RELATIONSHIPS OF SOUTH-EAST AUSTRALIAN SPECIES OF *SENECIO* (COMPOSITAE) DEDUCED FROM STUDIES OF MORPHOLOGY, REPRODUCTIVE BIOLOGY AND CYTOGENETICS

- by -

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University. To the best of my knowledge and belief this thesis contains no material previously published or written by another person, except where due reference is made in the text.

Margaret E. Lawrence

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SUMMARY

Relationships of 34 species of Senecio and representatives from 3 other genera of Senecioneae are examined. Evidence is presented from seven major lines of research:

1. Morphological evidence, including stamen, style and ovary wall microcharacters discussed in recent reviews of Senecioneae, is used to define three major subgeneric groups termed "radiate", "discoid" and "erechthitoid" (the latter superficially resemble the genus Erechtites). Three new species are described in a preliminary taxonomic treatment. Discoid and erechthitoid species form largely natural groups, whereas radiate taxa are diverse. Two species with radiate capitula are otherwise closer to discoid species, and may be the product of introgressive hybridization. Seven radiate taxa possess characters not normally found in Senecio. If recent taxonomic treatments of Senecioneae are followed, then these species are likely to be transferred to several new or existing genera.

2. Differing modes of reproduction largely explain observed phenetic relationships. All erechthitoid species are facultative inbreeders whereas all but one of the radiate and discoid species are obligate outbreeders. Annual and perennial life forms are loosely correlated with breeding systems but a number of exceptions occur in both categories. Dispersal potential in relation to seed size, and number, seed dispersal and seedling establishment indicates a range of adaptive strategies in different environments.

3. Chromosome numbers of 2N = 38, 40, 60, 70, 80, 98, 100 and 120 are reported for native taxa. The effective basic chromosome number of the genus is x = 10, but 2N = 40 is most widespread throughout the world. Hexaploid species are more abundant among Australian taxa than elsewhere in the world. Although hexaploid species can be subdivided into three groups on the basis of generation length, breeding system and capitulum morphology, their distinctive achene morphology suggests a common ancestor. Many Australian species of Senecio are hexaploid but they are not related to "cacalioid" genera of Senecioneae characterized by this ploidy level.

4. Recombination systems are discussed in terms of chromosome number, chiasma frequency and position, breeding system and generation length. Because of widespread polyploidy Darlington's recombination index cannot be applied to Senecio. Increases in basic chromosome numbers promote recombination but increases by polyploidy are likely to restrict recombination. High polyploid species of Senecio may therefore have recombination systems as restrictive as those produced by aneuploid reduction. When viewed in this manner, results generally support hypotheses concerning recombination systems found in different environments.

5. DNA amounts are reported for 52 taxa. There is a ten-fold difference in interspecific DNA amounts per nucleus (4.2 - 42.3 picograms per 4C nucleus) and a 9-fold difference per chromosome (0.084 - 0.714 picograms). Preliminary evidence of a 10% variation in intraspecific DNA amount is reported for two morphologically variable species. Polyploidy is thought to restrict further changes in genome size, and on this basis, high polyploids suggest a primitive or basic genome size of about 1.6 picograms for Senecio.

If this is correct then the genome size of specialized ephemerals has decreased whereas the genome size of some morphologically primitive species has increased. General correlations between DNA amount, cell size, minimum generation time and environmental conditions are thought to be best explained in terms of natural selection acting on the phenotype.

6. Karyotypes were constructed for most species, and compared on a percentage similarity basis. Relationships generally parallel those based on external morphology. Radiate species are again most diverse but some of the differences are due to inter-specific variation in DNA amount.

7. Studies of natural and synthetic hybrids between radiate and discoid, and radiate and erechthitoid species are discussed. Some characteristics of hybrids between parents of different ploidy levels may be determined by additive gene effects. However the rayed gene is apparently disomic with incomplete dominance. The parentage of one high polyploid and one sterile taxon previously recognised at the specific level were determined from karyotypes.

Conclusions based on combined evidence are that radiate species may represent two evolutionary lines - one derived from an early migrant species with characteristics intermediate between "senecioid" and "cacalioid" genera, and the other from a later migrant species representative of Senecio sensu stricto. Species with discoid and erechthitoid capitula most probably evolved in Australia. They appear to have a common ancestor although morphological differentiation associated with different breeding systems is extensive. The general success of Senecio, reflected

in the size of the genus, must in part be due to family characteristics of Compositae. However, Senecio appears to be the only genus in Compositae in which chromosomal evolution has occurred predominantly by polyploidy. Polyploid evolution, involving introgressive hybridization within mixed populations, may therefore be another factor contributing to the success of Senecio.

CHAPTER 1

General Introduction

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General Introduction

1.1 Evolutionary Processes and Very Large Genera

The nature of selective advantages or of general evolutionary processes is usually decided by comparing evidence from as many genera as possible. Such a method necessarily selects those genera that are most amenable to study - that is, genera with a known taxonomy and comparatively few species (less than 100) often restricted to one geographic area. However, it could be argued that genus size and distribution indicate the ability of a group of species to respond to selective pressures, and that small geographically restricted genera are therefore not as adaptable as large and cosmopolitan ones. If this is the case, then theories based only on evidence from small genera may be limited in their application. Although the greatest variety of adaptations are likely to occur in the largest and most widely distributed genera, these genera are often avoided as research subjects as their taxonomy is usually poorly understood. The major objective of this thesis was therefore to examine as many characteristics as possible in a number of species from a large genus in order to see if relationships and evolutionary processes follow the same trends observed in smaller genera. A second objective was to try and determine which characteristics contribute most to the size and apparent success of the genus.

Senecio (family Compositae, tribe Senecioneae) was selected as it contains an estimated 1,500 species (Nordenstam 1977) and is thought to be the largest angiosperm genus. Species occur on every continent and in habitats ranging from inland deserts to

alpine herbfields. The type species, Senecio vulgaris L., occurs naturally in Europe and is a self-compatible ephemeral herb with homogamous discoid capitula. However, the genus also contains self-incompatible species, annuals, perennial herbs, shrubs and lianas*, and species with heterogamous discoid or heterogamous radiate capitula.

The present study was largely restricted to species of Senecio occurring in south-eastern Australia and can be divided into two broad sections:

1. Chapters 2 - 3

   Discussion of morphological terminology, descriptions of taxa investigated with discussions of their past and present taxonomic treatment and a discussion of relationships between groups based on morphological evidence alone.

2. Chapters 4 - 8

   Discussions of the reproductive biology, recombination systems, DNA amounts, karyotypes and hybrids of species investigated. Where relevant, relationships based on these studies are compared with relationships deduced from morphological evidence.

Despite the restricted geographic area of study, variation was encountered in almost every aspect of the genus investigated. For example, ephemeral, annual and perennial life forms are

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*The comparatively well known arboreal species or "Tree Senecios" of St. Helena and Tropical Africa are considered by Nordenstam (1977, 1978) to be taxonomically isolated, and have been placed in the genera Pladaroxylon, Lachanodes and Dendrosenecio.

represented among the species examined and both self-compatible and self-incompatible species occur in each of the three categories. Gametic chromosome numbers of N = 19, 20, 30, 40, 49, 50 and 60 were determined as well as chiasma frequencies of 1.01 to 2.04 per bivalent and mean DNA amounts per chromosome of 0.084 to 0.469 picograms. It was therefore possible to compare predictions of a number of evolutionary concepts with the patterns of variation found in Senecio. Three of the concepts are described briefly below.

1. MacArthur and Wilson (1967) coined the terms "r-selection" and "K-selection" for selection in density-independent and density-dependent environments. The r- and K-selection model predicts that in stable density-dependent environments K-selection will favour late maturity, few large progeny, a long life and a small reproductive effort, whereas in an unstable density-independent environment, r-selection will favour early maturity, many small progeny, a short life and a large reproductive effort. Reproductive traits of Senecio species occurring in both stable and unstable environments are compared with predictions of r- and K-selection in Chapter 4.

2. A second and related theory suggested by Grant (1958) and Stebbins (1958) is that different reproductive strategies reflect selection for genetic systems that optimise the rate of expression of genetic variability - in other words - the rate of recombination. Grant (1958) discussed the possible influence on recombination of longevity, chromosome number, chiasma frequency, sterility barriers, breeding system, pollination system, dispersal potential, population size and isolating mechanisms. All of these factors have been extensively researched since the work of Grant and Stebbins, but no attempt has been made to compare most of the factors in one genus.

An obvious reason is that few genera show variation in all of the characteristics listed by Grant, but Senecio is an ideal subject. Recombination systems found in Senecio are discussed in Chapter 5.

3. A third concept examined is the "C-value paradox" (Thomas 1971), or the fact that the nuclear DNA content of an organism is not necessarily correlated with evolutionary advancement or structural complexity. Opinions are divided. Some have suggested that most of the eukaryotic genome contains "selfish" (Doolittle and Sapienza 1980) or "parasitic" DNA (Orgel and Crick 1980) and that natural selection acting on phenotypic characteristics is relatively unimportant. However, Cavalier-Smith (1978, 1980) and Bennett (1972) considered that the nucleotypic effect (as opposed to genotypic effect) of DNA amount on cell size, cell cycle time and minimum generation time forms the basis for the natural selection of DNA amounts. DNA amounts per nucleus and per genome vary considerably in Senecio and are discussed with respect to other characteristics of the genus in Chapter 6.

1.2 Listing of Species and Geographic Range of Study

There are 44 native and five adventive species of Senecio in Australia as well as ten species from other genera of Senecioneae. All are listed in Table 1.1 along with the occurrence of each in political states (see Figure 1.1A) and general capitulum and life form characteristics. The geographic area covered during field trips is shown in Figure 1.1B and is referred to as south-eastern Australia. The study area is approximately 1500 km from east to west, 600 km from north to south and represents about one seventh of the total area of Australia. However, the study area contains

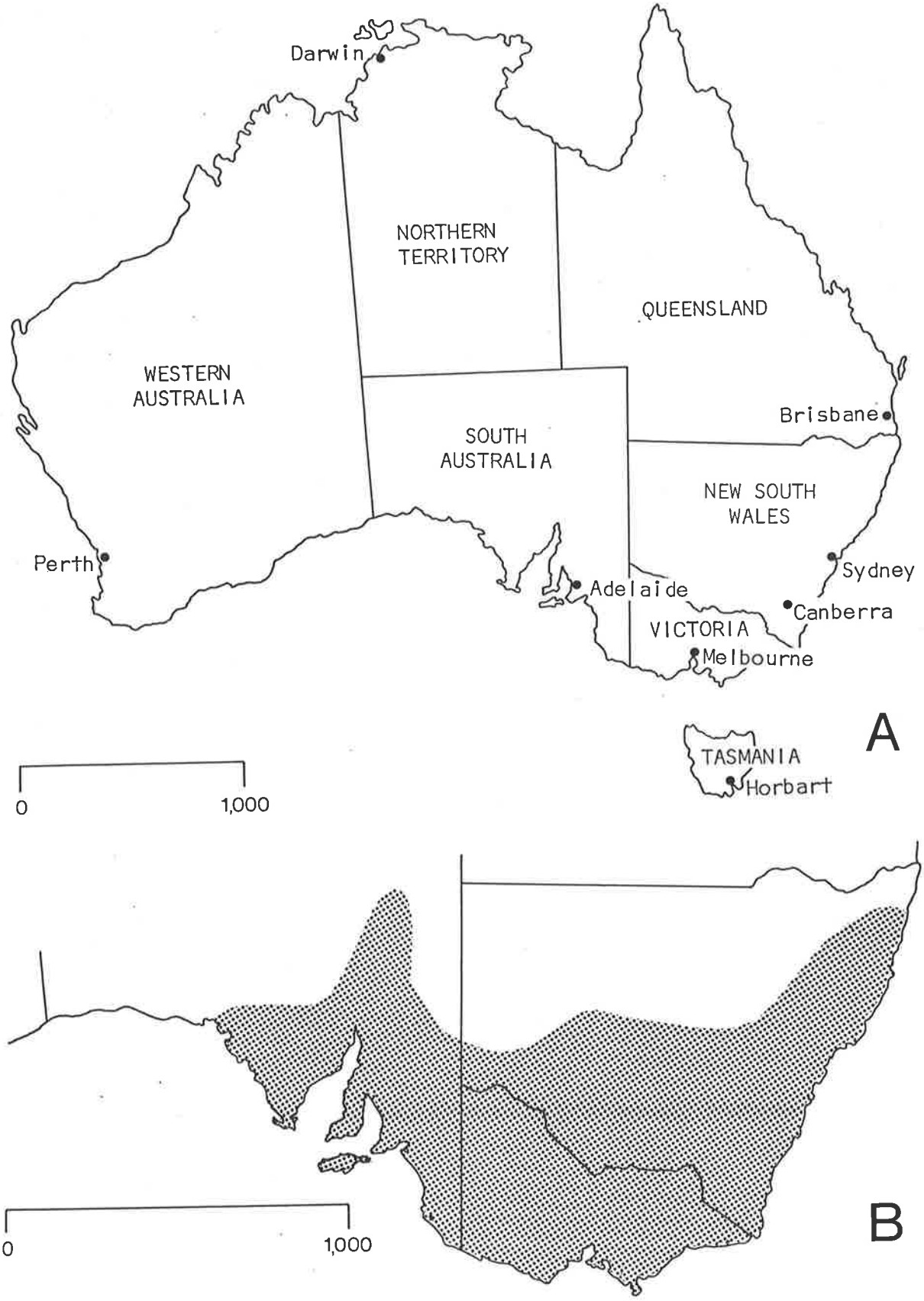

Fig. 1.1 A. Political states and capital cities of Australia referred to in text. B. Area covered during collection trips.

TABLE 1.1

Alphabetical Listing of All Species of *Senecio* Followed By All Species of Other Genera of Senecioneae Known To Occur in Australia, Their Occurrence in Each Political State and General Habit Characteristics (* indicates taxa included in present study)

	Occurrence							General
	WA	SA	VIC	TAS	NSW	QLD	NT	Characteristics
Species of *Senecio*								
amygdalifolius					+	+		* HET.R.P.H
anethifolius		+			+			* HOM.D.P.S
aff. *aparqiaefolius*		+	+		+			* HET.D.P.H
behrianus[1]		+	+		+			HET.R.P.S
biserratus		+	+	+	+			* HET.D.A.H
bipinnatisectus					+	+		* HET.D.A.H
cunninghamii[2]	+	+	+		+	+		* HOM.D.P.S
var. A[3]		+	+		+	+	+	* HOM.D.P.S
daltonii					+	+		HET.R.A.H
*elegans***	+	+	+	+				HET.R.A.H
gawlerensis[4]		+						* HOM.D.P.S
georgianus[1]	+	+	+					HOM.D.P.H
gilbertii	+							HOM.D.P.S
glomeratus	+	+	+	+	+			* HET.D.A.H
glossanthus	+	+	+		+	+	+	* HET.R.E.H
gregorii	+	+	+		+	+	+	* HET.R.E.H
gunnii			+	+	+			* HET.D.P.H
hispidulus[2]	+	+	+	+	+	+	+	* HET.D.A.H
var. *dissectus*			+		+			* HET.D.A.H
hypoleucus		+	+					* HOM.D.P.S

TABLE 1.1 - continued

	Occurrence							General Characteristics
	WA	SA	VIC	TAS	NSW	QLD	NT	
jacobaea**		+	+	+				HET.R.P.S
laceratus		+					+	HET.D.A.H
laticostatus[1]			+					HET.D.A.H
leucoglossus	+							HET.R.A.H
leptocarpus				+				HET.R.P.H
linearifolius[2]		+	+	+	+			* HET.R.P.S
var. A[3]			+	+	+			* HET.R.P.S
var. B[3]			+					* HET.R.P.S
lautus								
subsp. dissectifolius	+	+	+	+	+	+	+	* HET.R.P.H
subsp. alpinus			+	+	+			* HET.R.P.H
subsp. maritimus	+	+	+	+	+	+		* HET.R.P.H
subsp. lanceolatus			+		+			* HET.R.P.H
subsp. pilosus		+						* HET.R.? H
subsp. A[3]					+			* HET.R.P.H
magnificus	+	+	+		+	+	+	* HET.R.P.S
megaglossus[1]		+						HET.R.P.S
macranthus					+			* HET.R.P.S
mikanioides**		+	+	+	+			* HOM.D.P.L
minimus	+	+	+	+	+			* HET.D.A.H
picridioides[5]	+	+	+					* HET.D.A.H
odoratus[2]		+	+	+				* HOM.D.P.S
var. obtusifolius		+						* HOM.D.P.S
papillosus				+				HET.R.P.H
pectinatus			+	+	+			* HET.R.P.H
platylepis		+	+		+	+		HET.R.E.H
primulifolius				+				HET.R.P.H
pterophorus**		+						* HET.R.P.S

TABLE 1.1 - Continued

	Occurrence							General Characteristics
	WA	SA	VIC	TAS	NSW	QLD	NT	
quadridentatus	+	+	+	+	+	+		* HET.D.P.H
ramosissimus	+							HOM.D.P.S
runcinifolius		+	+		+			* HET.D.P.H
spathulatus			+	+	+			* HET.R.P.H
squarrosus	+	+	+	+				* HET.D.A.H
tuberculatus					+	+		HET.R.A.H
vagus[2]			+		+			* HET.R.P.H
subsp. eglandulosus					+			* HET.R.P.H
velleioides			+	+	+	+		* HET.R.A.H
vulgaris**	+	+	+	+	+	+		* HOM.D.E.H
sp. A[3]					+			* HET.R.P.S
sp. B[3]			+		+			* HET.D.A.H
sp. C[3]			+					* HET.D.A.H
Species from other genera of Senecioneae								
Arrhenechtites mixta			+		+			* HET.R.A.H
Bedfordia linearis				+				HOM.D.P.T
salicina			+	+	+			* HOM.D.P.T
Crassocephalum crepioides**					+			HOM.D.A.H
Emelia sonchifolius						+		HOM.D.A.H
Erechtites valerianaefolia**					+	+		* HET.D.A.H
Europs abrotanifolius**	+			+				HET.R.P.S
Gynura pseudochina					+	+		HOM.D.P.H
Petasites fragrans**				+				HET.R.P.H
Brachyglottis brunonis				+				HET.R.P.T

* included in present study

** adventive in Australia

TABLE 1.1 - Continued

1. rare, possibly extinct
2. typical variety
3. described in present study, not formally recognised
4. new status of S. georgianus var. latifolius (see Chapter 3)
5. new status of S. minimus var. picridioides (see Chapter 3)
6. WA = Western Australia, SA = South Australia, VIC = Victoria, TAS = Tasmania, NSW = New South Wales, QLD = Queensland, NT = Northern Territory
7. general characteristics - a. b. c. d.
   a. HOM = homogamous, HET = heterogamous
   b. D = discoid, R = radiate
   c. E = ephemeral, A = annual, P = perennial
   d. H = herb, S = shrub, L = liana, T = tree

the greatest diversity of Senecio species and of the total 44 only 6 are endemic in either Western Australia or Tasmania and three occur in drier parts of Australia. The study area therefore contains representatives of 35 of the 44 species occurring naturally in Australia.

