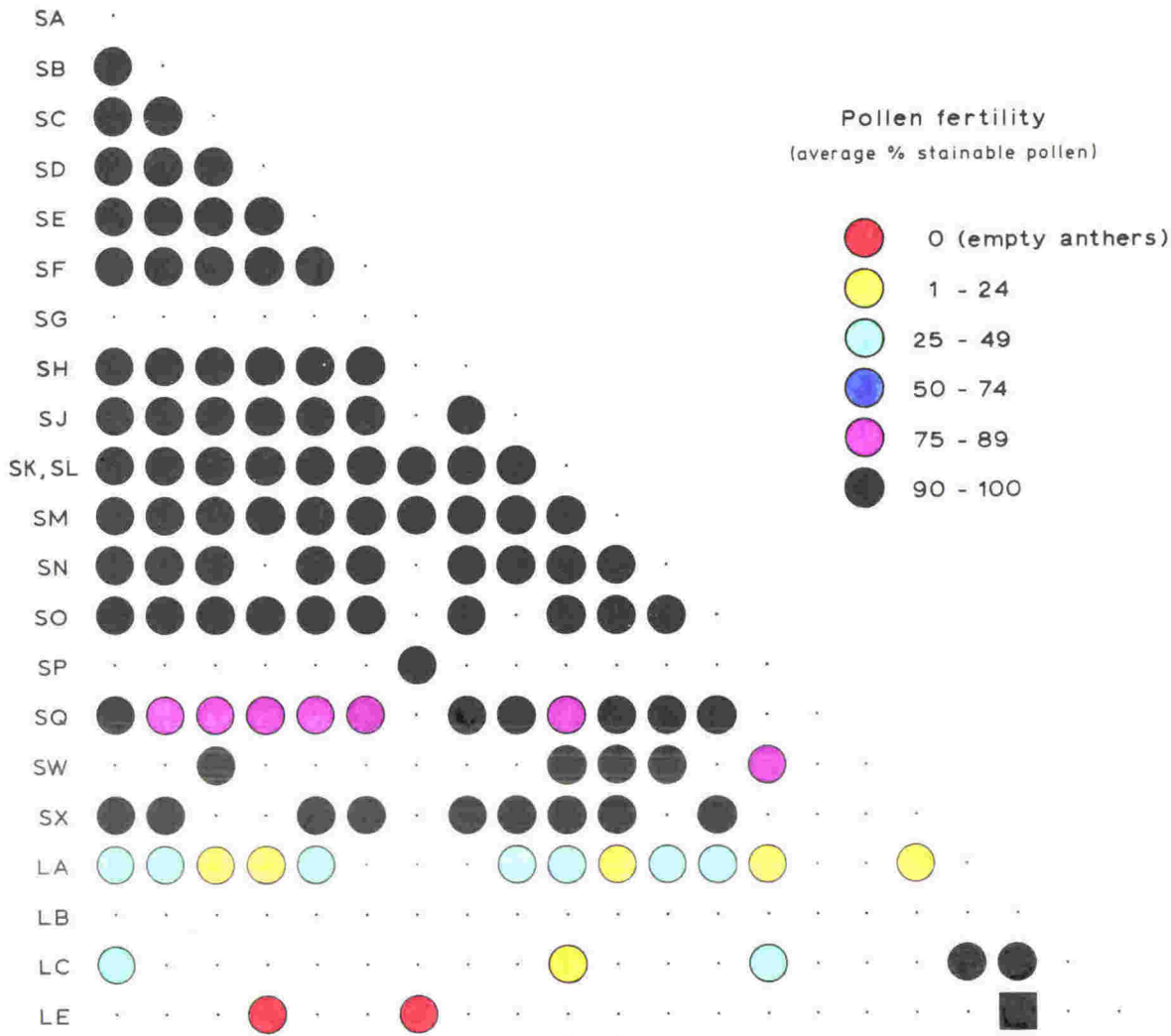
Fig. C

Average pollen fertilities in F<sub>1</sub> crosses within *Microseris* subgenus *Monermos*, together with unsuccessful crosses.

		♀																									
		SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SW	SX	LA	LB	LC	LE	LF		
M. scapigera	SA		97	99	95	99	97		98		93		100		100	97				99	32				*		
	SB	99		99	99	99	99	100		99		99			99	—				99	31						
	SC	82	—		98	91	—	98		99	85			99	97				99		18				*		
	SD	*	99	*		93	*	97		*	98			99	*					*	21						
	SE	99	99	95	99		91	99	99	99	85			99	100		—			98	28						
	SF	99	97	99	99	98		100		100		99		98	91					99							
	SG										99																
	SH	98	99	96	99	96	99			100		99		97	98		99										
	SI							100																			
	SJ	87	100	99	98	94	99		99			98				—		94		96	40						
	SK	99		99	83	96	99	99	90		99			99	94				98		42		19		55		
	SL		99																	93							
	SM	92	96	99	98	99	91	100	98		99	99		99	98		93	91	98		9				20		
	SN	98	—	99	▲	99	—		99		98		99		—			98	—		27						
	SO	—	99	98	98	97	100		—		—	99		94					99	49							
	SP							97											88		19		30	*	*		
SQ	98	88	83	89	87	89		86		93		89		93	95												
SW											97				—												
SX	—	—	—	—	—	80		—		99	99			—							11						
M. lanceolata	LA																										
	LB																										
	LC	32																			96	▲		*			
	LE				0			0														94	—	*			
	LF											—											—	*			

\* Only progeny were parental selfs. — Seed did not germinate. ▲ Fertility of F<sub>1</sub> was not determined. Not shown: SR x LF (=\*)

Summary of pollen fertility in F<sub>1</sub> crosses within *Microseris* subgenus *Monermos* \*



CAPITULA OF CROSSES. *M. scapigera* and *M. lanceolata* - selected intraspecific and interspecific crosses: pressed capitula from glasshouse-cultivated plants.