The present study includes 30 of the 35 species in the study area, ten subspecies and varieties, four of the five adventive species, one species (S. discifolius) occurring only in Africa, nine naturally occurring hybrids and three species from other genera of Senecioneae occurring in Australia - a total of 57 taxa.

1.3 Taxonomic History of Senecioneae and Senecio

Taxonomic problems associated with treatments of Senecio are closely related to the size of the genus. Nordenstam (1977) estimated that Senecio contains 1,500 species and has been "burdened by something like 3,000 specific names" - numbers approached only in Solanum (Solanaceae), Vernonia and Hieracium (both of the Compositae). An even greater problem is created by the ill-defined boundaries of Senecio sensu stricto. At the time of writing, a full description of Senecioneae has been given by Nordenstam (1977), but no general description of Senecio that includes evidence of the last century exists in the literature. Senecio sensu stricto must comprise those species most closely allied to the type, S. vulgaris, but precise generic limitations have not yet been determined. It is therefore necessary in any treatment of Senecio to also consider characteristics of other genera of Senecioneae.

1.3.1 Senecioneae

1.3.1.1 General treatments.

Senecioneae was first recognised as a tribe of Compositae by Cassini (1826, 1829, 1834), but his creation of at least 300 new genera led his work to be viewed with some scepticism. The most widely accepted treatment of Compositae is by Bentham (1873 a and b) who reviewed the work of previous authors and arrived at a system of 13 tribes that remains largely unchanged even today. In the most recent conspectus of Compositae (Heywood, Harbourne and Turner 1977a) major changes have been suggested only in the treatment of Bentham's Helenioideae (=Helenieae) and Senecionideae (=Senecioneae), but the changes are outweighed by the overall agreement of modern treatments.

Bentham divided Senecioneae into four subtribes - (in modern nomenclature) Liabinae, Tussilagininae, Senecioninae and Othonninae. Although Hoffman (1894) largely followed Bentham's treatment of Compositae he recognised only three subtribes in Senecioneae (merging Tussilagininae with Senecioninae). Many studies have since been completed at the regional level but none managed to establish major taxonomic changes on a world-wide basis. Rydberg (1927) and Robinson and Brettell (1973) both proposed that subtribe Liabinae be recognised at the tribal level but the change was not commonly accepted. Elevation of Liabinae to the tribal level was again suggested by Nordenstam (1977) in a review of Senecioneae for the two volume "Biology and Chemistry of the Compositae" (edited by Heywood, Harbourne and Turner (1977)). Although the tribe Liabinae appears to be gaining acceptance, Nordenstam's suggestion that a number of genera related to Arnica might also merit tribal recognition was not as

well received by other contributors. As circumscribed by Nordenstam (1977, 1978) Senecioneae contains two subtribes - Senecioninae with 96 genera and Blennospermatinae containing 4 genera with more obscure affinities. Although Nordenstam (1977) did not consider that Senecioninae could be further subdivided, he discussed two loosely characterized complexes termed "cacalioid" and "senecioid" genera. As both "cacalioid" and "senecioid" features occur in some Australian species classified as Senecio the characteristics of each complex are fully described in Chapter 2.

A most difficult problem that is related to Senecioneae exists in the proposed redistribution of genera previously ascribed to Helenieae by Bentham (1873a). Turner and Powell (1977) commented that "in erecting this group Bentham seemed more intent on making more homogeneous the tribes from which the included genera were withdrawn than he was concerned with the recognition of a monophyletic assemblage." Turner and Powell therefore proposed a redistribution of the genera among six tribes, most of these being placed with the Heliantheae and Senecioneae. However, Nordenstam (1977) preferred to maintain a taxonomically homogeneous view of Senecioneae, accepting only the subtribe Blennosperminae and rejecting the Chaenactidinae, Peritylinae, Eriophyllinae, Flaveriinae and Arnicinae positioned there by Turner and Powell. If the present tribal division of Compositae (i.e. $\pm$ 13 tribes) is to be maintained it would seem obvious that additional genera of Helenieae must be accepted into Heliantheae and Senecioneae. To expect all genera of so diverse a family as Compositae to conveniently fall into one of 13 homogeneous tribes would seem extremely optimistic. The alternative of elevating problematic subtribes to the tribal level can only compound the problem as phyletic positions are likely to then

be obscured. If the Compositae is accepted as an extremely successful and actively evolving family, then the presence of subgroups with intermediate characteristics must be expected and such groups should be incorporated into the taxonomy rather than divorced from it.

A second but preliminary review of Senecioneae by Jeffrey, Halliday, Wilmot-Dear and Jones also appeared in 1977. Although the work is titled "Generic and sectional limits in Senecio" much of Senecioneae is covered. Jeffrey et al. proposed a system of three major series, 16 groups and 62 clusters each containing one or more modal species around which other species might be reliably grouped. However, the treatment is extremely brief (20 pages) and provides no reasoning for the placement of modal species. Furthermore, in a second and even shorter publication (Jeffrey 1979) the original treatment was completely revised - the 16 groups being reduced to 10, the clusters frequently combined into subgroups and the treatment expanded to include other recognised genera of Senecioneae. Jeffrey (1979) commented of Nordenstam's work that it demonstrates "on the one hand, progress towards resolving some of the taxonomic anomalies pointed out by Jeffrey et al. (1977), but, on the other hand, some of the dangers involved in attempts to dissect Senecio sensu lato piecemeal without the guidance of a universally applicable background scheme." Although I cannot comment on the validity of new or reinstated genera proposed by Nordenstam (1978), or of the soundness of Jeffrey's (1979) criticism of Nordenstam's work, I have generally found that comments made by Nordenstam (1977, 1978) are most applicable to Australian species belonging to Senecioneae and Senecio. I support the opinion expressed by Jeffrey (1979) that the limits of Senecio sensu stricto should be decided by working outward from the type

S. vulgaris, but I consider the subdivision of Senecioneae proposed by Jeffrey (1979) to be very confusing and unacceptable in its present form.

1.3.1.2 Genera of Senecioneae occurring in Australia.

Only six of the 100 genera of Senecioneae listed by Nordenstam (1977) occur naturally in Australia although a further four are recent introductions, each represented by one species (see Table 1.1). Bedfordia is the only endemic Australian genus although eight genera (according to Nordenstam 1977, 1978) are endemic in Australasia. Taxonomic problems associated with Australian genera of Senecioneae are comparatively few, but the genus Arrhenechtites deserves mention. Arrhenechtites consists of five species from New Guinea known only from their holotypes and A. mixta found only in Australia. Belcher (1956) modified the protologue of Arrhenechtites to admit Senecio mixtus Rich. with pistillate florets subligulate and more numerous than the phyllaries. According to Belcher, Arrhenechtites is characterized by functionally staminate disc florets with style arms reduced and astigmatic. However, I found the disc florets of A. mixta were fully fertile and stigmatic (although reduced) and believe it may be necessary to create a new and monospecific genus to accomodate this species.

1.3.2 Senecio

1.3.2.1 General treatments.

The first formally recognised description of Senecio is that of Linnaeus (1754). Regional collections and systematic treatments rapidly increased the size of the genus and when DeCandolle (1837)

described all known species the number had reached 596. The generic boundaries of Senecio were not again considered as a whole until Bentham's treatment in "Genera Plantarum" (Bentham 1873a), by which time the estimated number of species was 900. As was the case with Senecioneae, no attempts were made to revise Bentham's protologue of Senecio until 1977 when the works of Nordenstam and Jeffrey et al. were published. Both treatments recognised that Bentham's widely accepted description of Senecio was much too broad, but neither of the 1977 treatments were able to give a clear description of Senecio sensu stricto. Characteristics summarized in Table 1.3 are taken from the works of Nordenstam (1977, 1978), Jeffrey et al. (1977) and Jeffrey (1979) and are apparently typical of Senecio.

1.3.2.2 Species of Senecio occurring in Australia.

Australian species of Senecio have only twice been considered as a whole - by DeCandolle in 1838 and by Bentham in 1866. The earliest description of a species occurring in Australia is that of S. lautus published by Willdenow in 1803*. By 1837, an additional 12 species of Senecio had been described by different authors and following the work of DeCandolle (1837) the number increased to 32. DeCandolle divided Australian taxa on the basis of capitulum morphology, placing all those with marginal filiform florets in Erechtites and the remainder in Senecio as either subgroup Radiati or Discoidei of his series 4 - Australasici. Australian taxa were not again considered as a whole until Bentham's treatment in "Flora Australiensis" (Bentham 1866), but in the intervening years a further 16 species of Senecio had

*Although Willdenow's description of S. lautus was based on New Zealand specimens, Ali (1969) concluded that Australian and New Zealand populations are conspecific.

TABLE 1.3

Characteristics of a Typical *Senecio* Species

Characteristic	References* 1	2
1. Stigmatic surface of two marginal lines	+	+
2. Style apices truncate, without a sterile appendage or median fascicle	+	+
3. Filament collar basally swollen (balusterform)	+	+
4. Endothecal tissue "radial"	+	+
5. Involucre uniseriate with a basal calyculus	+	
6. Pappus bristles uniform or dimorphic		+
7. Receptacle naked	+	
8. Gametic chromosome number of N = 10, 20 or obvious aneuploid derivatives	+	

* Reference 1: Nordenstam (1977, 1978)

Reference 2: Jeffrey et al. (1977), Jeffrey (1979)

been described by F. von Mueller. Bentham followed DeCandolle's treatment of Australian taxa, maintaining both the genus Erechtites and series Radiati and Discoidei of Senecio. Although Bentham did not effect any major generic changes, he critically examined all previously named taxa and reduced many to synonymy.

For the next 100 years the taxonomy of Australian Senecio species remained largely unchanged, all flora writers following Bentham's treatment of the genus. However, in 1956 Belcher examined Australian species placed in Erechtites by DeCancolle (1837), and on the basis of style arm morphology, returned them all to Senecio. Belcher did not create a new section in Senecio for the erechthitoid species, saying that there are some species which "clearly intergrade into the discoid group and others which intergrade into the radiate group." Belcher cited as examples radiate forms of the discoid S. vulgaris and marginally pistillate florets on a specimen of the discoid S. aureus var. subnudus - neither of which is native in Australia. Some intergradation was observed in this study (see Chapter 8) but plants of intermediate morphology were always completely sterile (or almost so) F1 hybrids.

After the work of Belcher (1956), taxonomic studies of Australian Senecio species were largely confined to two variable species - S. linearifolius and S. lautus. In the case of S. linearifolius, a short discussion clarifying some early taxonomic problems was published by Willis (1957). S. lautus received considerably more attention, both in New Zealand (Ornduff 1960, 1964) and in Australia (Ali 1964a, 1964b, 1964c, 1966, 1968, 1969). Past and present problems associated with this species are fully discussed in treatment 1 of Chapter 3.

In recent years, reference has been made to a few Australian species of Senecio by Jeffrey et al. (1977), Jeffrey (1979) and

Nordenstam (1977, 1978). Jeffrey et al. proposed a system of 182 modal species of Senecio "around which other species might reliably be clustered." The modal species were arranged into 62 clusters, 16 groups and 3 major series. Four Australian species were included among the modal species and of these, S. gregorii (radiate), S. quadridentatus (erechthitoid) and S. hypoleucus (discoid) occur in group 9, subgroup a, minor series 6, cluster 33 - along with various African and Madagascan species. The Australian S. lautus was placed with the type species, S. vulgaris, in subgroup c, cluster 40 of the same group. However, in a later modified scheme (Jeffrey 1979) cluster 33 was placed with clusters 38, 21, 39 and 38 which include some South American species, and clusters 40 and 41 were combined to make a cosmopolitan group. Furthermore, S. gregorii was removed from group 9 (considered by Jeffrey et al. to be "true" Senecio species) and placed in group 10 next to the genus Othonna. As it has not been possible to examine specimens or trace descriptions of all species supposedly allied to Australian taxa, I cannot comment on the soundness of the scheme proposed by Jeffrey (1979). However, my general opinion is that the system is confusing and most unsatisfactory in its present form. A significant point is that Nordenstam (1978) also considered S. gregorii to be "anomalous" in its present position in Senecio, although he did not mention which characteristics were atypical. My own conclusions concerning S. gregorii are given in treatment 4 of Chapter 3.

The most significant works in the taxonomic history of Australian species of Senecio are therefore the treatment of erechthitoid species by Belcher (1956) and the treatment of discoid and radiate species by Bentham (1866). Although time did not permit a formal taxonomic revision of all Australian

species in the present study, it was necessary to re-examine the taxonomy of those species included and to provide descriptions in all cases. Past and present taxonomic treatments of each species are discussed after each description in Chapter 3.

CHAPTER 2

Morphological Variation and Descriptive Terminology

Chapter 2 - continued

2.11 The achene

2.11.1 Pubescence and mucilaginous properties

2.11.2 Surface sculpturing

2.11.3 Polymorphisms

2.12 "Senecioid" and "cacalioid" characteristics

2.1 Introduction

The objectives of this chapter are to provide a guide to terminology used in morphological descriptions (see Chapter 3) and to compare the characteristics of Australian species of Senecio with those of species occurring in other parts of the world. Unless otherwise specified, descriptive terminology follows the glossaries of Stearn (1966) and Porter (1967).

Heywood et al. (1977b) made the following observation of characters found to be taxonomically useful in the Compositae:

> "In common with other natural families such as Cruciferae, Umbelliferae and Gramineae, the uniformity in inflorescence, floral and fruit structure imposed by the family characters tend to make recognition of tribes and genera difficult. For the recognition and circumscription of tribes and genera, use has often to be made of small scale or 'trivial' characters whose validity and significance is often placed in doubt."

The comments are of equal relevance to characters used in the subdivision of Senecioneae and Senecio. Style and stamen morphology are of fundamental importance at all taxonomic levels, but can only be observed after careful dissection and examination of structures at 100x to 400x magnification. In the last decade previously neglected features such as ovary wall crystals, endothecal tissue types and the shape of the filament collar have been added to the list of microcharacters. Such characters may frustrate the casual student of Compositae, although with practice they are relatively easy to observe.

A problem more difficult to reconcile is the criteria by which genera are recognised. Genera of Senecioneae are rarely, if ever, distinguished by a single character. Instead, a suite of characters uniquely combined in (but not necessarily unique to) a particular genus form the basis of taxonomic recognition.

In the present study, some Australian species classified as Senecio were found to possess one or more characteristics not typical (see Table 1.3) of Senecio. A difficulty is then encountered in deciding how many atypical characteristics a species can possess before it warrants recognition at the generic level.

2.2 Materials and Methods

With three exceptions material of each taxon was collected in the field by the author (a complete list of collection sites is provided after each species description in Chapter 3). Senecio discifolius and S. lautus subsp. lautus do not occur in Australia and were raised from seed in the glasshouse. S. amygdalifolius could not be found during field trips but plants were raised from cuttings of material sent from Coffs Harbour in New South Wales. At each site, herbarium specimens of three individuals were collected, a minimum of ten capitula were fixed in FAA (1:1:18 formalin:acetic acid:70% alcohol) and young capitula were fixed for cytological investigations (see methods in Lawrence (1980); copy bound with thesis).

Variation in the size and number of structures was assessed from measurements of the three plants collected from each population, and in most cases, a minimum of three populations were examined. Structures of different sizes were treated as follows:

1. those greater than 1 cm in length or width were measured with a ruler calibrated in mm units;
2. those between 1 mm and 10 mm were measured using a stereo microscope fitted with a 1 cm graticule calibrated in 0.1 mm units;

3. those smaller than 1 mm were measured at 100x or 400x magnification using a microscope fitted with a 1 mm graticule calibrated in 10 μm units.

2.3 Vegetative Characteristics

All native Australian species of Senecio have alternate leaves and pinnate venation. In the majority of cases, leaves are sessile or basally attenuate but the leaves of S. hypoleucus and S. amygdalifolius are distinctly petiolate. Leaves of S. vagus differ from all other species - being either compound or deeply incised. However, general leaf morphology has not been frequently used above the specific level in Senecioneae. Exceptions are the genera Gynoxys, Scrobicaria and Herodotia with opposite leaves, and sections of a number of genera including Senecio distinguished by palmate venation (Nordenstam 1977).

Leaf and stem pubescence varies widely among Australian species, from those that are completely glabrous such as S. magnificus and S. velleioides to those that are densely white-tomentose such as S. hypoleucus. The morphology of individual trichomes has been shown to be significant in the taxonomy of Senecioneae by Drury and Watson (1965) and Drury (1973a). However, in this study observations of vestiture were restricted to general characters visible under a stereo microscope.

2.4 The Inflorescence

The term inflorescence is here interpreted as the arrangement of all capitula above the uppermost full-sized cauline leaf.

Eames (1971) commented that "the inflorescence is not a morphological unit but rather a part of the branching system of the stem with more or less definitely segregating flowering tips." It is therefore not surprising that the inflorescence has always been a rather difficult morphological character to classify. Inflorescence forms occurring among Australian species are illustrated in Figure 2.1. By the above definition, S. gregorii (Fig. 2.1B) has solitary capitula but might elsewhere be described as having capitula in a simple leafy corymb. By far the most common inflorescence form of Australian species is a corymbose panicle (Fig. 2.1C and D), although less regular forms also occur (Fig. 2.1E). Nordenstam (1977) described the inflorescence of Senecioneae as consisting of terminal or lateral, solitary, paniculate, corymbose or racemose capitula, but the character does not appear to have been widely used above the specific level.

Inflorescence density varies considerably and is a direct function of the peduncle length (the term peduncle here refers to the flowering stem immediately below the capitulum). As the inflorescence density is in turn correlated with capitulum morphology and breeding system, peduncle lengths are included in all species descriptions.

2.5 The Involucre and Receptacle

All but one Australian species of Senecio have a uniseriate involucre of free but interlocking involucral bracts (phyllaries). One species, S. gregorii, has fused phyllaries that split irregularly to release mature achenes, and it is presumably because of this character that Jeffrey (1979) placed S. gregorii with Othonna in his subdivision of Senecioneae. However,

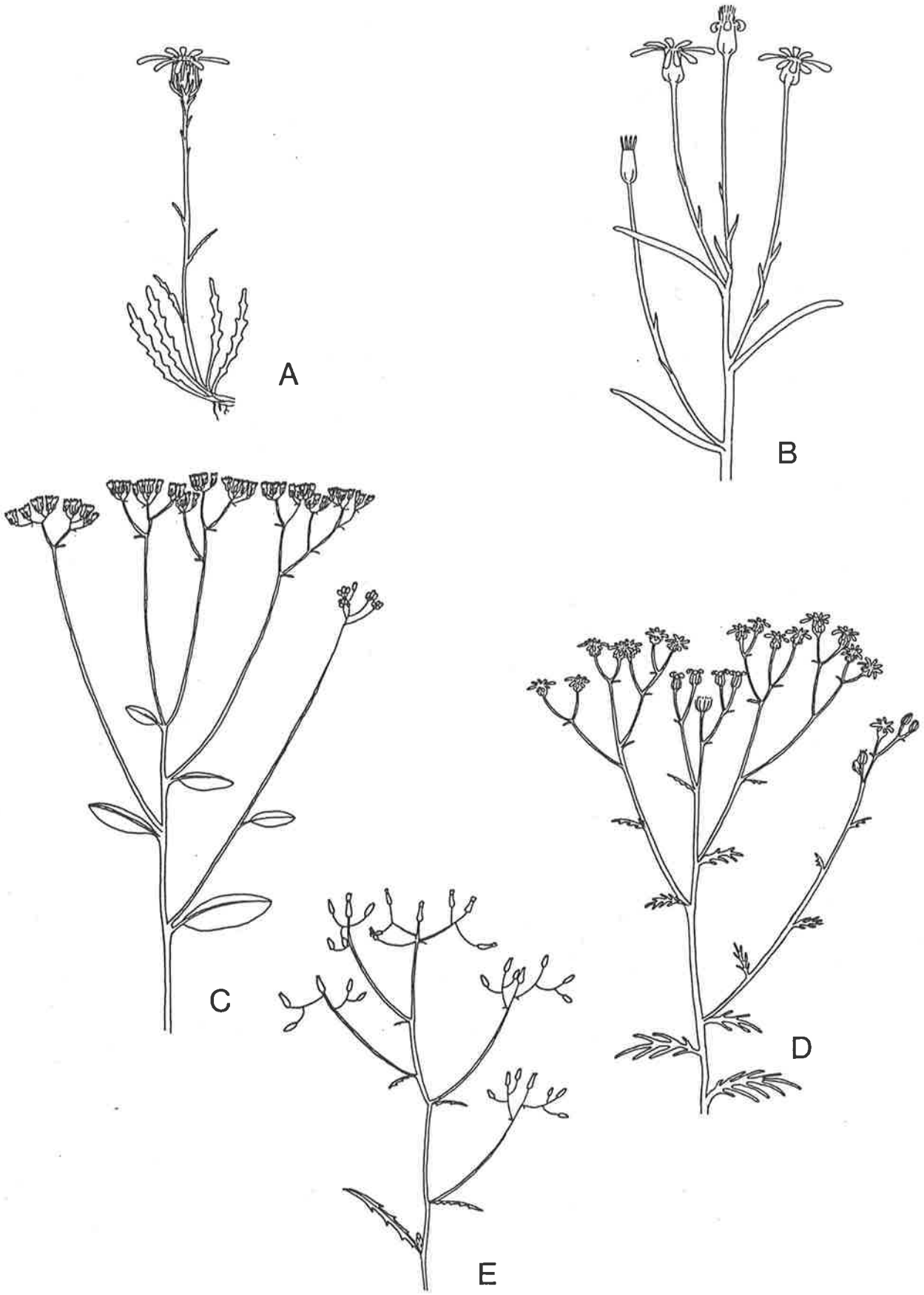

Fig. 2.1 Inflorescences of Australian Senecio species.
A. S. pectinatus. B. S. gregorii. C. S. hypoleucus.
D. S. lautus. E. S. runcinifolius.

Nordenstam (1977) commented that "the connate involucre has been overemphasized in the past" and that "even within a single genus, viz. Euryops this character is not absolutely constant, and it recurs occasionally in species of Senecio."

A second involucral characteristic is the calyculus, a row or several rows of bracts occurring at the base of the involucre. The base of the involucre is here interpreted as the base of the receptacle and is not therefore synonymous with the base of the phyllaries (see Fig. 2.2A). The calyculus of Australian species varies from a single row of radiating bracts almost as long as the phyllaries (e.g. S. macranthus, Fig. 2.2B), to several rows of shorter adpressed bracts (e.g. S. lautus, Fig. 2.2C) or three or four short adpressed bracts in one row (e.g. S. hypoleucus Fig. 2.2D). S. gregorii (Fig. 2.2E), S. magnificus (Fig. 2.2F) and S. velleioides have no calyculus at all. It is not known if other species currently accepted in Senecio also lack a calyculus, but significantly, Othonna and Euryops are both characterized by ecalyculate involucres.

The receptacle of all Australian species of Senecio is flat, although convex to subconical receptacles occur elsewhere in Senecioneae (Nordenstam 1977). The receptacle surface is always pitted (the pits corresponding to attachment points of florets) but the pit margins of Australian species are variable. In some the pit margins are obscure and the receptacle naked, but in others the margins are raised and then shortly toothed or with scale-like projections. As variation within one species was sometimes large (e.g. S. lautus) the receptacle surface was of little taxonomic value.

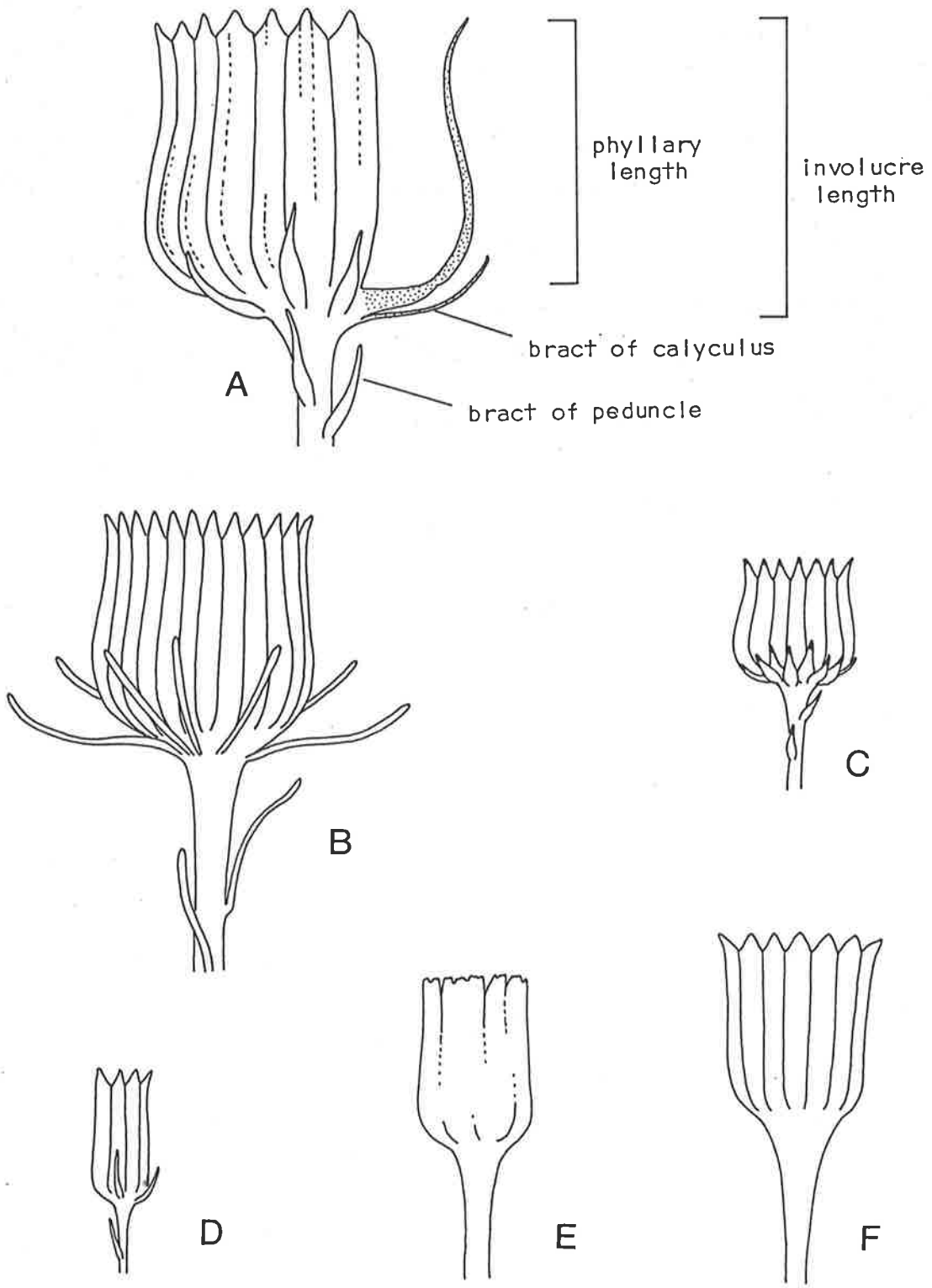

Fig. 2.2 Involucre characteristics and variation in Australian species of Senecio. A. General involucre morphology. B. S. macranthus. C. S. lautus. D. S. hypoleucus. E. S. gregorii. F. S. magnificus. (B-F 2x actual size)

2.6 Distribution of Florets Within Capitula

Floret morphology and gender are of fundamental importance to the taxonomy of Compositae. Capitula of Australian species of *Senecio* (and Senecioneae) can be classified into one of three types on the basis of the distribution of florets within capitula:

1. heterogamous radiate (radiate species, Fig. 2.3D)
2. homogamous discoid (discoid species, Fig. 2.3E)
3. heterogamous discoid (erechthitoid species, Fig. 2.3F)

Only one other form apart from those illustrated in Figure 2.3 occurs in Senecioneae and that is capitula with staminate or male disc florets. Belcher (1956) placed the Australian *Arrhenechtites mixta* in this category, but in the present study (see treatment 36, Chapter 3), the species was found to have fertile and bisexual disc florets.

Capitulum form is also indicative of breeding system. With two exceptions, all species of groups 1 and 2 above were found to be self-incompatible whereas species of group 3 were self-compatible. The exceptions are both self-compatible - the European *S. vulgaris* with homogamous discoid capitula and the Australian *S. glossanthus* with heterogamous radiate capitula.

A confusing point of terminology that deserves mention is that ray and ligulate florets of Compositae are not the same, although the terms are often used interchangeably. Ligulate florets by definition are restricted to Cichorieae (Carlquist 1976) and can be identified by their deeply slit, 5-toothed corolla with veins outlining each tooth. Ray florets usually have three teeth and superficially fewer veins.

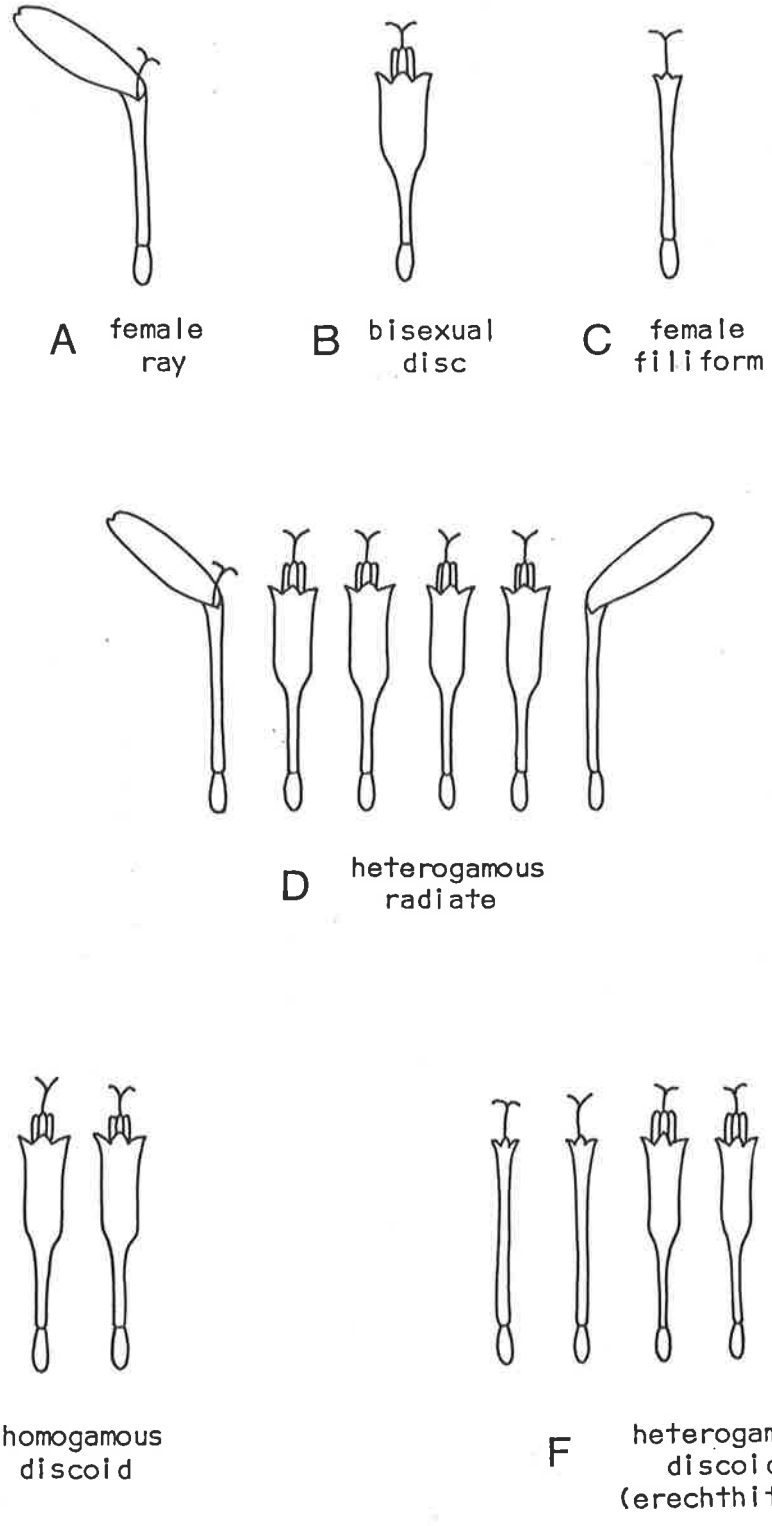

Fig. 2.3 Floret types (A-C) and their distribution in capitula (D-F) of Australian species of Senecio.

2.7 The Corolla

The basic corolla form of all Compositae is a 5-lobed tube, but in many species the lobes of some florets are fused and extended to form a ligule. Four characteristics of the corolla are taxonomically useful and each is discussed below.

2.7.1 Shape

Corolla shapes found among Australian species of Senecio are illustrated in Figure 2.3 A to C, and are typical of forms occurring in Senecioneae. Some variation does occur - the most obvious being ray length which varies from 1 to 20 mm (S. glossanthus and S. macranthus, respectively). Although disc florets (Fig. 2.3B) are nearly always 5-lobed, filiform florets (Fig. 2.3C) may have 3-, 4- or 5-lobed corollas. Lobe lengths may also vary, and although the majority of species have disc corolla lobes about 1/10 as long as the corolla tube, those of S. amygdalifolius are about 1/6 as long.

2.7.2 Venation

Most Australian radiate species have four longitudinal veins apparent on the ligule - the most common number in Senecioneae (Jeffrey et al. 1977). However, the ligules of S. spathulatus are 6- to 9-veined and those of S. vagus are consistently 7-veined. S. megaglossus, a rare, possibly extinct species is exceptional with 16 to 20 veins on each ligule (the highest number of ligule veins reported by Jeffrey et al. (1977) was 10).