All crosses are  $F_1$ 's except Plate 49, Fig. B ( $F_2$ ).

Capitula of  $F_1$  crosses are shown between capitula of parent populations (ovule parent to left, pollen parent to right).

## PLATE 46

Fig. A	SC x SW	(H177)	<i>M. scapigera</i> x <i>M. scapigera</i>
Fig. B	SK x SC	(H16 )	" "

## PLATE 47

Fig. A	SK x SG	(H180)	" "
Fig. B	SM x SC	(H150)	" "

## PLATE 48

Fig. A	SM x SK	(H147)	" "
Fig. B	SM x SW	(H179)	" "

## PLATE 49

Fig. A	SW x SK	(H184)	" "
Fig. B	$F_2$ of above	Heads from 21 plants arranged to show segregation: SW types left → SK types right.	

## PLATE 50

Fig. A	SC x LA	(H162)	<i>M. scapigera</i> x <i>M. lanceolata</i> race 1
Fig. B	SK x LA	(H160)	" "

## PLATE 51

Fig. A	SK x LF	(H194)	<i>M. scapigera</i> x <i>M. lanceolata</i> race 2
Heads from two plants showing differences between the involucre. Lower head has furfuraceous pubescence (white) on bracteoles. Upper head is from same plant as head in Frontispiece.			
Fig. B	LC x SA	(H174)	<i>M. lanceolata</i> race 1 x <i>M. scapigera</i>

## PLATE 52

Fig. A	LE x LB	(H191)	<i>M. lanceolata</i> race 2 x <i>M. lanceolata</i> race 1
Fig. B	LE x SD	(H208)	<i>M. lanceolata</i> race 2 x <i>M. scapigera</i>

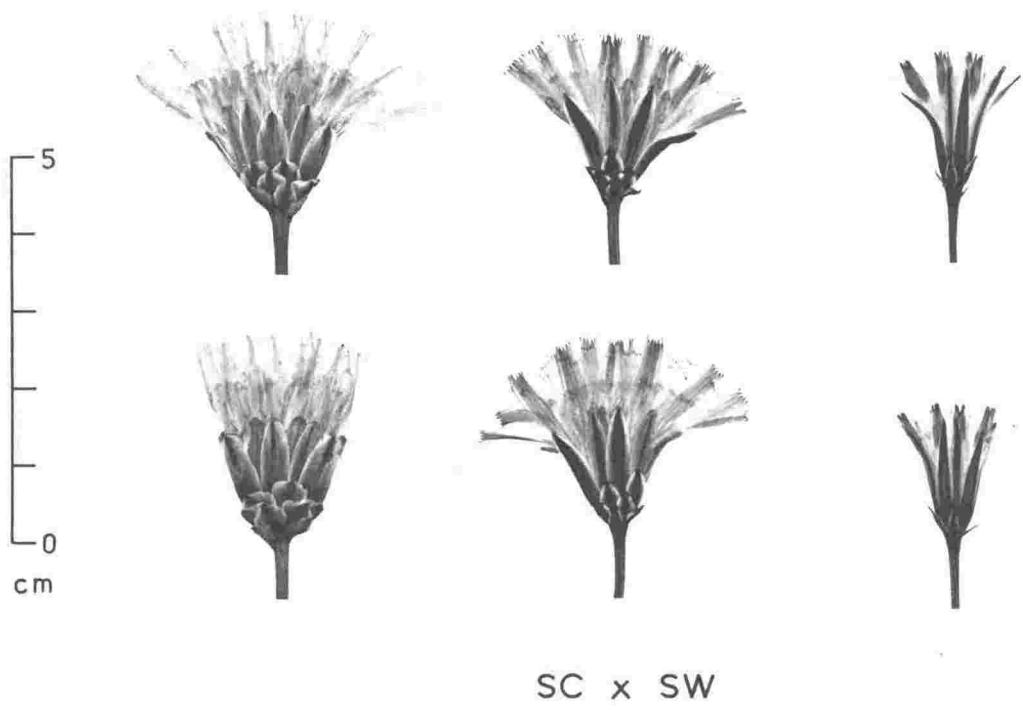


Fig. A

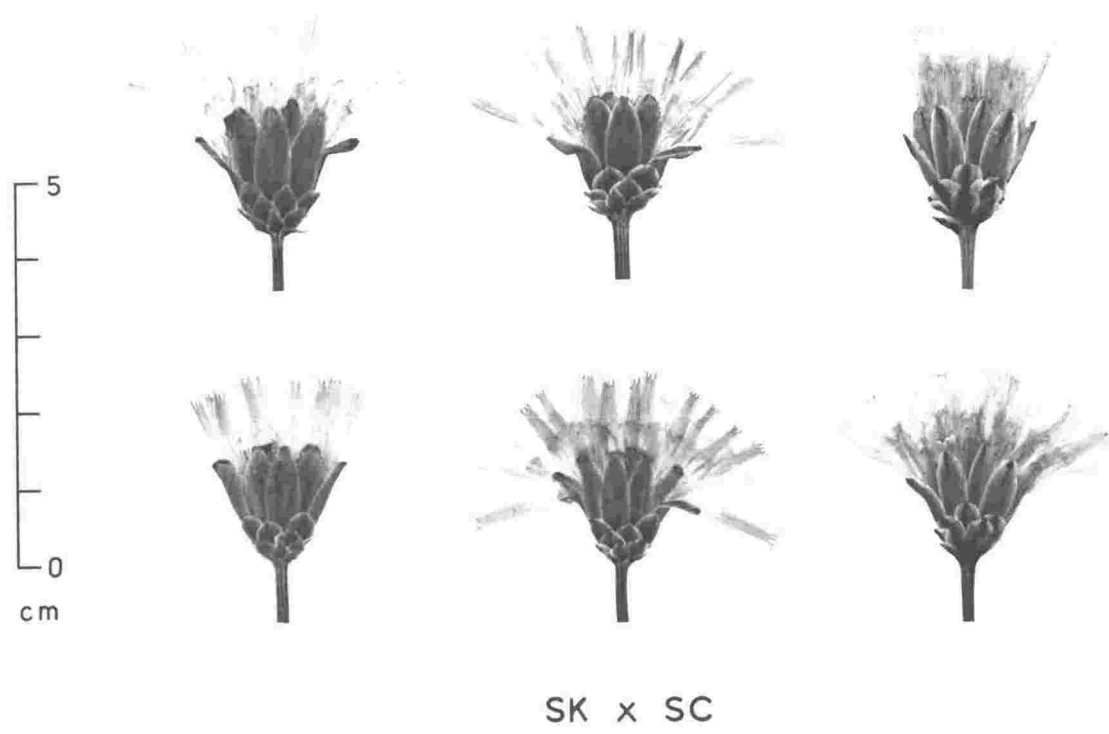


Fig. B

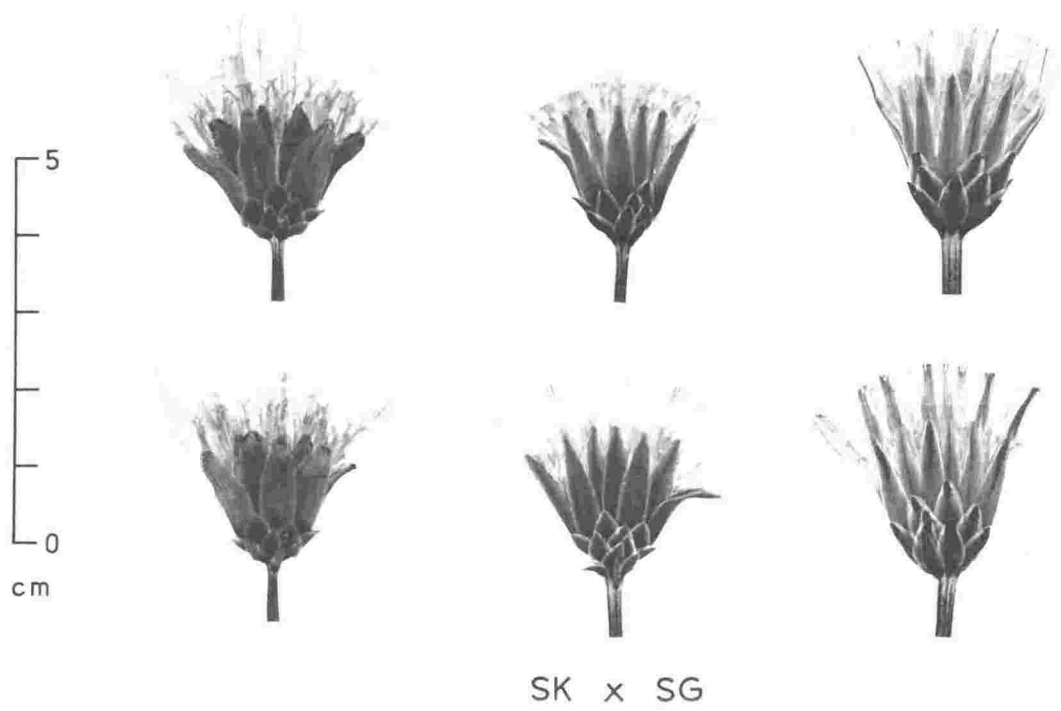


Fig. A

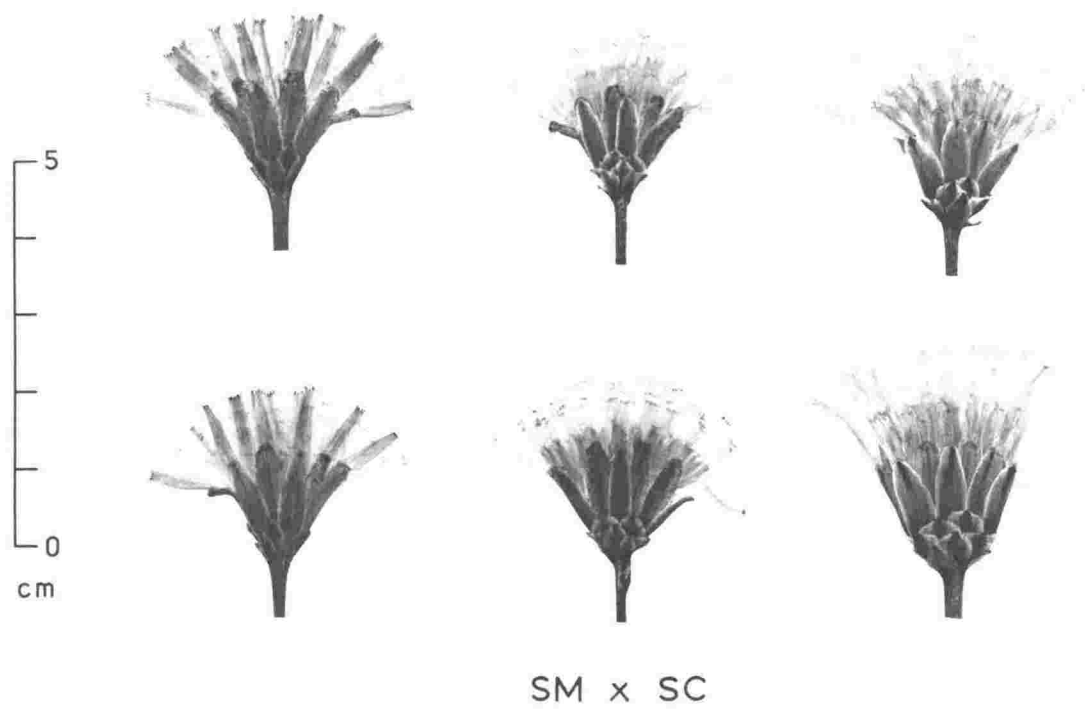


Fig. B

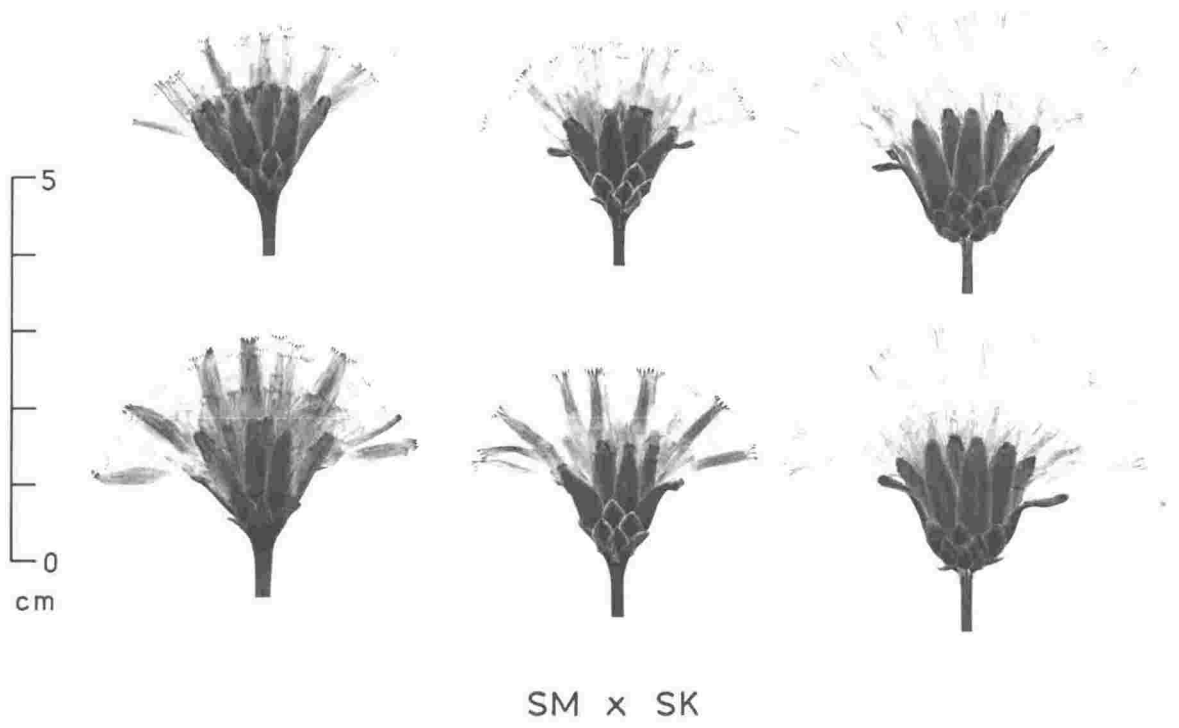


Fig. A