2.7.3 Pubescence

The occurrence and distribution of hairs on the corolla tube in Australian species of Senecio is variable. Hairs occur most frequently on the upper portion of ray floret corollas but are

absent from the ray florets of S. pectinatus and S. vagus. Disc floret corollas are less commonly pubescent, occurring in S. magnificus, S. macranthus and S. linearifolius as well as the outermost disc florets of 4 of the 6 homogamous discoid species. Hairs were also found on the outermost filiform floret corollas of most heterogamous discoid species (erechthitoid species). In all cases the hairs were apparently glandular, but varied from uniseriate to biseriate and from 2 to 15 cells in length. Nordenstam (1978) and Jeffrey et al. (1977) both mention corolla pubescence but neither have used the characteristic to distinguish taxa. Among Australian species of Senecio the character is also of limited taxonomic use.

2.7.4 Ligule Colour and Epidermis

All Australian species of Senecio studied have a yellow ligule with a smooth epidermis. However, ligules of the African S. discifolius (raised from seed) proved to be yellow with a papillose epidermis. Baagøe (1977) found that cell types of the upper ligule surface were correlated with ligule colour in Senecioneae - smooth cells occurring on yellow ligules and papillose cells on non-yellow (white or purple) ligules. Nordenstam (1978) found three exceptions to the rule in Urostemon, Dolichoglottis and Dorobaea, but Senecio discifolius appears to be the only known exception in Senecio.

2.8 The Pappus

Three pappus types were found among Australian species of Senecio - uniform and persistent, uniform and caducous and dimorphic and caducous. The last is the most frequent form and occurs in the type species, S. vulgaris, but the other forms are included in the variation described by Nordenstam (1977) for

Senecioneae. Dimorphic pappus bristles were first observed by Drury and Watson (1966). Most bristles in such a pappus are of the "typical" form (Fig. 2.4A) but a few are somewhat shorter, 2-celled throughout and have apical cells with inverted or retrorse teeth (Fig. 2.4B). Drury and Watson (1966) termed the latter bristle type "fluked".

Persistent pappus types were found in the Australian Senecio gregorii, S. magnificus and S. spathulatus and may affect the dispersal potential of achenes (see Chapter 4.4.5). Each of these species have longer bristle teeth than other species and in the most extreme case (S. magnificus, Fig. 2.4C) the bristles are subplumose. The pappus of Bedfordia salicina was also found to be persistent but in this case the bristles were distally 3- to 4-celled and the cells very crowded (Fig. 2.4D). Although pappus types may be indicative of phylogenetic relationships as suggested by Drury and Watson (1966), it is also possible that they are related to the dispersal requirements of different species. Similar pappus types need not therefore reflect phylogenetic affinities.

2.9 Androecium

The androecium of all species of Senecioneae and of most species of Compositae consists of 5 epipetalous stamens alternating with the corolla lobes. The filaments are free, but anthers cohere laterally to form a cylinder (anther collar) around the style. Skvarla et al. (1977) reviewed the literature concerning pollen morphology in Compositae. Considerable variation occurs in some tribes, but the variation is not as extensive in Senecioneae. The pollen of all Australian species

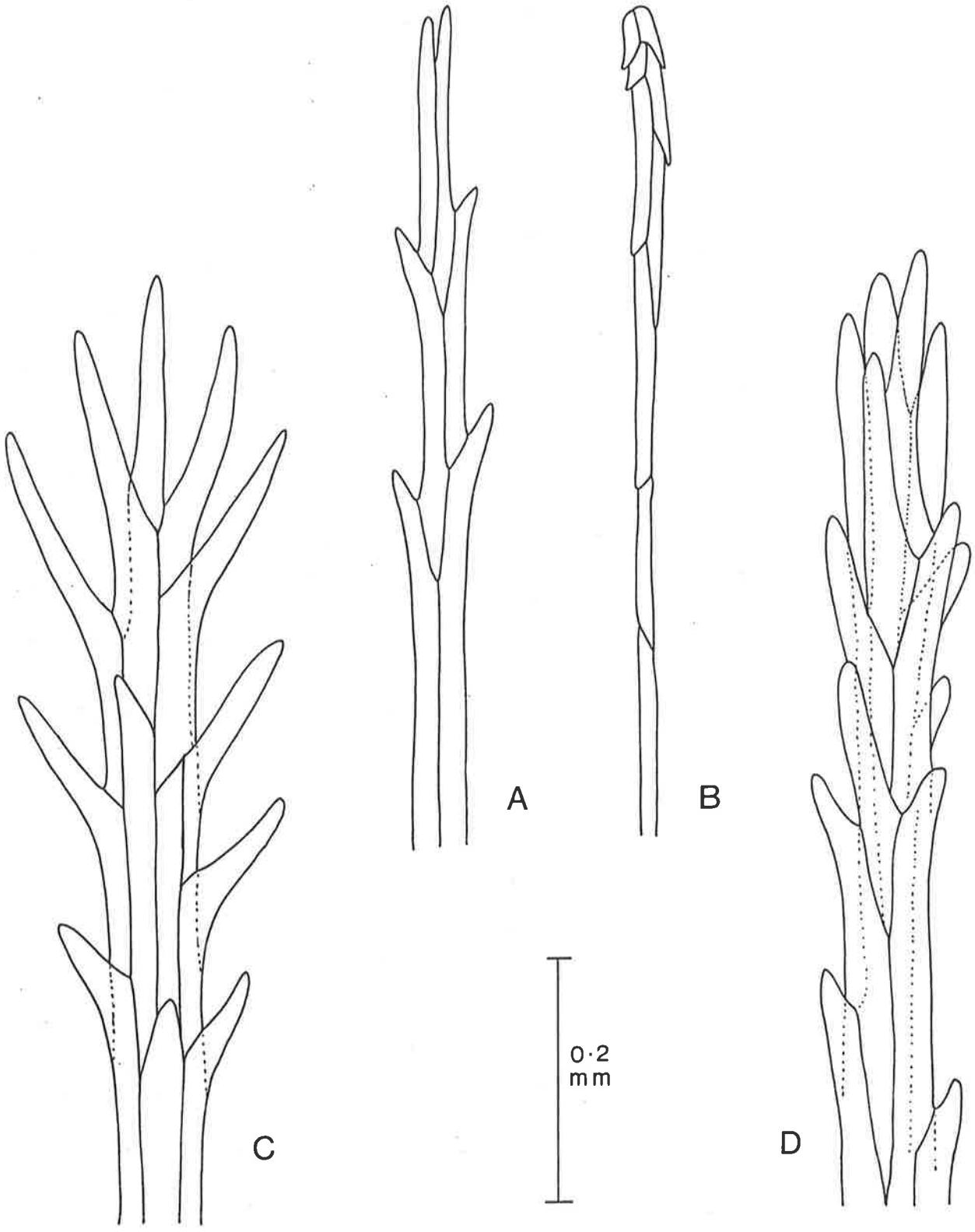

Fig. 2.4 Pappus types of Australian Senecioneae. A. Typical *Senecio* bristle. B. 'Fluked' *Senecio* bristle. C. Subplumose bristle of *S. magnificus*. D. *Bedfordia salicina*.

was found to be triporate and typically echinate, varying only in size. Greater variation was found in the four staminal structures described below.

2.9.1 Filament Collar

The filament collar is collectively those portions of the filaments immediately below the anthers, and can be distinguished by its transparent cells with thick cell walls. Cells of the remaining portion of the filament are opaque and difficult to distinguish. Two collar types are found in Senecioneae:

1. cells of uniform size and the collar no wider than the filament (Fig. 2.5 I), termed "cylindrical" by Drury (1973b) and "cacalioid" by Nordenstam (1978)
2. cells of the basal collar region variously inflated and the collar slightly to very much wider than the filament (Fig. 2.5G and H), termed "balusterform" by Drury (1973b) and "senecioid" by Nordenstam (1978).

To avoid confusion, filament collars are described as either "cylindrical" or "basally swollen" in the present study. The filament collars of all Australian species of Senecio examined are basally swollen (although only slightly so in the cases of S. velleioides and S. amygdalifolius). The only species with a truly cylindrical filament collar and included in this study is Bedfordia salicina.

2.9.2 Anther Base

Bentham (1873a) and others since included the character of tailed anther bases among those used to separate tribes of Compositae. However, the anther bases of Australian species of Senecio vary from obtusely rounded (2.5 D) to shortly tailed

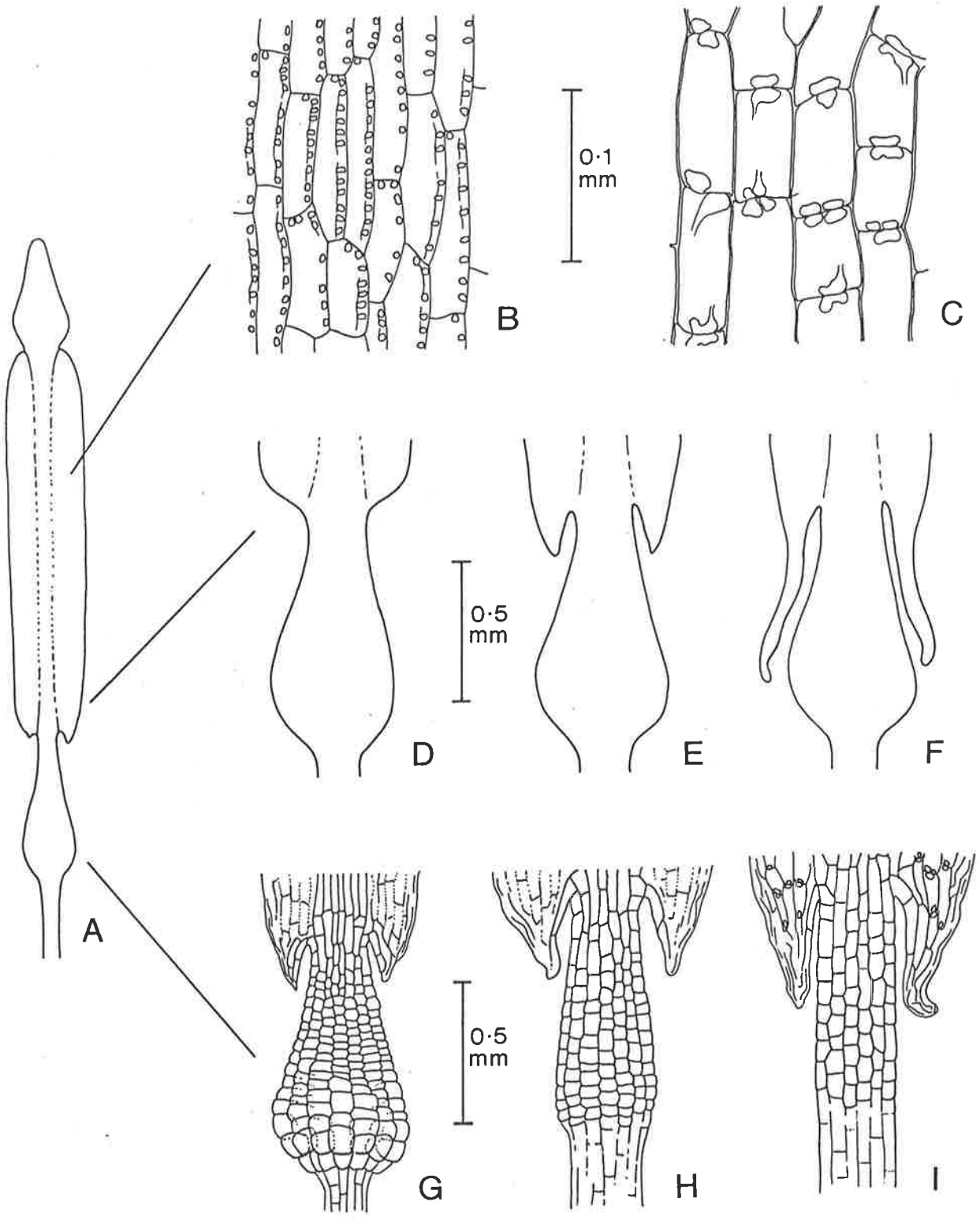

Fig. 2.5 Variation in androecium characteristics of Australian Senecioneae. A. General stamen morphology. B. Radial endothecal tissue (Senecio). C. Polarized endothecal tissue (Bedfordia). D-F. Variation in theca bases. G-I. Filament collars, G. Senecio lautus, H. S. velleioides, I. Bedfordia salicina.

(2.5 F). Nordenstam (1977, 1978) observed similar variation in other genera of Senecioneae. The use of anther bases in the taxonomy of Compositae would therefore seem best restricted to the generic or subgeneric level.

2.9.3 Endothecal Tissue

Dormer (1962) first observed that cells of the anther lobes (fibrous or endothecal tissue) can be classified into three forms on the basis of wall thickenings:

1. end walls ribbed, side walls smooth-- termed "polarized"
2. all walls distinctly ribbed - termed "radial"
3. cells uniformly thickened - termed "transitional"

Polarized and transitional forms are easy to classify as all cells are of the one type, but as Dormer (1962) indicated, anthers classified as "radial" have all three cell types in different regions and observations must be made of the abaxial lobe surface. All Australian species of Senecio have "radial" endothecal tissue (Fig. 2.5B) but Bedfordia salicina was again distinctive with "polarized" endothecal tissue (Fig. 2.5 C).

2.9.4 Apical Appendage

The sterile connective tissue of Compositae anthers is usually distally elongated to form a flattened apical appendage. Appendages of Australian species of Senecio vary in size and shape but the variation was largely correlated with anther length and width.

2.10 The Gynoecium

All Compositae have a bifurcate style and a unilocular inferior ovary containing one basal ovule, Despite this underlying uniformity, parts of the gynoecium are of fundamental importance to the taxonomy of Compositae.

2.10.1 Style Branches

Some of the variation in the style branch morphology of Australian species of Senecioneae is indicated in Figure 2.6. The style branch most typical of Senecio is shown in Figure 2.6A. The branches are dorsally glabrous, more or less truncate distally with several rows of collecting hairs forming a partial crown (i.e., hairs absent on the ventral surface) and have two marginal lines of stigmatic papillae on the ventral surface. The most significant departure is a continuous stigmatic surface found in several heterogamous radiate species presently classified as Senecio (see group 1A, Chapter 3.6.2). Nordenstam (1977) considered a continuous stigmatic surface to be one of three characteristics normally associated in "cacalioid" (as opposed to "senecioid",) genera. Although Australian species of Senecio with continuous stigmatic surfaces are in other respects "senecioid" (see part 12 of this chapter) their classification is placed in doubt.

2.10.2 Style Base and Nectary

Nordenstam (1978) found significant variation in the degree of swelling of the style base and in the shape and size of the nectary immediately beneath. However, in all species examined in the present study the style base was only slightly swollen and was placed on a minute cylindrical nectary.

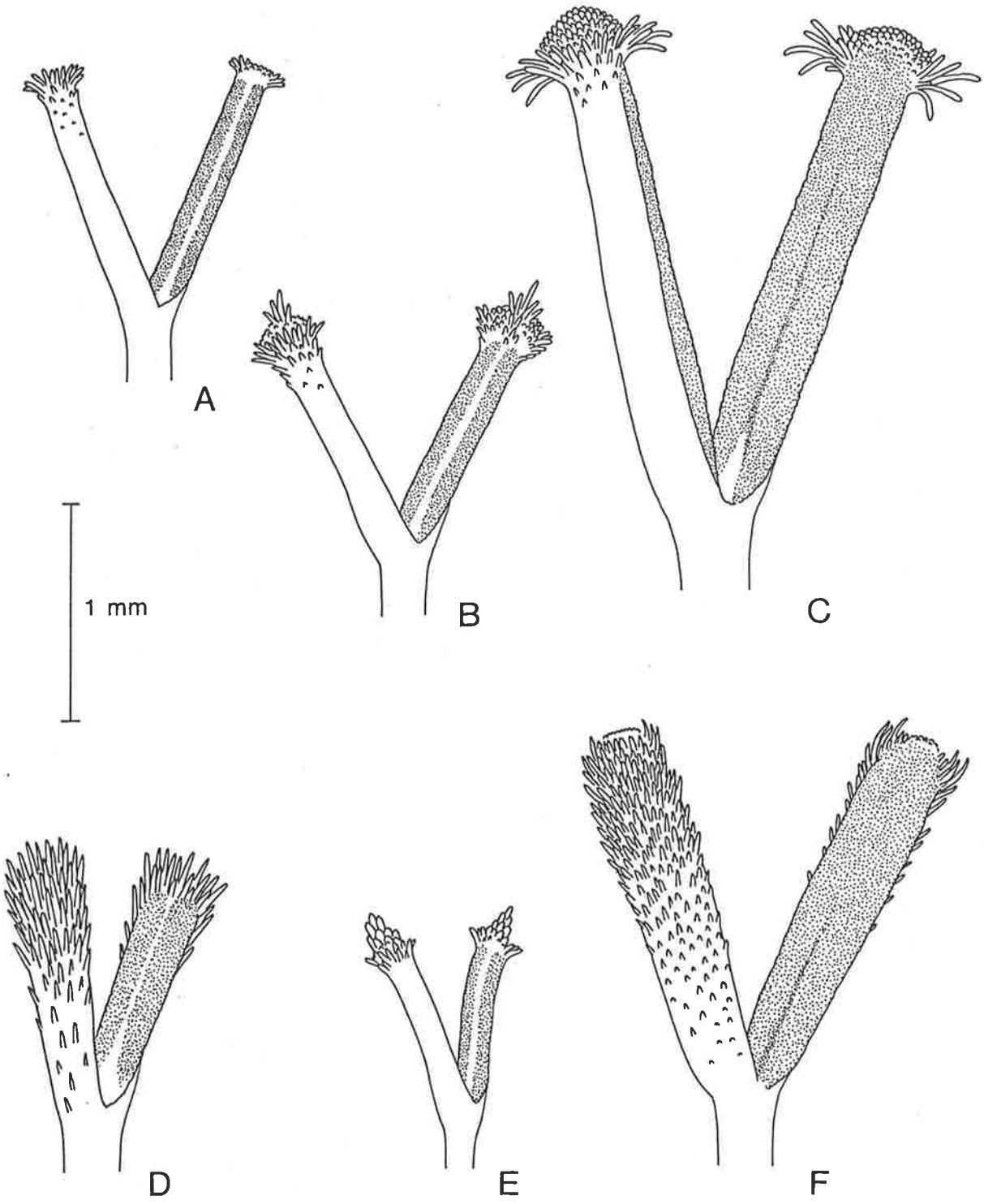

Fig. 2.6 Variation in style branches of Australian Senecioneae. A. Typical Senecio morphology. B. S. gregorii. C. S. magnificus. D. Arrhenechtites mixta. E. Erechtites valerianaefolia. F. Bedfordia salicina.