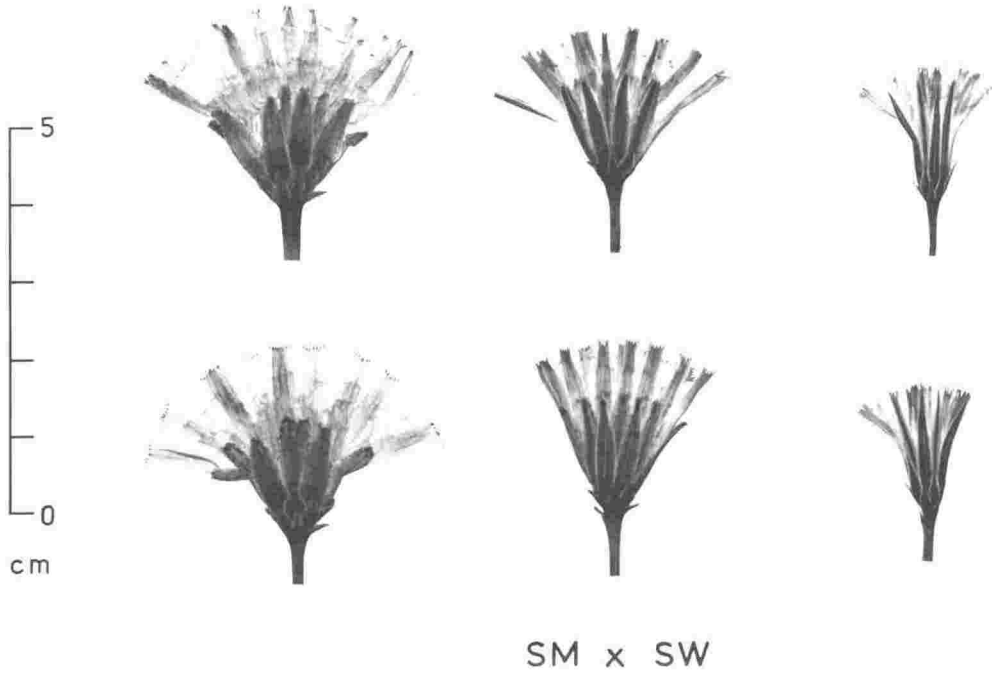


Fig. B

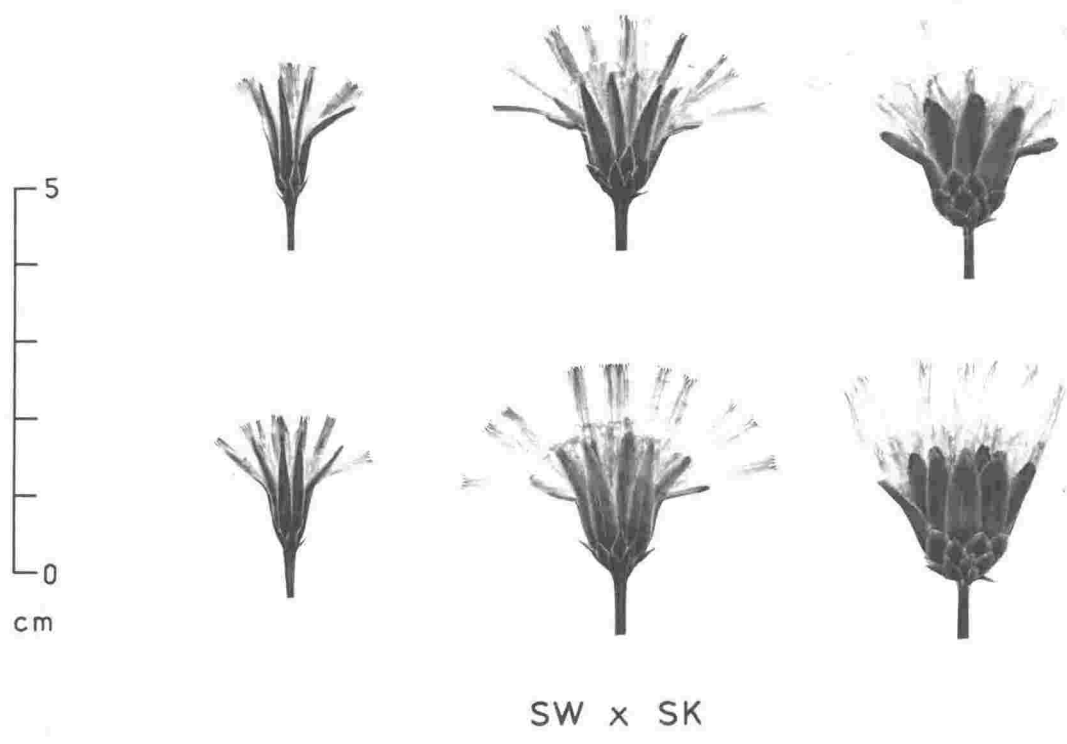


Fig. A

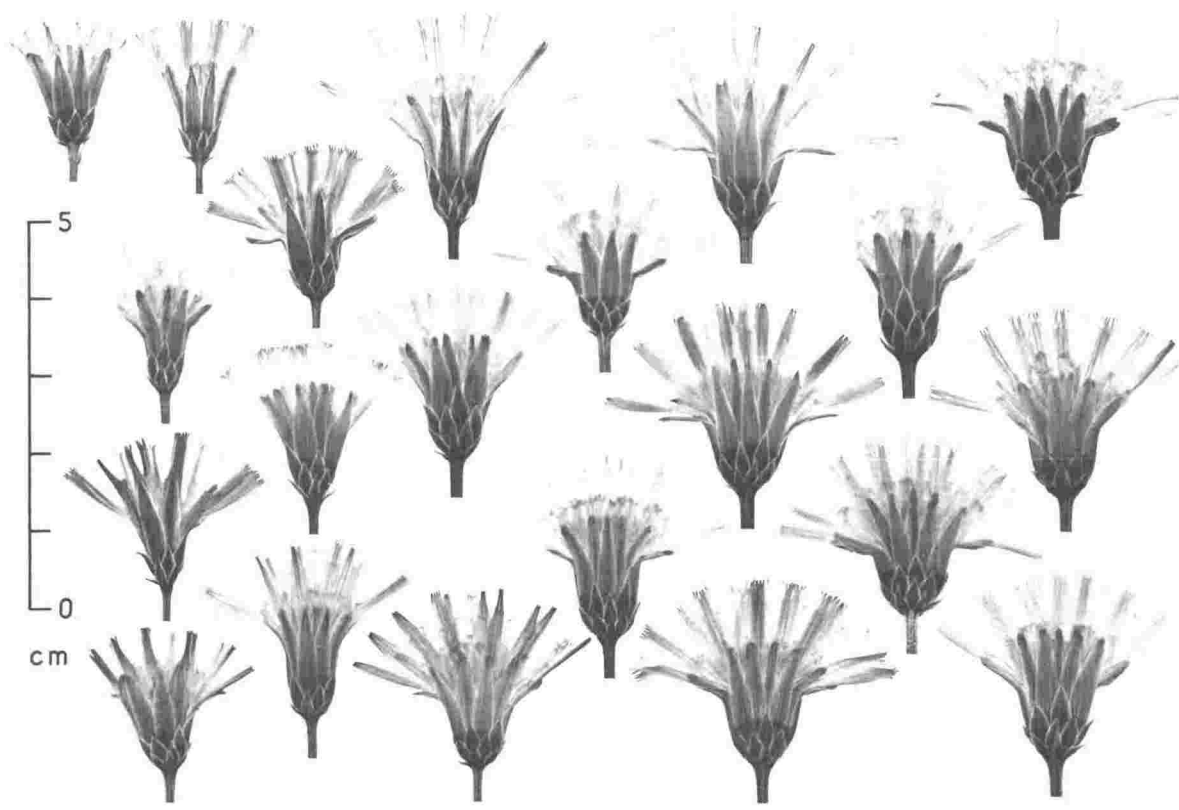


Fig. B

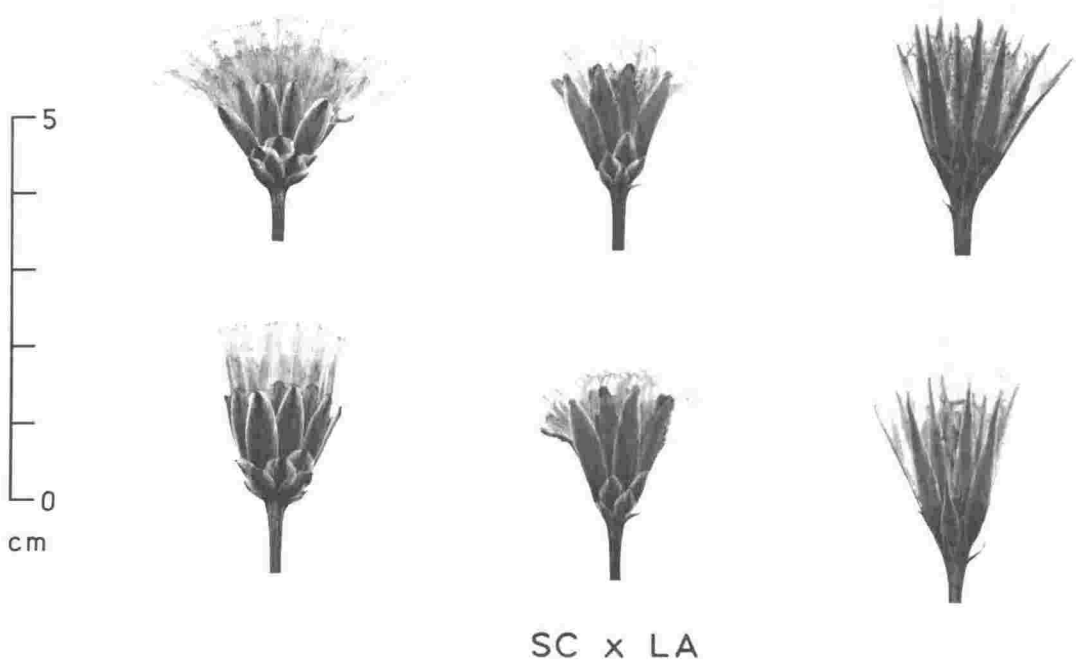


Fig. A

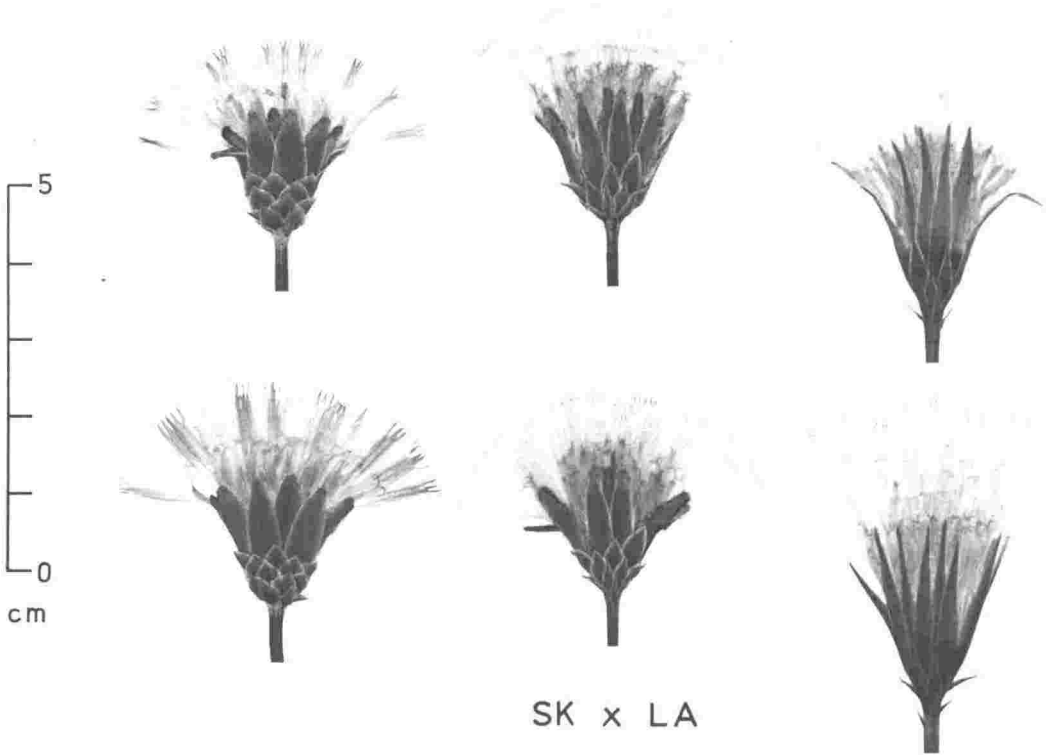


Fig. B

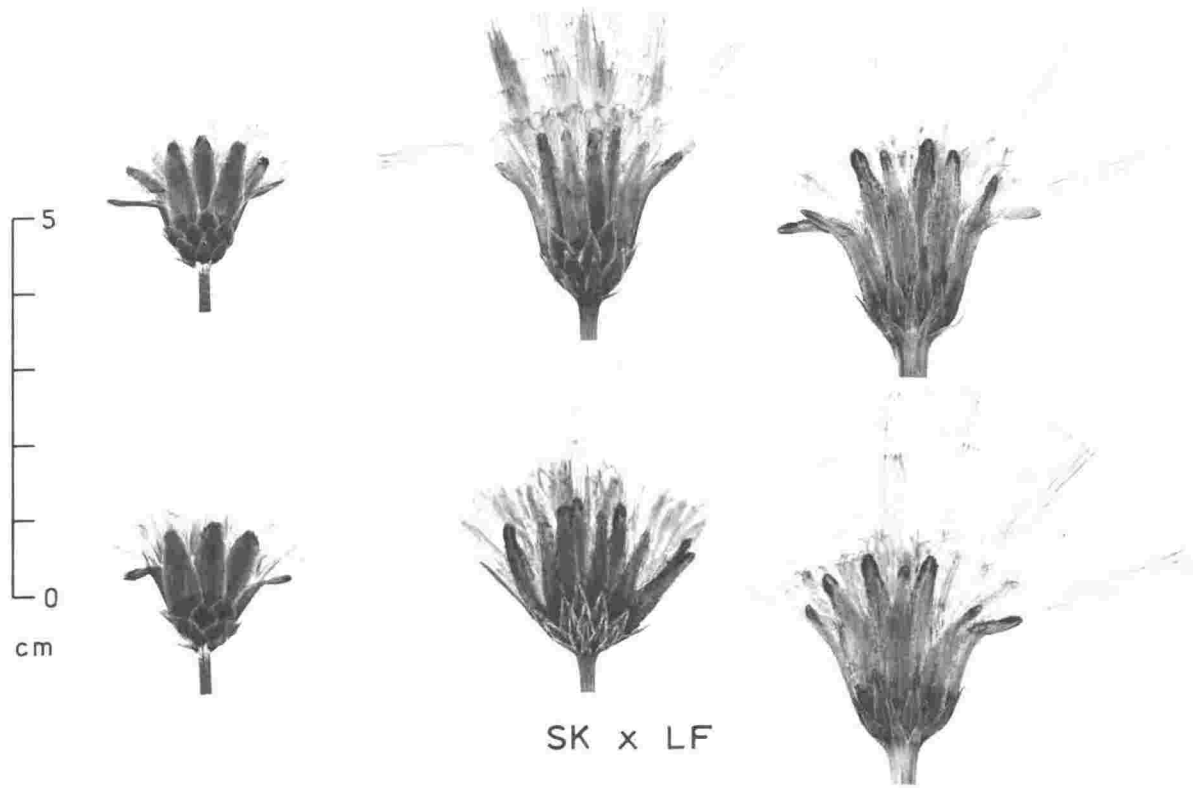