2.10.3 Ovary Wall Crystals

Examples of ovary wall crystals found in species of Senecioneae examined are shown in Figure 2.7. Most species have one large crystal in each cell of the ovary wall, and although crystals may vary considerably in size within one species, one crystal form is usually predominant. The most frequent form is a flat hexagonal plate 4 to 7 times longer than wide, although a few small druse or cluster crystal types usually occur in the same tissue. Distinctive rhombic plates occurred in Erechtites valerianaefolia (Fig. 2.7 A) and comparatively small and irregular crystal in Arrhenechtites mixta (Fig. 2.7 B).

Since their discovery by Dormer (1961) various authors (Drury and Watson 1965, Nordenstam 1978) have examined the form of calcium oxalate crystals in the ovary walls of Senecioneae. Nordenstam (1978) indicated that ovary wall crystals might be taxonomically useful, but that much more study is needed to determine the range of crystal forms in Senecio. Variation found in the present study suggests that ovary wall crystals may be useful at the generic level.

Nordenstam (1978) photographically illustrated 15 different crystal forms providing up to 13 examples of each, however, the photographs are very misleading. Each crystal appears to have a thick wall and an inner lumen, but the "wall" is in fact the remains of the original photographic background and the "lumen" is the crystal itself. Although the crystals in Figure 2.7 are intensified by phase-contrast optics, their shape is accurately represented.

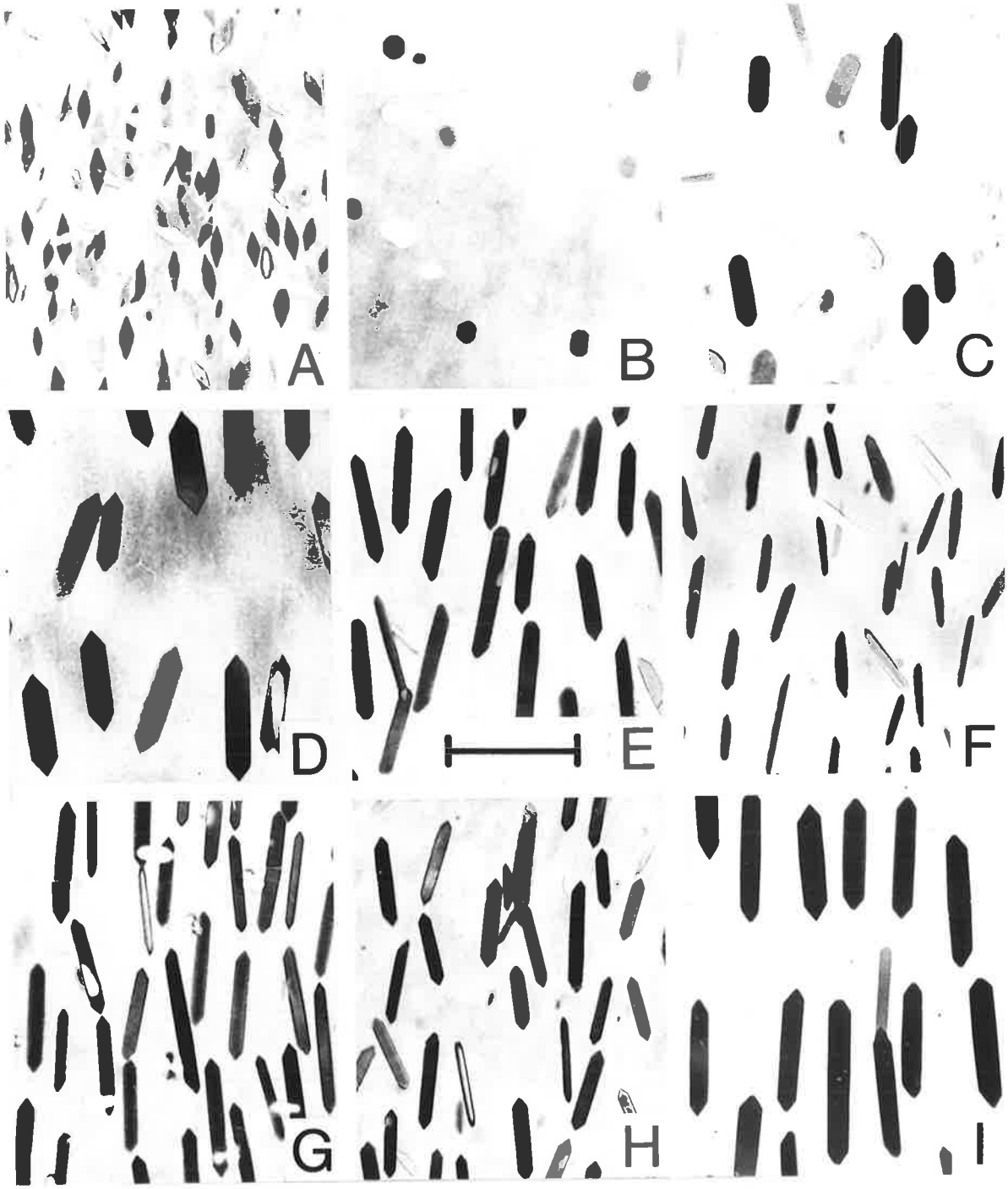

Fig. 2.7 Ovary wall crystals of Senecioneae.

A. Erechtites valerianaefolia. B. Arrhenechtites mixta.

C. Bedfordia salicina. D. Senecio discifolius.

E. S. cunninghamii. F. S. hispidulus. G. S. odoratus.

H. S. gregorii. I. S. biserratus. All figures at same magnification. Scale 30 µm.

2.11 The Achene

2.11.1 Pubescence and Mucilaginous Properties

Achenes of Australian species of Senecio may be glabrous or pubescent, and then the hairs distributed uniformly or in bands corresponding to surface grooves (see 2.11.2 below). All achenal hairs examined were duplex (of two slender cells fused longitudinally) and all released a gelatinous mucilage when wet. Mucilaginous properties have been attributed to a few species in the past, but it is possible that all pubescent achenes can produce mucilage. The property may have been previously overlooked as a gelatinous covering on a moist achene is visible to the naked eye only in those species with very long or very dense hairs. In the present study, achenal hairs were scraped into a drop of water and then observed at 100X magnification. All were found to immediately release two to four tightly intertwining spirals, assumed to be mucilage, from each cell of the hair. Jeffrey et al. (1977) described the achenal hairs of group 9 species (thought to be Senecio sensu stricto) as "usually spirally thickened," but it is likely that the "thickening" observed was in fact the tightly packed spirals of mucilage within each cell.

2.11.2 Surface Sculpturing

The surface sculpturing of achenes examined in this study varied greatly, but an underlying uniformity was found that has not apparently been reported elsewhere. The achene wall of all species examined consists of usually eight to ten longitudinal segments which separate along narrow surface grooves when pressure is applied. Segments of different species vary from convex to

flat to concave in section (see Fig. 2.8), so that either convex or concave segments may give the achene surface a ribbed appearance. It was found that in all species with longitudinal rows of hairs on the achenes, the hairs always corresponded with the grooves separating achene segments (see Fig. 2.8).

Belcher (1956) distinguished Senecio biserratus and S. minimus by the couplet "hairs in rows between broad low ribs" and "hairs on sharp narrow ribs." Strictly speaking the hairs of both are in narrow surface grooves, but a greater problem is the observation that both S. minimus and S. biserratus may have more or less flat segment surfaces (compare Fig. 2.8C to E). Achene sculpturing is therefore a poor characteristic to distinguish between these species as less ambiguous features are available.

2.11.3 Polymorphisms

Achenes within one capitulum of many Australian species of Senecio are polymorphic in colour, size or pubescence (or combinations of these). However, polymorphic achenes were only found in species with heterogamous capitula. Colour polymorphism was most pronounced in S. quadridentatus. The outermost female florets produced olive-green achenes, the remaining female florets produced red-brown achenes while those of the few bisexual florets were black. Differences in size and pubescence were most pronounced in some forms of S. glossanthus. Achenes of ray florets were 3 mm long and covered by long spreading hairs, while those of disc florets were 2 mm long with usually fewer and shorter hairs in longitudinal rows. Although the biological significance of colour polymorphisms in achenes is not known, differences in size and pubescence may well affect dispersal potential (see discussion in Chapter 4.4.5).

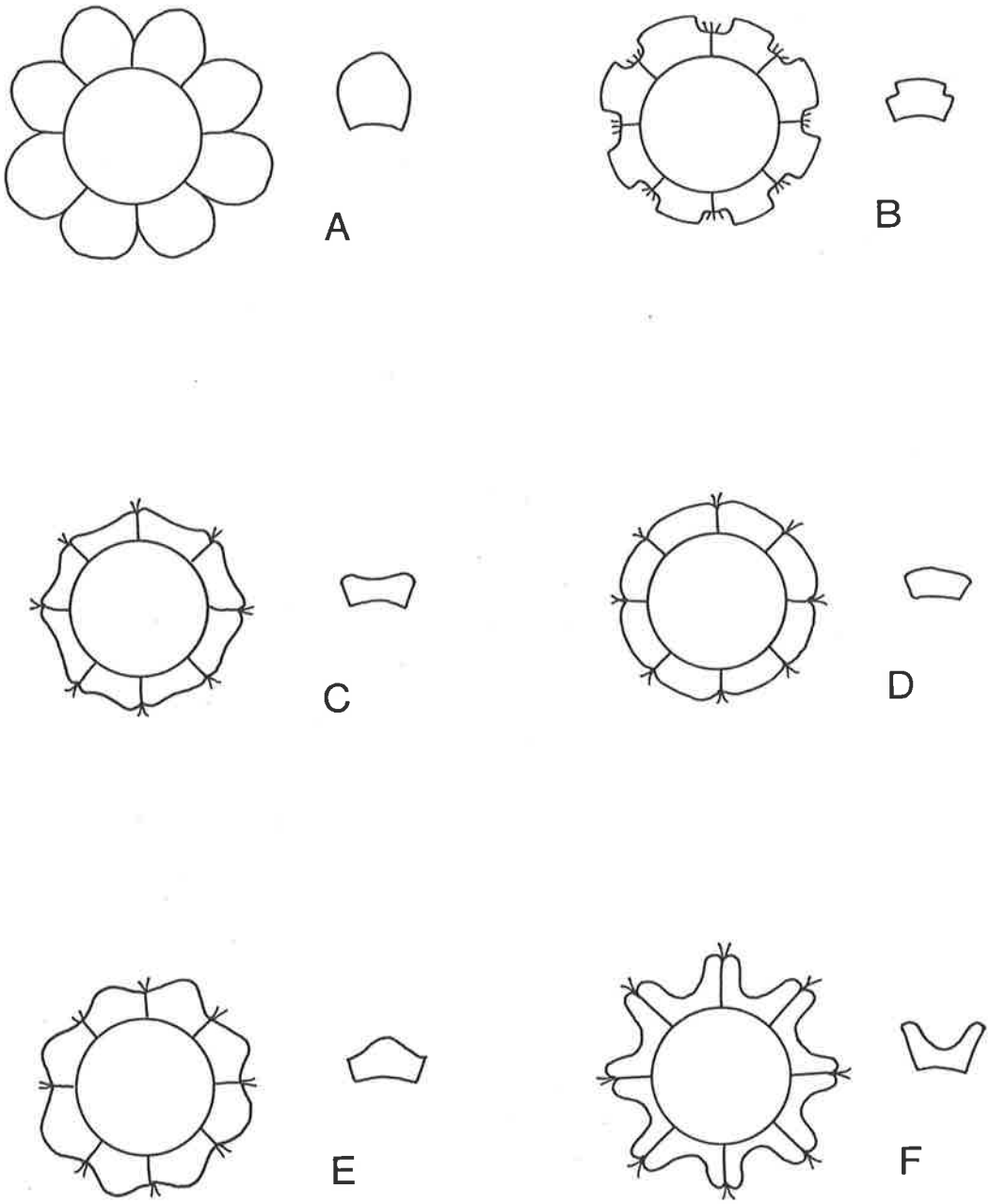

Fig. 2.8 Representatives of Senecio achene cross-sections showing variation in wall segments (one segment is shown next to each section). A. S. macranthus. B. S. quadridentatus. C-D. S. minimus. E. S. biserratus. F. S. velleioides.

2.12 "Senecioid" and "Cacalioid" Characteristics

Nordenstam (1977, 1978) used the terms "senecioid" and "cacalioid" to describe two loosely characterized complexes of genera in subtribe Senecioninae. He arranged the 96 genera of Senecioninae in a list so that "cacalioid" genera preceeded "senecioid" ones, commenting that the complexes are "connected by various transitional genera, and a subdivision into further subtribes is not possible." Characteristics of each complex are summarized in Table 2.1.

Senecio and Cacalia presumably typify the "senecioid" and "cacalioid" genera of Senecioneae, but surprisingly, Cacalia is genus 11 and Senecio is genus 78 in the list of 96 genera. One species from each of Bedfordia, Arrhenechtites and Erechtites were included in the present study for comparative purposes. These genera occupy positions 45, 47 and 48, respectively, and in view of Nordenstam's comments were expected to be intermediate in some characteristics. However, Bedfordia salicina is truly "cacalioid" and Arrhenechtites mixta and Erechtites valerianaefolia are "senecioid" in all respects. Nordenstam's comment concerning "transitional genera" is therefore in need of clarification.

"Cacalioid" characteristics do occur in some Australian species of Senecio. More than half of the species examined have a chromosome number of 2N = 60, a number described as "genuinely rare and no doubt secondary" in true Senecio species by Nordenstam (1977). In an earlier publication (Lawrence 1980, copy bound with thesis) I suggested that the abundance of hexaploids (2N = 60) among Australian Senecio species might be a taxonomic artifact rather than a genuine difference in chromosome number distributions. However, since examining characteristics

TABLE 2.1

Characteristics of "Senecioid" and "Cacalioid" Genera
Of Subtribe Senecioninae (after Nordenstam 1977)

Character	"Senecioid"	"Cacalioid"
Stigmatic surface	two marginal lines	continuous
Filament collar	basally swollen	cylindrical
Endothecal tissue	"radial"	"polarized"
Calyculus	present	absent
Chromosome number	2N = 20, 40	2N = 60
Corolla colour*	yellow	non-yellow
Capitula*	radiate	discoid

*less constant characters

of a truly "cacalioid" species - Bedfordia salicina - I must agree that genera with 2N = 60 are taxonomically distinct. A second "cacalioid" characteristic occurs in 7 of the 11 radiate species, and that is a continuous stigmatic surface. The position of these species is difficult to assess from a regional level. All have therefore been treated as Senecio throughout the study, and an opinion based on all evidence given in Chapter 9.

CHAPTER 3

Morphology and Systematics

3.1 Introduction

The primary aim of this chapter is to provide, by description, a comprehensive guide to each species and variety investigated. As existing floras and monographs are extremely variable in descriptive content, and do not give details of floral microcharacters, a full description is provided for each species. Characters common to all species investigated are mentioned only in the general description of *Senecio* or in general descriptions preceeding Groups 2 and 3. Keys to all genera of Senecioneae and all species of *Senecio* in Australia are also provided as these are not available in the literature.

This chapter is not intended to be a formal taxonomic revision as only specimens at the Adelaide (AD), Melbourne (MEL) and Sydney (SYD) herbaria were examined. Type specimens lodged at other institutions have not been seen. However, herbarium work coupled with field studies have revealed a number of apparent errors in existing taxonomic treatments. These are discussed after each description whereas phenetic and possible phylogenetic relationships are considered at the end of the chapter.

Throughout the chapter a uniform concept of both species and variety based on discontinuities in morphological variation was maintained. Major departures from previous taxonomic treatments include the elevation of two varieties to the rank of species - *S. georgianus* var. *latifolius* to *S. gawlerensis* (*S. latifolius* is already in use at the specific level) and *S. minimus* var. *picridioides* to *S. picridioides*. *S. spathulatus*, reduced to synonymy with *S. lautus* subsp. *maritimus* by Ali (1969), is treated as a distinct species. *S. orarius* proved to be a sterile F1 hybrid. Taxonomic notes are given in treatment 39, and plants are

further discussed as S. lautus x S. biserratus in Chapter 8. I have not attempted to assign specific or varietal epithets to previously undescribed taxa as I believe this could be misleading in an informal treatment. Instead, new taxa are designated as "A, B, C" etc. Synonyms are restricted to those of relevance to Australian floras since the work of Bentham (1866) as type specimens to which earlier epithets refer have generally not been seen. The reader is referred to Bentham (1866) for additional synonyms of radiate and discoid taxa, and to Belcher (1956) for listings of all synonyms of erechthitoid species.

A list of field populations sampled is given after each description. Each is referenced by my own collection number prefixed by "ML" and representative specimens will be lodged with the Adelaide herbarium (AD).

3.2 Senecioneae

The description of tribe Senecioneae given below is from Nordenstam (1977). Genera previously assigned to subtribe Liabinae are therefore not included. I have placed aspects of the description that do not apply to native Australasian genera in square parentheses []. The few parentheses used by Nordenstam are rounded ().

3.2.1 TRIBE SENECIONEAE Cass.

Shrubs, perennial or annual herbs, [vines] or trees, glabrous or variously pubescent. Leaves alternate [or more seldom opposite] or rosulate, sessile or petiolate, [sometimes peltate], herbaceous to coriaceous or succulent. Capitula terminal or lateral, solitary, paniculate, corymbose or racemose, radiate or

disciform or discoid, sometimes diclinic, yellow-, orange- [red-, purple-, pink] or white-flowered. Involucral bracts usually 1-2 seriate and ± equal, [rarely imbricated in more series and gradated], herbaceous to coriaceous or carnose, seldom submembranous, free or connate; involucre often with outer, ± reduced phyllaries (calyculus). Receptacle flat or convex [to subconical, rarely with a central conical projection (Arnoglossum)], naked, sometimes with raised and occasionally scale-like pit margins. Marginal florets female (or 0), glabrous or sometimes glandular or laxly hirsute-setose; corolla ligulate or tubular-filiform. Style bifid or bifurcate with oblong-linear, obtuse-rounded or truncate, glabrous or papillate-penicillate style-branches. Disc-florets perfect or staminate (♀-sterile). Corolla tubular basally, widening towards the apex or with a campanulate limb, glabrous or sometimes basally laxly hirsute, 5- (or rarely 4-) lobed; lobes with or without a distinct midvein, apically sometimes papillate. Style bifid to bifurcate; style-branches flattened [or seldom semiterete], dorsally glabrous or papillate-hirsute, apically usually truncate and penicillate, sometimes subglabrous or with a sterile convex-subconical-subulate, glabrous or papillate-hirsute appendage; stigmatic lines ventro-marginal, discrete or fused to a continuous stigmatic area; [style when sterile either branched or simple, with or without a conical appendage;] style base often swollen, placed on top of a nectary formed by the stylopodium. Anthers basally rounded-acute-sagittate, sometimes caudate; apical appendage (connective extension) ovate-lanceolate-oblong, ± flat, obtuse-acute; endothecal cells short or elongate, with thickenings on vertical and/or horizontal walls. Filament collar cylindrical-flattened, often dilated basally. Achenes homomorphic or seldom heteromorphic, terete-angular or sometimes flattened, smooth or

variously ribbed or sculptured, glabrous [or glandular] or pubescent; achene hairs duplex or sometimes simple, with or without mucilaginous properties. Achenal and/or ovarian wall often with short to elongate calcium oxalate crystals. Pappus uni- to pluriseriate or 0, of straight or flexuous, barbellate, scabrid, smooth or rarely subplumose, soft-coarse bristles, sometimes connate to a basal annulus [or rarely to a single scale (Emiliella)], persistent or caducous, white or coloured (straw-coloured; tawny, [rufuos, purple] etc.).

C. 100 genera, close to 3000 spp., the whole world.

3.2.2 Key to Genera of Senecioneae in Australia

(If only one species occurs in Australia, the specific name is given and the key applies only to that species.
* indicates introduced species.)

1a Capitula heterogamous; marginal florets female, filiform or ligulate; central florets bisexual.

2a Female florets tubular, filiform, 10-50 in one to several rows; annual or perennial herbs

3a Style branches terminating in a conical appendage longer than the sweeping hairs; female florets fewer than bisexuals; pappus mauve . . . . . .*Erechtites valerianaefolia

3b Style branches apically truncate or rounded; female florets more numerous than bisexuals; pappus white . . . . . ."erechthitoid" *Senecio* species

2b Female florets ligulate, 4-22 in one row (ligules rarely absent in *S. glossanthus* and then filiform florets 4-6); herbs or shrubs

4a Style branches of disc florets shortly bilobed, sterile or superficially sterile; herbs

5a Leaves mainly basal, deeply cordate and dentate; anthers purple . . . . .*Petasites fragrans

5b Leaves mainly cauline, pinnatisect; anthers yellow . . . . . *Arrhenechtites mixta*

4b Style branches of disc florets bifid, usually long, recurved, and receptive; herbs, shrubs, or small trees.

6a Large shrub 2-4 m tall, leaves somewhat sticky, staminal filament collar cylindrical, endothecal tissue "polarized" . . . . . Brachyglottis brunonis

6b Herbs or shrubs less than 2m tall, leaves never sticky, staminal filament collar basally swollen, endothecal tissue "radial"

7a Capitula solitary on leafless peduncles, leaves pinnatisect into linear lobes . . . . . *Europs abrotanifolius

7b Capitula usually numerous, if solitary then peduncles leafy or bracteate, leaves entire to pinnatisect . . . . . "radiate" Senecio species

1b Capitula homogamous, all florets bisexual and tubular.

8a Involucre ecalyculate, corolla purple or orange-purple . . . . . Emelia sonchifolia

8b Involucre calyculate, corolla yellow, white or greenish

9a Apex of style branches truncate or convex

10a Small trees 1.5-5m tall, involucre densely white tomentose, staminal filament collar cylindrical, endothecal tissue "polarized" . . . . . Bedfordia

10b Shrubs 0.5-3 m tall, involucre rarely white tomentose, staminal filament collar basally swollen, endothecal tissue "radial" . . . . . "discoid"
Senecio species

9b Apex of style branches with a long, sterile appendage.

11a Appendage longer than the stigmatic surface, inflorescence of 1-8 capitula . . . . . *Gynura pseudochina*

11b Appendage about as long as the stigmatic surface, inflorescence of more than 8 capitula . . . . . .*Crassocephalum crepidioides*

3.3 Australian Species of *Senecio*

3.3.1 General Description of Species Native in Australia

Characters in square parentheses are common to all species and are not included in subsequent species descriptions.

Senecio Linnaeus, Sp. Pl. 866 (1753)

Perennial or annual herbs or shrubs, erect or prostrate, sometimes stoloniferous. STEMS solitary or many from a common base, simple to much branched. LEAVES [alternate] simple or rarely compound, petiolate or sessile, [pinnately veined], margins entire to pinnatisect. CAPITULA either homogamous disciform, or heterogamous and then radiate or disciform; solitary, or few to many in a terminal usually corymbose panicle; peduncles leafy, or bracteate [the bracts like those of the calyculus]. INVOLUCRE [uniseriate] cylindrical or campanulate, coriaceous or herbaceous; phyllaries free or fused, usually subequal; with or without a calyculus. RECEPTACLE flat, naked or variously scaly. MARGINAL FLORETS either undifferentiated, bisexual and tubular, or female and then ligulate or filiform; corolla [yellow], tube variously pubescent or glabrous, ligules, when present, 4-5 (-20) veined, veins rarely absent, [upper ligule surface of smooth cells]. Disc florets [bisexual], corolla [yellow] usually glabrous, campanulate or expanded distally; lobes (3-4)5, with or without a median resin duct and trace. STAMINAL FILAMENT with a distal collar; collar slightly or very swollen basally. ANTHERS [5]; theca bases obtuse, acute or tailed; apical appendage triangular to ovate-deltoid, [endothecal tissue "radial"]. STYLE [slightly swollen basally, placed on a short cylindrical nectary as wide as style base]; branches [flattened], dorsal surface glabrous or papillate, stigmatic

surface of two marginal lines or continuous, apex truncate, rounded or domed, partially or completely encircled by erect or spreading marginal papillae, with or without a median fascicle. [Ovary wall crystals predominantly hexagonal plates 15-30 x 3-4 (-8)μm, usually with some druse types 3-5μm in diameter towards distal end of ovary.] PAPPUS white, bristles uniform or dimorphic, stout or slender, persistent or caducous, in 2-3 rows; barbellate throughout or distally subplumose, apex 2-4 celled. ACHENES homomorphic or heteromorphic; white, yellow, brown, black or green; subcylindrical [with a white callose-annulate apex]; surface of 5-10 longitudinal segments separated by narrow grooves, segments transversely flat, convex or concave; glabrous or pubescent and then hairs usually along the grooves; [hairs duplex, distally obtuse, even the smallest extruding long spiralled mucilaginous threads when wet].

Chromosome numbers: 2N = 38, 40, 60, 80, 98, 100, 120.

Includes 44 species, most frequent and diversified in south-eastern Australia, three endemic in south-western Western Australia, four endemic in Tasmania, extending into but with no endemics in northern tropical regions.

3.3.2 Key to all Australian Species of *Senecio*

(Species included in this study are indicated by their description number. All hybrids are discussed in Chapter 8. * Designates exotic taxa)

Key to Groups

1a Florets of the disc tubular and bisexual, marginal florets ligulate and female, ligules sometimes reduced (rarely absent in *S. glossanthus* and then female florets fewer than bisexuals) . . . . . GROUP 1

1b Florets all tubular, female florets more numerous than bisexuals or all florets bisexual.

2a Capitula homogamous; florets bisexual, often exserted 2-5 mm, spreading and together wider than the involucre, sometimes scarcely exserted and then about as wide as the involucre . . . . . GROUP 2

2b Capitula heterogamous; outer 1-4 rows female and filiform; central florets less numerous, bisexual and shortly campanulate below the apex not or scarcely exserted at anthesis, exserted 1-3 mm as the achenes mature and then the involucre base swelling and wider than the florets . . . . . GROUP 3

GROUP 1 - RADIATE SPECIES

1a Leaves mainly radical, those of the flowering stem progressively smaller or absent, capitula solitary or less than 6 in a terminal corymb.

2a Upper surface of leaves densely pubescent, hairs multicellular with tuberculate bases, blade ovate . . . . . S. papillosus

2b Upper surface of leaves glabrous or sparsely pubescent, blade broad-linear to ovate.

3a Blade cordate, coarsely crenate-dentate . S. primulifolius

3b Blade basally attenuate or sessile, margins various

4a Capitula solitary

5a Leaves more than 5 cm long, linear-lanceolate to oblanceolate, entire or irregularly toothed; ligules less than 1 cm long . . . . . S. daltonii

5b Leaves less than 5 cm long, linear, entire or toothed, or up to 10 cm long and then broadly oblanceolate or spathulate, cleft or pinnately lobed; ligules usually more than 1 cm long . . . . . 7. S. pectinatus

4b Capitula 3-5, in a dense or lax corymbose panicle

6a Bracts of calyculus not more than 1/4 involucre length, closely adpressed to phyllaries . . . . . 1. S. lautus ssp. alpinus

6b Bracts of calyculus 1/3 to 1/2 involucre length, not adpressed and grading into peduncle bracts . . . . S. leptocarpus

1b Leaves mainly cauline, at least at the flowering stage, inflorescence of 1-many capitula

7a Involucre of fused membranous bracts, splitting unequally to release achenes; capitula solitary on leafy peduncles . . . 4. S. gregorii

7b Involucre of free coriaceous bracts, splitting into subequal segments to release achenes; capitula 1-many.

8a Calyculus of 6 or more bracts, rarely 4-5 in some but not all capitula.

9a All bracts of calyculus at least 1/3 as long as phyllaries

10a Plants less than 30 cm tall, calyculus adpressed to involucre, ligules less than 1 cm long . . . . S. daltonii

10b Plants more than 30 cm tall, calyculus radiating, ligules 1 cm or more in length.

11a Phyllaries 12-15, ligules 7-veined leaves deeply cleft or compound . . . . S. vagus

11b Phyllaries 20-22, ligules 4-5 veined, leaves subentire, denticulate or shortly toothed . . . S. macranthus

9b All or most bracts of calyculus less than 1/3 as long as phyllaries.

12a Leaves sparsely to densely white tomentose beneath, denticulate or coarsely toothed, bracts of calyculus linear or narrowly triangular.

13a Phyllaries more than 17, leaves decurrent, involucre more than 4 mm wide . . . . . 32. *S. pterophorus**

13b Phyllaries less than 17, leaves sessile or auriculate, involucre less than 4 mm wide.

14a Ligules 5-7, 1-5 mm long, distally entire to deeply lobed *S. pterophorus* X *S. hypoleucus*

14b Ligules 9-15, 0.8-2 mm long, shortly lobed . . . . . *S. pterophorus* X *S. glomeratus*

12b Leaves glabrous or with scattered hairs beneath; entire, toothed or pinnatisect, bracts of calyculus lanceolate to ovate-deltoid

15a Involucre 10 mm or more broad; achenes glabrous, 4-6 mm long; inflorescence of 1-5 capitula . . . . . 2. *S. spathulatus*

15b Involucre less than 8 mm broad; achenes pubescent or glabrous, less than 4 mm long; inflorescence of (1-)8-60 capitula.

16a Ligules purple, rarely white; leaves pinnatisect with obtusely lobed segments . . . . . *S. elegans**

16b Ligules yellow; leaves entire, toothed or pinnatisect and then segments entire or acutely toothed.

17a Capitulum, including ligules more than 1 cm in diameter, ligules spreading 1. *S. lautus*

17b Capitulum, including ligules less than 1 cm in diameter, ligules usually recurved . . . . . 35. *S. lautus* X *S. biserratus*

8b Calyculus of 5 or less bracts, rarely 6-7 in some but not all capitula.

18a Ligules less than 4 mm long.

19a Ligules white or light purple, usually 3 and recurved . . . . . *S. leucoglossus*

19b Ligules yellow, sometimes fading to white; 4-8 and spreading or recurved.

20a Annual herb 5-40 cm tall, leaves serrate or distantly lobed . . . . 3. *S. glossanthus*

20b Perennial herbs or shrubs 60-120 cm tall, leaves denticulate or toothed.

21a Leaves white tomentose beneath; ovate-lanceolate and then toothed or denticulate, or lanceolate with distant acute teeth; ligules distally toothed, rarely entire . . *S. pterophorus* X *S. hypoleucus*

21b Leaves glabrous or with scattered hairs beneath, lanceolate, denticulate or toothed, rarely white tomentose and then lanceolate and subentire; ligules distally entire 11. *S. linearifolius*

(NOTE: *S. linearifolius* hybridizes with *S. bipinnatisectus* and *S. hispidulus*. Hybrids have short, toothed ligules and leaves intermediate between those of parents.)

18b Ligules more than 4 mm long.

22a Phyllaries 12 or less, bisexual florets less than 25.

23a Leaves with a slender petiole 1-2 cm long, average peduncle length more than 2 cm . . . . . 8. *S. amygdalifolius*

23b Leaves sessile or attenuate, not petiolate; average peduncle length less than 2 cm.

24a Plants 15-25 cm tall, leaves linear, less than 3 cm long, margins recurved . . . . . *S. behrianus*

24b Plants 60-120 cm tall, leaves linear, lanceolate or ovate lanceolate, more than 3 cm long, margins not recurved . . . . . 11. *S. linearifolius*

22b Phyllaries more than 12, bisexual florets more than 25.

25a Leaves pinnatisect.

26a Achenes tuberculate, distally attenuate, primary lobes of leaves entire or again divided into linear lobes . . . *S. tuberculatus*

26b Achenes pubescent or glabrous, not distally attenuate, primary lobes of leaves coarsely toothed or acutely lobed.

27a Inflorescence of less than 20 capitula, phyllaries about 15, 7-10 mm long . . . . . *S. platylepis*

27b Inflorescence of more than 20 capitula; phyllaries about 12, 4-5 mm long . . . . . S. jacobaea*

25b Leaves subentire, denticulate or toothed.

28a Achenes less than 4 mm long, involucre less than 9 mm long, leaves broadly auriculate.

29a Leaves white tomentose beneath, average peduncle length about 1 cm, involucre calyculate . . . . . 12. S. sp A

29b Leaves glabrous, average peduncle length about 2 cm, involucre ecalyculate . . . . . 6. S. velleoides

28b Achenes more than 4 mm long, involucre more than 9 mm long, leaves sessile or stem-clasping, rarely broadly auriculate.

30a Ligules 4-5(-8) veined, capitulum including ligules not more than 4 cm in diameter . . . . . 5. S. magnificus

30b Ligules 12-20 veined, capitulum including ligules 5-9 cm in diameter . . . . S. megaglossus

GROUP 2 - DISCOID SPECIES

1a Phyllaries (7-)8(-10), florets 9-14(-16).

2a Leaves palmately veined, petiolate, with reniform stipules about 1 cm long, climbing plant . . . . . 31. S. mikanioides*

2b Leaves pinnately veined, petiolate or sessile, stipules absent or minute and lanceolate, shrubs.

3a Leaves without auricles

4a Leaves pinnatisect into filiform or linear segments . . . . . 16. S. anethifolius

4b Leaves entire, denticulate or toothed.

5a Leaves with a distinct petiole 1-3 cm long, blade broad-lanceolate to ovate lanceolate, densely white tomentose beneath . . . . . 13. S. hypoleucus

5b Leaves sessile or attenuate, not petiolate, linear to broadly oblanceolate, glabrous or white tomentose beneath . . . . . .15. S. cunninghamii

3b Leaves auriculate

6a Plant glabrous or leaves sparsely arachnoid beneath, glaucous . . . . . 14. S. odoratus

6b Plant not glabrous, youngest shoots white, with an adpressed tomentum, or tomentum more widespread and covering involucre 15. S. cunninghamii

1b Phyllaries 11-25, florets 15-70.

7a Phyllaries 15-25, distal half of calyculus black . . . . . 33. S. vulgaris*

7b Phyllaries 11-14, calyculus bracts green or minutely black tipped.

8a Leaves auriculate.

9a Inflorescence a lax corymbose panicle, leaves pinnatisect . . . . . S. gilbertii

9b Inflorescence a dense panicle, longer than wide, leaves denticulate or toothed . . . . . S. ramosissimus

8b Leaves without auricles.