Fig. A

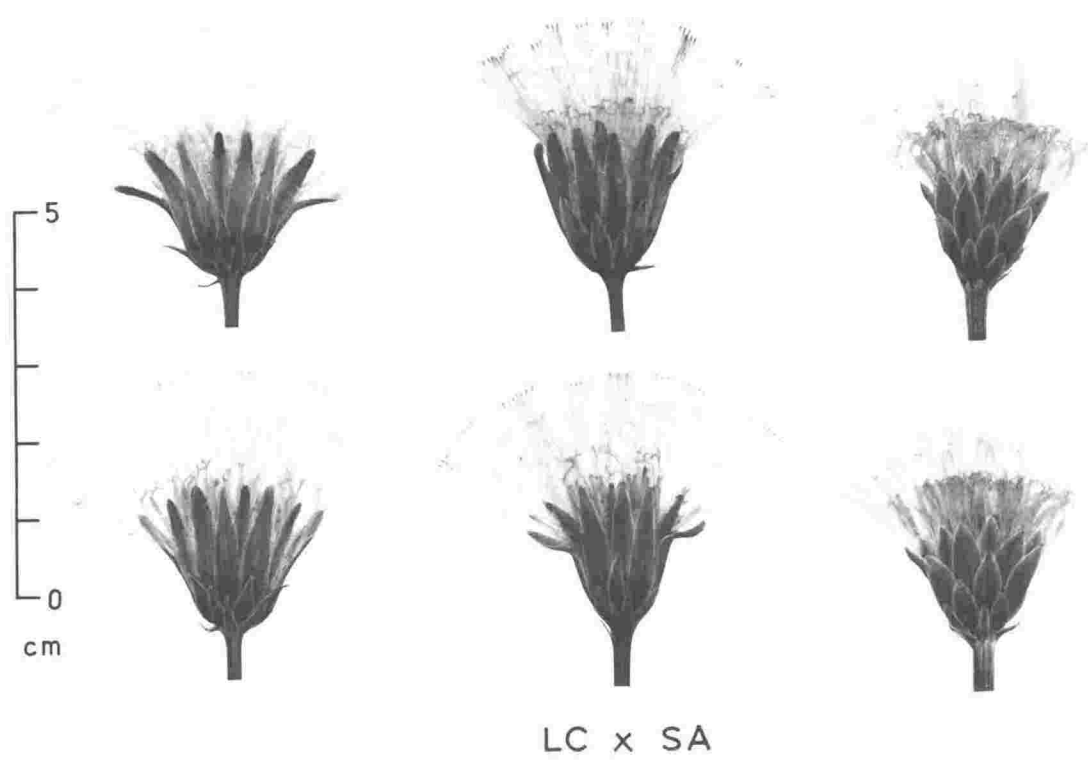


Fig. B

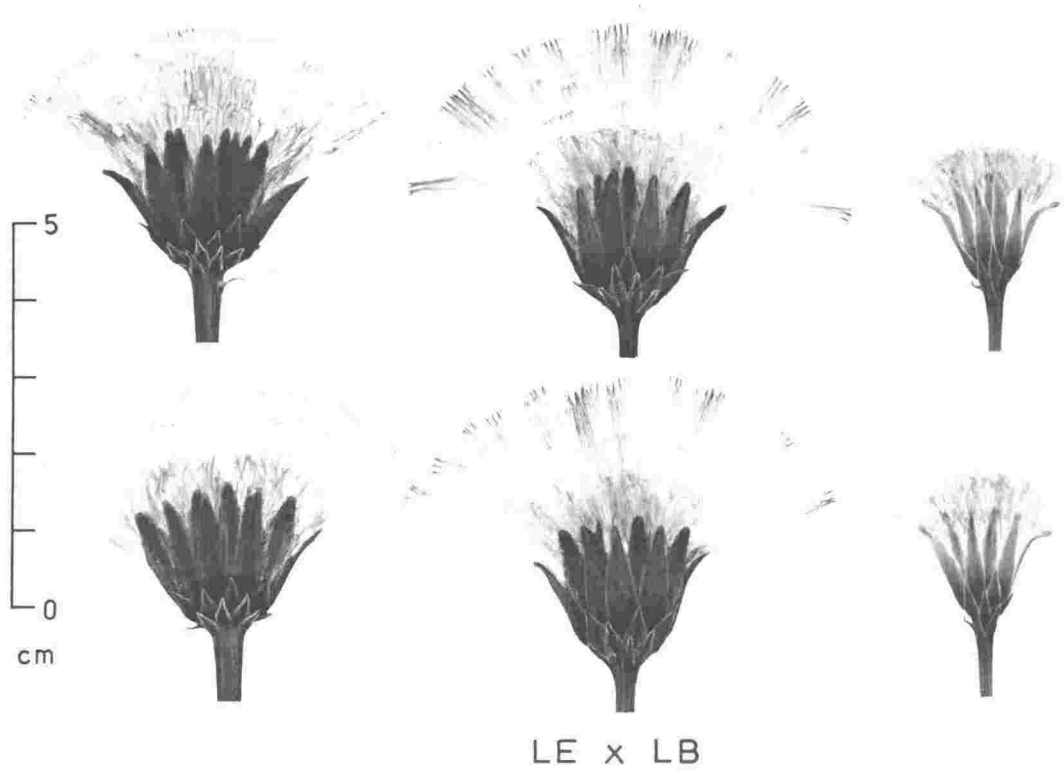


Fig. A

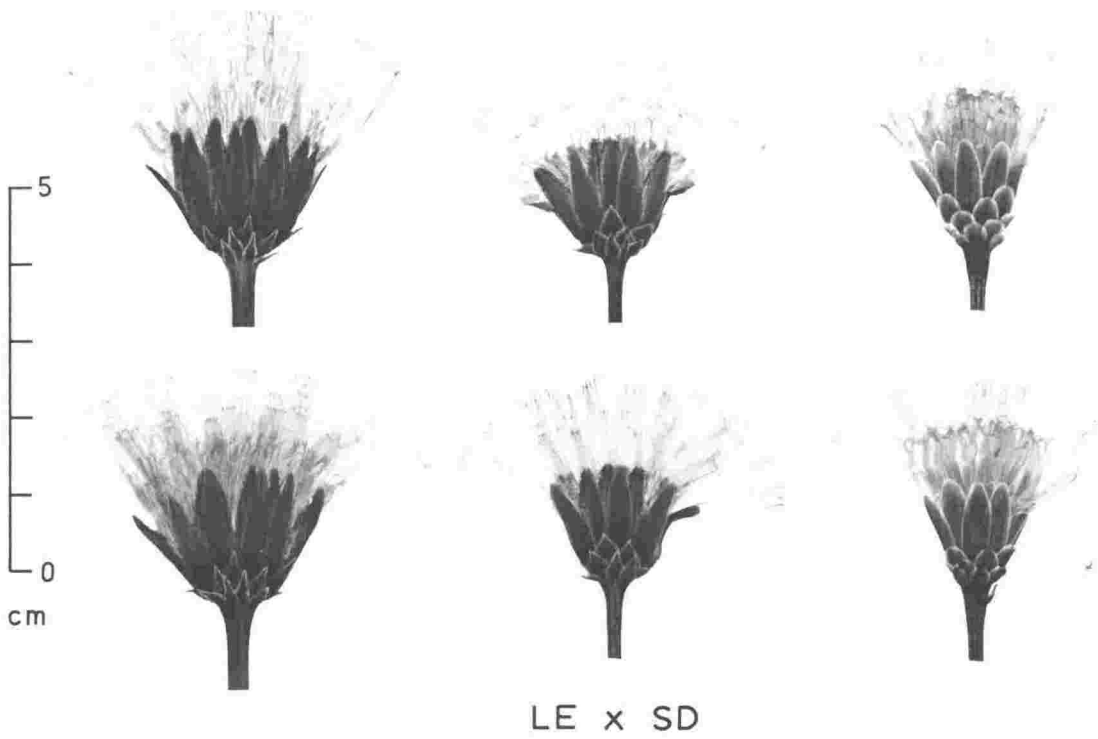


Fig. B

ADDENDUM

The following two papers were overlooked in the preparation of this thesis:

GANDOGGER, M. (1918). Sertum plantarum novarum. Pars prima. *Bull. Soc. Bot. France* 65: 24-69.

MCGILLIVRAY, D.J. (1973). Michel Gandoger's names of Australian Plants. *Contrib. N.S. Wales Nat. Herb.* 4(6): 319-359.

Gandoger validly described six species of *Microseris* (as '*Microderis*'), five from Australia (*M. latifolia*, *M. obtusifolia*, *M. tasmanica*, *M. tenuicula* and *M. walteri*) and one from New Zealand (*M. neozelandica*).

McGillivray reduced the five Australian names to synonyms under *M. scapigera* (Soland. ex A. Cunn.) Schultz-Bip.

According to the treatment in my thesis Gandoger's five Australian names would be synonymized under *M. lanceolata* (Walp.) Sch.-Bip. and his New Zealand name under *M. scapigera* (Sol. ex A. Cunn.) Sch.-Bip.

n  
AS741  
VUW  
PhD  
TB  
13

371,499