10a Florets 35-40, leaves linear or lanceolate, entire or scarcely toothed . . S. georgianus

10b Florets 18-25, leaves broad-lanceolate to ovate, deeply toothed or pinnatisect 17. S. gawlerensis

GROUP 3 - ERECHTHITOID SPECIES

(based on key by Belcher (1956))

1a Phyllaries 5-9, rarely 10-11 in some but not all capitula.

2a Leaves distinctly once or twice pinnatisect, laminate portions broad-linear . . . . . .25. *S. bipinnatisectus*

2b Leaves not divided, merely toothed or incised

3a Stem purplish-black, leaves cut into rounded and acutely toothed lobes . . . 27. *S. picridioides*

3b Stem green or purplish basally, leaves various.

4a Leaves crowded towards base of stem, entire, denticulate or coarsely and distantly toothed . . . . . .20. *S. aff. apargiaefolius*

4b Leaves mainly cauline, denticulate or biserrate.

5a Leaves coarsely and irregularly biserrate, less than or about 3 times longer than wide . . . . . *S. biserratus*

5b Leaves denticulate or toothed, more than 3 times longer than wide.

6a Leaves auriculate or stem clasping, regularly denticulate . . . . . *S. minimus*

6b Leaves sessile, usually with small paired lanceolate bracts at the stem, irregularly denticulate or toothed *S. sp. B*

1b Phyllaries 12 to 20, rarely 9 to 11 in some but not all capitula.

7a Phyllaries 16 or more . . . . . 24. S. squarrosus

7b Phyllaries (9-)12-13(-15)

8a Leaves and stems superficially glabrous

9a Leaves irregularly and sharply toothed or biserrate . . . . . S. laceratus

9b Leaves runcinately pinnatifid . . . .21.S. runcinifolius

8b Leaves and stems conspicuously pubescent.

10a Leaves entire or denticulate, rarely toothed; achenes fusiform, 2-5 mm long, those of bisexual florets black, rarely red-brown.

11a Lower leaves linear to lanceolate 18.S. quadridentatus

11b Lower leaves oblanceolate to obovate 19. S. gunnii

10b Leaves toothed, incised or pinnatifid; achenes short cylindric, 1.5-2.5 mm long, those of bisexual florets red-brown.

12a Base of involucre conspicuously white-lanate; leaves densely arachnoid beneath, sparsely arachnoid or glabrate (never hispid) above.

13a Phyllaries distally acute with scarious margins; achenes with about 10 low broad ridges . . . . . 28. S. glomeratus

13b Phyllaries distally long and slenderly acuminate, essentially lacking scarious margins; achenes with 5 high, narrow ridges . . . . . S. laticostatus

12b Base of involucre glabrous; leaves with crisped multicellular hairs beneath, hispid or scabrid above, rarely glabrate.

14a Phyllaries distally recurved, peduncles and involucre purplish black . . 29. S. sp.C

14b Phyllaries distally erect, peduncles and involucre green . . . . . 28. S. hispidulus

3.4 Description of Species and Discussion of Systematic Treatments

Species descriptions are arranged in an order loosely indicative of phenetic relationships. To facilitate the location of species, their order of appearance is listed below.

Radiate species of *Senecio*

1. *S. lautus*
2. *S. spathulatus*
3. *S. glossanthus*
4. *S. gregorii*
5. *S. magnificus*
6. *S. velleioides*
7. *S. pectinatus*
8. *S. amygdalifolius*
9. *S. macranthus*
10. *S. vagus*
11. *S. linearifolius*
12. *S.* sp. A

Discoid species of *Senecio*

13. *S. hypoleucus*
14. *S. odoratus*
15. *S. cunninghamii*
16. *S. anethifolius*
17. *S. gawlerensis*

Erechthitoid species of *Senecio*

18. *S. quandridentatus*
19. *S. gunnii*
20. *S.* aff. *apargiaefolius*
21. *S. runcinifolius*
22. *S. biserratus*
23. *S.* sp. B
24. *S. squarrosus*
25. *S. bipinnatisectus*
26. *S. minimus*
27. *S. picridioides*
28. *S. glomeratus*
29. *S. hispidulus*
30. *S.* sp. C

Exotic species of *Senecio*

31. *S. discifolius*
32. *S. pterophorus*
33. *S. mikanioides*
34. *S. vulgaris*

Sterile hybrids wrongly given taxonomic status

35. *S. lautus* x *S. biserratus*

Species from other genera

36. *Arrhenechtites mixta*
37. *Erechtites valerianaefolia*
38. *Bedfordia salicina*

3.4.1 Radiate species of Senecio (Group 1 of key to species)

To avoid unnecessary repetition, descriptions of discoid and erechthitoid species (groups 2 and 3) are each preceeded by a general description of characters common to all members of the group. Species of group 1 have in common an outermost row of ray florets, but further generalizations are not possible. I have therefore described each radiate species in full. Descriptions of S. linearifolius and S. sp A are included in group 1 as both have ray florets, however, these species are more closely related to discoid taxa of group 2 (see general discussion at end of chapter).

1. Senecio lautus G. Forst. ex Willd., Sp. Pl., Ed. 4, 3(3): 1981 (1803).

According to Ornduff (1960) and Ali (1964a) subsp. lautus is confined to New Zealand. I have treated subsp. lautus after descriptions of Australian subspecies.

Key to Australian subspecies

1a. Leaves fleshy or succulent, flattened or almost terete, entire, dentate or obtusely lobed; plants (5-)10-30(-40)cm tall - coastal dunes or cliffs less than 1 km from beach . . . . . 2.subsp. maritimus

1b. Leaves coriaceous, thickened or membranous, not succulent, entire to pinnatisect, plants 10-120 cm tall

2a. Both leaf surfaces uniformly covered by intertwining multicellular hairs, leaves pinnatisect - Franklin Island . . 5. subsp. pilosus

2b. Both leaf surfaces glabrous or with a few scattered hairs, leaves entire to pinnatisect

3a. Stems prostrate or ascending, often sparsely pubescent; lower cauline leaves oblanceolate to broadly spathulate, entire, crenately lobed or pinnatisect - alpine regions, altitude more than 1,300 m . . . . . 3. subsp. alpinus

3b. Stems erect, glabrous; lower cauline leaves broadest at or below the middle, entire to pinnatisect

4a. Leaves subtending inflorescence ovate-triangular or deltoid in outline, lacerate and stem-clasping; cauline leaves >6x1cm; acutely toothed, biserrate or pinnately cleft; plants 60 or more cm tall - wet sclerophyll forests of eastern states . . . . 4. subsp. lanceolatus

4b. Leaves subtending inflorescence linear to lanceolate, entire to pinnate, not or shortly stem clasping; cauline leaves < 6 cm long, margins and plant heights various

5a. Phyllaries 20 or more, about 0.7 mm wide, leaves narrowly oblanceolate or oblong, entire denticulate or shortly and acutely toothed - northern New South Wales . . . . . 6. subsp. A

5b. Phyllaries 12-14(-19), 1-2 mm wide, leaves linear and entire, lanceolate and serrate or broad-lanceolate to ovate and pinnatisect - widely distributed in all states . . . . . 1. subsp. dissectifolius

1.1 Senecio lautus G. Forst. ex Willd. subsp. dissectifolius Ali, Aust. J. Bot. 17:168(1969). (Figure 3.1A.)

(?) S. capillifolius Hook f. in Hook., Lond. J. Bot. 6:123(1847).

Erect glabrate short-lived perennial herb (10-)20-40 cm tall in drier areas, up to 100 cm tall in wet-sclerophyll forests. STEMS usually branched, slender, cylindrical and striate, woody and sometimes purplish basally. LEAVES simple, coriaceous or slightly fleshy; either broad-linear, 1-5 cm long, sessile and entire, - or narrowly lanceolate, 3-7x0.3-0.8 cm, sessile, denticulate or serrate, - or lanceolate to ovate in outline, 3-7x1-4.5 cm, sessile or shortly stem clasping, deeply pinnatisect, primary lobes 2-12, linear and entire or broad-linear to narrowly oblanceolate and then denticulate or irregularly toothed. CAPITULA radiate, (3-)10-25(-50) in a lax terminal corymbose panicle; peduncles slender, 1-3 cm long, bracteate. INVOLUCRE campanulate, 4.5-6.5x4-5 mm; phyllaries 12-15(-19), free, subequal, dorsal surface prominently 2-3 ribbed. Calyculus of (6-)8-11 crowded, adpressed lanceolate to ovate-lanceolate bracts, 1.5-2 mm long, in 2-3 rows. RECEPTACLE flat, faintly pitted, pit margins obscure or raised into small scales. RAY FLORETS 8-14, ligule 5-12x2-3 mm, 4(-5) veined; tube pubescent distally and sometimes basally, hairs both uni- and biseriate, clavate, 7-11 cells long. DISC FLORETS 55-80, corolla 5-7 mm long, exserted 1-2 mm beyond the involucre, glabrous, tubular basally, upper half campanulate; lobes 5, ovate-deltoid, 0.5-0.7 mm long, spreading, with a faint median resin duct. STAMINAL FILAMENT 0.08 mm wide; collar 0.35-0.4x0.15-0.2 mm, swollen basally, tapering distally. ANTHERS 1.3-1.5 mm long; theca basally acute; apical appendage ovate-lanceolate, 0.3 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two broad but discrete marginal lines;

apex convex, encircled by many long marginal papillae, ventral papillae rarely elongate and apex superficially fascicled. PAPPUS white, or many slender caducous bristles in 2-3 rows; dimorphic, a few bristles 'fluked', others minutely barbellate with acute teeth, cells not crowded distally, apex 2-celled. ACHENES subcylindrical, 2-4x0.5-1 mm, tapering or rounded basally; surface 8-10 ribbed, uniformly covered in short adpressed hairs or pubescent only on or between the ribs, rarely glabrous; colour heteromorphic, 'ray' and central 'disc' achenes red-brown or grey, outer 'disc' achenes olive-green.

Flowering period: September to February, occasional throughout the year.

Chromosome number: 2N = 40.

General distribution. Throughout all states from the coast to inland deserts to subalpine regions (altitudes less than 1,300m).

Habitat. Extremely variable, see collection sites for examples.

Collection sites. South Australia: ML408-17:4.5 km W. Ardrossan silos, in deep red sand; 5.viii.1976. -ML462-66: 1.5 km E. Stenhouse Bay township, swampy ground near quarried gypsum; 8.viii.1976. -ML487-91:5.2 km NE. Pondalowie Bay, sandy loam with Eucalyptus rugosa; 9.viii.1976. - ML561-8:2.5 km SE. Port Germain, in roadside clay with Atriplex sp.; 12.ix.1976.-ML578-9:4.3 km S. Monarto South, low sand dune with mallee scrub; 15.ix.1976.-ML598-602:22.2 km W. Morgan, clay soil in roadside excavation; 24.ix.1976. -ML604-8, 630-42: 1.3 km E. Blanchetown, deep red sand; 24.ix.1976. -ML644-5:0.6 km below Kangaroo Creek Dam wall, clay-loam in dry sclerophyll forest; 23.xi.1976.-ML876-8:9.4 km S. Tooligie, in roadside limestone rubble; 19.x.1977.-ML900-902:4.6 km NNE. Coffin Bay township, in estuarine marsh with Melaleuca halmaturorum; 21.x.19

Victoria: ML1120-22: 11.7 km SSW. of Deans Marsh, Otway Ranges, Otway Ranges, wet sclerophyll forest; 5.xii.1978.-ML1173-5:16.4 km E. Nelson, dry sclerophyll forest; 6.xii.1978.

New South Wales: ML1418:16.9 km from Thredbo on road to Khancoban, roadside shale slope, wet sclerophyll forest

1.2 Senecio lautus G. Forst.ex Willd. subsp. maritimus Ali, Aust. J. Bot. 17:171(1969) excl. S. spathulatus A. Rich. Voy. Astrolabe(Bot.)2:125(1834) included in synonomy by Ali (1969). (Figure 3.1B.)

Differs from subsp. dissectifolius in having very fleshy or succulent leaves which are almost terete, 6-20x3-6 mm, sessile and entire, or flattened, lanceolate to ovate-lanceolate, 0.7-4x0.3-1.5 cm, sessile, dentate or obtusely lobed. Capitula fewer, (1-)3-12 in irregularly corymbose terminal panicles. Plants never more than 40 cm tall.

Flowering period: throughout the year.

Chromosome number:2N = 40.

General distribution. Exposed coastal areas of all states, not more than 1 km inland.

Habitat. Sand dunes, cliff faces, rocky areas and limestone ledges exposed to at least some salt spray. Usually among established vegetation if on loose sand, not a sand-binding species.

Collection sites. South Australia: ML431-49: Wool Bay, among stunted cliff top vegetation; 7.viii.1976.-ML456-60:2.4 km NW. Troubridge hill, dunes 0.3 km inland; 7.viii.1976.-ML482-6: Pondalowie Bay, dunes 0.2 km inland; 9.viii.1976.-ML510-16: Corny Point, clifftop on weathered limestone; 10.viii.1976.-ML531-44.- 7 km NNW Wallaroo, cracks in rocky cliff above beach; 11.viii.1976.-ML615-19: The Bluff, Victor Harbour, in sandy loam above granite cliffs; 3.x.1976.-ML732-33:Cape Gantheaume Conservation Park, sand above pebble beach; 6.iii.1977.-ML736-38: Hanson Bay, dune adjacent to beach; 7.iii.1977.-ML846-48: 18 km SW. Streaky Bay, on limestone at cliff top; 15.x.1977.-ML903-5: Farm Beach, N. Coffin Bay, dune adjacent to beach; 21.x.1977.-

ML924-938: Fishery Bay, S. Port Lincoln, series of dunes between beach and mallee scrub; 20.x.1977. New South Wales: ML1358-60: Wamberal, among stunted vegetation on dune adjacent to beach; 26.xii.1978.

1.3 Senecio lautus subsp. alpinus Ali, Aust. J. Bot. 17:167(1969). (Figure 3.1D.)

Differs from subsp. dissectifolius in having prostrate or ascending stems 10-25(-45) cm long, often rooting in contact with the ground, glabrous or sparsely hairy. Leaves subradical or largest towards the base, coriaceous or thickened but not succulent; oblanceolate, basally attenuate, crenately lobed or pinnatisect with broad-lanceolate or oblanceolate segments, each denticulate or acutely toothed. Leaves reduced and more dissected towards the inflorescence. Capitula 4-15(-30) in a rather dense corymbose panicle.

Flowering period: November to April (Ali 1969).

Chromosome number: 2N = 40.

General distribution. Alpine regions of Victoria, New South Wales and Tasmania at altitudes of more than 1,300 m.

Habitat. Frequent in tussock grassland, sometimes forming small mats in bare stony areas. Occasional in most open areas.

Collection sites. Victoria: ML1252-54: 1.4 km NW. Mt. Hotham summit, in cracks of large rocky sheet; 12.xii.1978.-ML1258-60: 20.3 km from Falls Creek on road to Omeo, edge of alpine meadow among grass; 12.xii.1978. New South Wales: ML1400-1402: Spencers Creek near Mt. Kosciusko, among grass beside creek; 1.i.1979.-ML1442-44: 5.2 km N. Kiandra, areas of shale among tussock grass; 1.i.1979.

1.4 S. lautus subsp. lanceolatus (Benth.) Ali, Aust. J. Bot. 17:173(1969). (Figure 3.1C.)

S. lautus var. lanceolatus Benth., Fl. Austral. 3:667(1866).

Differs from subsp. dissectifolius in being a robust plant (60-)80-120 cm tall. Largest cauline leaves lanceolate, 6-8(-13)x 1-2(-5) cm, sessile or stem-clasping, serrate or with narrowly triangular crowded teeth, rarely pinnatisect with crowded, broad-lanceolate denticulate segments; leaves below and among the inflorescence shorter, ovate-triangular to deltoid, broadly stem-clasping, deeply toothed or lacerate.

Flowering period: September to June (Ali 1969).

Chromosome number: 2N = 40.

General distribution. Wetter regions of Victoria and south eastern New South Wales, and near the Victorian border in South Australia. Also north eastern New South Wales and the southeast corner of Queensland (Ali 1969).

Habitat. Most frequent in understory of wet sclerophyll forests although locally abundant among roadside vegetation in agricultural regions of southern Victoria.

Collection sites. Victoria: ML1080-82: 1.3 km from Lang Lang on road to Nyora, roadside scrub in farming area; 3.xii.1978.- ML1093-95: 11.5 km NW. Forster, roadside grassy slope in farming area; 3.xii.1978.- ML1123-25; eastern Otway Ranges, roadside in wet sclerophyll forest; 5.xii.1978.- ML1279: 36 km from Dargo on road to Stratford, in wet sclerophyll forest; 13.xii.1978.

1.5 Senecio lautus subsp. pilosus Black stat. nov.

S. lautus var. pilosus Black, Trans. Roy. Soc. S. Aust. 52:230(1928).

Differs from subsp. dissectifolius in having a simple stem 12 cm tall. Leaves crowded, pinnatisect with broad-linear toothed segments, both surfaces uniformly covered by intertwining hairs, the cells of which are possibly inflated (collapsed on herbarium specimen). Similar in floral characteristics but no mature achenes present.

Known to me only from the holotype collection.

South Australia: Osborn s.n.: Franklin Island; Jan. 1922 (AD 96132090).

1.6 S. lautus subsp. A

South American material is described and discussed by Cabrera and Re (1965).

S. incognitus Cabrera, Rev. Mus. La Plata, Bot. 4:313 Fig. 99(1941) n.v. non S. burchellii DC., Prodr. 6:401(1837) as suggested by Cabrera and Re (1965).

Differs from all other subspecies in having 20-24 phyllaries 0.4-0.7 mm wide excluding narrow scarious margin, rarely 17-19 phyllaries in some but not all capitula. CAPITULA few, 2-10 in a lax terminal panicle. Vegetatively similar to some forms of subsp. dissectifolius. Plants less than 40 cm tall; leaves broad-linear to narrow-lanceolate, 5-7x0.3-0.5 cm, sessile or shortly stem-clasping; entire, denticulate or rarely shortly and acutely toothed. ACHENES all red-brown, 8-10 ribbed; hairs short, adpressed or erect in rows between ribs, rarely glabrous.

Not collected, known to me from the following herbarium specimens. New South Wales: Crofts 9: Wollongbar, red basaltic soil;1.viii.1952(SYD).-Story 6553; Wallsend, Hunter Valley; 6.viii.1959(SYD), an attached typed note reads "Near S. burchellii, widespread and common on all types of soil, lax, yellow flowers, on clay soil at Wallsend." - Ising s.n.: North Tarramurra, suburb of Sydney; 10.ix.1969(AD97016201).- Coveny 6497 and Powell: Millfield on Cessnock-Wollombi road; 11.vi.1975(SYD).
South America, Argentina: Fabris 2603:Prov. Buenos Aires; 29.xii.1960(AD96434017, ex. Museo de la Plata).

1.7 *Senecio lautus* subsp. *lautus* (Figure 3.2A).

S. australis G. Forst. ex Willd., Sp. Pl., Ed.4, 3(3): 1981(1803).- non Benth., Fl. Austral. 3:668(1866) = *S. linearifolius* A. Rich.

Differs from subsp. *dissectifolius* in being annual, with erect or ascending herbaceous stems less than 35 cm tall, not woody basally. Cauline leaves herbaceous but not succulent, broadly lanceolate to ovate, pinnatisect, the segments broadly oblanceolate, entire or acutely toothed. Involucre 4.5-5x4-4.5 mm. Calyculus of 4-7 lanceolate bracts 1-2 mm long. Capitula radiate with ligules 1-5 mm long, or disciform and then marginal florets bisexual and zygomorphic but not ligulate. Differs from subsp. *maritimus* in having upper leaves with a lacerate or nearly entire auriculate clasping base.

Flowering period: September to June (Ornduff 1960).
Chromosome number: 2N = 40.

General distribution and Habitat. New Zealand, on cliffs, rocks or sand dunes of the coastal areas of the North Island and probably similar habitats along the northern and eastern portions of the South Island coast (Ornduff 1960).

Collection site (seed source). *New Zealand*: South Island Leg. J. B. Moss: Kaikoka Beach, NW. Nelson; 31.xii.1978.

Discussion (all subspecies.) The variability and confused nomenclatural history of Senecio lautus prompted study of the species both in New Zealand by Ornduff (1960,1964) and in Australia by Ali (1964a, 1964b, 1964c, 1966, 1968, 1969). Ornduff concluded S. lautus is a New Zealand endemic, and that Australian forms similarly named should be excluded from the species. However, Ali (1964a) argued that morphological separation of Australian and New Zealand forms is difficult and suggested the New Zealand population be given the status of subspecies - S. lautus subsp. lautus. Ali (1969) then divided Australian forms into four additional subspecies - maritimus, dissectifolius, alpinus and lanceolatus. Unfortunately the key to subspecies, and extremely brief diagnoses given by Ali (1969) in his final paper, have led to considerable confusion - evident by frequent mislabelling of herbarium specimens. Ali also failed to mention Black's var. pilosa, known only from the holotype but a most distinctive form. In keeping with Ali's work I have changed the rank of var. pilosa to subspecies. In view of the poorly understood relationship between Australian and New Zealand forms of S. lautus, I obtained seeds of the subsp. lautus and was able to raise a few plants in the glasshouse. Although my specimens lacked ligules, and therefore differed from Ornduff's (1960) description, their identification was confirmed by Sykes in New Zealand. Sykes, who is concurrently studying New Zealand populations, commented that the rayless form is not common, but occurs elsewhere round the New Zealand coast (personal communication). As all New Zealand populations are self-compatible (Ornduff 1964), it is likely that rayless forms of S. lautus have arisen in the absence of selective pressures to attract pollinators.

The Australian subspecies of S. lautus are a complex assemblage, with intermediates existing between each form.

However, an alternative taxonomic treatment, of not recognising any subspecific taxa, cannot be justified in view of the enormous variation in morphology. With the exception of subsp. A, the variation is predominantly vegetative. I have maintained Ali's (1969) subspecies, but I have expanded and amended his diagnoses. In my treatment, most plants with pinnatisect leaves belong to subsp. dissectifolius. Exceptions are very fleshy coastal plants with deeply and obtusely lobed leaves, alpine plants above 1,300 m with leaves pinnatisect into oblanceolate segments and wet sclerophyll forest plants with leaves pinnatisect into crowded, broad-lanceolate segments. I consider Ali's treatment of subsp. dissectifolius to be too restrictive, and his 'descriptions' of subsp. maritimus, alpinus and lanceolatus too broad. It would seem preferable to have one relatively broad and heterogeneous subspecies than four such subspecies.

I have followed Ali (1969) and placed S. capillifolius in synonomy with S. lautus subsp. dissectifolius as I am not familiar with populations of the former. S. capillifolius is apparently restricted to islands of Bass Strait (Curtis 1963), and has pinnatisect or bipinnatisect leaves with long filiform segments. As the leaves do not resemble, by description, any mainland forms of which I am aware, I believe the status of S. capillifolius requires further investigation. Ali also reduced S. spathulatus to synonomy with S. lautus subsp. maritimus. I strongly disagree with this decision, and have treated S. spathulatus as a distinct species (see discussion following description of S. spathulatus).

The taxonomic problem associated with Ali's subsp. lanceolatus is perhaps the most significant. Ali's (1969) description and key characters for subsp. lanceolatus include the types of Bentham's (1866) var. lanceolatus (photos sent from Kew), but I have

amended Ali's description to exclude plants with leaves pinnatisect into distant segments. My observations suggest that subsp. lanceolatus (sensu Bantham) is most distinctive and should not be merged into subsp. dissectifolius. Although Ali correctly used key characters of leaves greater than 5.5x1.2 cm and plants more than 52 cm high for subsp. lanceolatus, he determined a number of herbarium specimens "subsp. lanceolatus" that are considerably below these limits. One in particular, "Story 6553" from Wallsend in New South Wales was cited by Cabrera and Re (1965) as synonomous with South American specimens.

The implications of Cabrera and Re's paper are that the South American S. incognitus, the Australian element of S. lautus and the South African S. burchellii are all conspecific. Although I did not collect plants corresponding to the "Story 6553" specimen, I felt the relevance of this problem deserved immediate attention. At my request Mr. Brooker at Kew examined types and specimens of S. lautus and S. burchellii (he could not locate South American material). He concluded that the duplicate "Story 6553" specimen and S. burchellii are vegetatively similar but differ in phyllary number (about 20 and 12, respectively). Furthermore, S. burchellii is vegetatively unlike any other specimens of S. lautus at Kew. I compared a specimen of S. incognitus sent by Cabrera (lodged at the Adelaide herbarium (AD)) with a "Story 6553" specimen (SYD) and agree they are conspecific. However, based on phyllary number they are not conspecific with S. burchellii. With this preliminary evidence I described subsp. A of S. lautus to include Australian and South American specimens corresponding to the "Story 6553" specimen. I believe the relationships between subsp. A, other Australian subspecies and S. burchellii are urgently in need of further attention.

2. Senecio spathulatus A. Rich., Voy. Astrolabe (Bot.) 2:125(1834) (Figure 3.2B).

Ascending glabrous perennial herb 10-30 cm tall. STEMS stout, cylindrical, faintly striate, much branched basally but this region usually covered by sand, exposed portions usually purplish. LEAVES fleshy, spathulate or broadly oblanceolate, 1-3x0.6-1.5 cm, stem-clasping or auriculate, finely serrate or biserrate. CAPITULA radiate, 2-5 in a crowded terminal leafy corymb or rarely solitary; peduncles stout, 0.5-1.5 cm long, bracteate. INVOLUCRE broadly campanulate, 9-12 mm long and wide; phyllaries fleshy, 12-14, free subequal and dorsally smooth. Calyculus of 7-11 crowded adpressed widely-ovate bracts, 2-2.5 mm long. RECEPTACLE flat, faintly pitted. RAY FLORETS 9-13; ligule 7-9x3.5 mm, 6-9 veined; tube pubescent distally, hairs biserrate, clavate, 7-11 cells long. DISC FLORETS 55-90, 8-11 mm long, glabrous, tubular below, campanulate on upper half; lobes 5, spreading, ovate deltoid, 0.7x0.6 mm with a faint median resin duct. STAMINAL FILAMENT 0.1 mm wide, collar 0.5x0.2 mm, swollen basally, tapering distally. ANTHERS 1.5 mm long, theca obtuse basally, apical appendage ovate-lanceolate, 0.3 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two broad but discrete marginal lines, apex truncate to convex, encircled by many long spreading papillae. PAPPUS white, of many stout persistent bristles in 2-3 rows, uniform, minutely barbellate with acute teeth, cells slightly crowded distally with elongate but adpressed teeth, apex 2-celled. ACHENES subcylindrical, 4.5-5.5x0.8 mm, tapering basally and distally, glabrous, all light yellow, surface of 11-13 rounded ribs separated by narrow deep channels.

Flowering period: October to April.

Chromosome number: 2N = 40.

General distribution. Along the coast from Lakes Entrance, Victoria, to The Entrance, New South Wales. Also Tasmania.

Habitat. Sandy beaches not far from high tide level and before first major dune, sometimes with Spinifex hirsutus and apparently sand binding.

Collection sites. Victoria: ML 1305-7: 10 km E. Marlo, swale behind low sandy rise on beach; 15.xii.1978. New South Wales: ML 1354-56: Wamberal, swale behind low sandy rise on beach, 26.xii.1978.

Discussion. I disagree with the reduction of S. spathulatus to a synonym of S. lautus subsp. maritimus by Ali (1969). I have seen only two field populations of S. spathulatus but both are very different from all forms of S. lautus subsp. maritimus. Major differences are summarised in Table 3.1. Particularly significant is the persistent pappus, found in only two other species in this study, S. magnificus and S. gregorii. I believe the differences justify the maintenance of S. spathulatus as a distinct species.

TABLE 3.1

Comparison of *S. spathulatus* and *S. lautus* subsp. *maritimus*

Character	*S. spathulatus*	*S. lautus* subsp. *maritimus*
capitulum size	5x4 mm	10x10 mm
number of veins on ligule	4(-5)	6-9
achene size	3.5x0.6 mm	5x0.8 mm
achene colour	red brown, grey-green	light yellow
achene ribs	low, obscure	high, very conspicuous
pappus bristles	deciduous, slender dimorphic	persistent, stout, uniform

3. Senecio glossanthus (Sond.)Belcher, Ann. Mo. Bot. Gdn. 43:80(1956) (Figure 3.2C).

Erechtites glossantha Sond. Linnaea 25:524(1853).

S. brachyglossus F.v. Muell. ex Benth., Fl. Austral. 3:670(1866) - and var. major Benth. l.c. - excl. var. elatior Benth. l.c. = hybrid of S. linearifolius.

Erect sparsely hairy annual herb 3-25(-40) cm tall. STEMS slender, cylindrical and striate; usually simple, branched only at the inflorescence, sometimes branched at the base in larger specimens; glabrous or with a few long hairs on younger parts; purplish towards the base. LEAVES simple, usually lanceolate to broad-lanceolate, 0.8-2.5(-4.5) cm x 3-10 mm, base attenuate sometimes subpetiolate, margins entire, irregularly denticulate or serrate, apex acute or acuminate; sometimes ovate-lanceolate in outline, up to 6x2.5 cm with 1-6 broad-linear distant lobes about five times longer than broad, each denticulate or toothed; leaves often stem clasping or with toothed or lacerate auricles; glabrate or with a few long hairs beneath. CAPTULA radiate, 3-40(-150) in a terminal corymbose panicle, congested at first, becoming lax at maturity; peduncles slender, 4-13 mm long, bracteate. INVOLUCRE narrowly campanulate 5-6x3-3.5 mm, swelling as achenes mature; phyllaries 7-9 (-12), free, subequal, faintly 2-3 ribbed dorsally. Calyculus of 2-3 narrowly triangular adpressed bracts 0.5-1 mm long. RECEPTACLE flat, pit margins obscure, slightly raised under disc florets, forming a small to pronounced 'ball and socket' joint under ray florets. RAY FLORETS 4-8; ligule 0.8-1.5x 0.5-1 mm, without veins (ligules rarely absent and the female tube distally entire); tube sparsely pubescent distally or on all parts, hairs more or less adpressed to the corolla, stout, biseriate, clavate, 9-12 cells long. DISC FLORETS 17-30, corolla 3.5-5 mm long

glabrous, tubular below, expanded but not campanulate distally; lobes 5, narrowly ovate to ovate - deltoid, 0.2x0.2-0.3 mm, spreading slightly, without a median duct. STAMINAL FILAMENT up to 0.06 mm wide, collar 0.3-0.4x0.07-0.1 mm, slightly swollen basally. ANTHERS 0.5-0.6 mm long; theca acute or shortly tailed basally, apical appendage triangular, 0.2 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two narrow marginal lines; apex truncate with a few long erect papillae around the abaxial margin. PAPPUS white, uniform,; ray florets with a few bristles, rarely none, disc florets with many slender caducous bristles in 2-3 rows; minutely barbellate with acute teeth, teeth less pronounced or absent distally, apex (1-)2-celled. ACHENES sybcylincrical, tapering basally, usually dimorphic; ray floret achenes 3x0.8 mm, olive-green, width doubled by dense spreading hairs; disc floret achenes 2x0.8 mm, red-brown, densely covered by either long spreading hairs or short adpressed hairs; rarely all achenes with short adpressed hairs.

Flowering period: mainly August to September, occasional throughout the year.

Chromosome numbers: 2N = 40, 2N = 80

General distribution. Widespread in the drier areas of all states except Tasmania.

Habitat. Extremely variable but commonly requiring conditions that are only temporarily wet (see collection data for examples).

Collection sites. (All in South Australia.)

Plants with 2N = 40: ML429:23 km SW. Stansbury, edge of salt lake; 6.viii.1976. - ML475:0.8 km WSW. Marion Lake, grassy hillslope under Eucalyptus foecunda; 8.viii.1976(2N = 80 also present). - ML509:20.4 km S. Corny Point, moss over sheet limestone; 10.viii.197

ML517: 2.8 km S. Port Rickaby, 1.5 km from beach, lower slope

of sand dune; 10.viii.1976. - ML 791; 5 km NNW. Iron Knob, litter under Callitris sp.; 12.x.1977. -ML 841:23.2 km S. Hiltaba homestead, clay mounds in salt lake; 14.x.1977. -ML 1077-78:Chowilla Ck., 20 km NNE. Renmark, clay at water's edge; 10.xi.1978. Plants with 2N=80: ML461:12.3 km ESE. Warooka, under shrubs in saline clay pan; 7.viii. 1976. -ML427:23.6 km NW. Stansbury, sandy soil under Eucalyptus incrassata; 6.xiii.1976. -ML476:0.8 km WSW. Marion Lake, grassy hill-slope under Eucalyptus foecunda; 8.viii.1976 (2N=40 also present). -ML545:5 km W. Bute, around rabbit warren under Eucalyptus porosa; 12.viii.1976. -ML788:13.8 km NNE. Whyalla, edge of saline clay pan with S. gregorii; 11.x.1977. -ML859:25.3 km SSW. Mt. Double, soil pockets in rocky outcrop with S. gawlerensis; 16.x.1977. -ML885: 21.7 km NW. Cummins, edge of salt lake; 19.x.1977.

Discussion. My description of S. glossanthus is representative of all material I have examined, and is rather broad for two reasons. Firstly, S. glossanthus is strongly affected by environmental conditions. Seeds germinate after suitable winter rains, but overall plant development relys on subsequent rainfall. Under dry conditions plants may have more or less entire leaves, produce only 2 or 3 capitula and flower when 3 cm tall. If, however, rains continue for several weeks luxuriant plants with dissected leaves, 50-100 capitula and up to 40 cm tall are produced. Secondly there are two genetically different forms of S. glossanthus, one with 2N = 40 (tetraploid) and one with 2N = 80 (octoploid). I could find no differences in the distribution or habitats of each form; in fact, at one site near Marion Lake both forms grew together. The forms can be distinguished when grown under uniform glasshouse conditions, but in the field, the effects of environment sometimes obscure any effects due to chromosome number. For this reason I have included both forms in my description and have indicated in Table 3.2 the differences sometimes found in the field.

TABLE 3.2

Differences Sometimes Found in Field Populations of Tetraploid and Octoploid S. glossanthus

Character	2N = 40	2N = 80
leaf margins	entire, denticulate or serrate	serrate or deeply and irregularly lobed
plant height	3-30 cm	3-40 cm
hairs on ray floret achenes	long and spreading, rarely short and adpressed	long and spreading
hairs on disc floret achenes	short and adpressed	long and spreading

(Belcher (1956) reviewed the nomenclature of S. glossanthus. He rightly concluded it would be unwise to maintain Bentham's var. major, distinguished by larger flower heads with about 12 phyllaries and more numerous florets. Plants corresponding to var. major can be found in both tetraploid and octoploid populations and appear to be related to seasonal conditions. Belcher's exclusion of Bentham's var elatior is also fully justified. I examined a syntype from the Sydney herbarium (SYD) and believe it represents a hybrid between S. linearifolius and an erechthitoid species, possibly S. bipinnatisectus. I collected such a hybrid in the field (ML1327). Although many achenes were shrivelled and sterile, a few were fertile. These were about 2 mm long, cylindrical and glabrous, like the achenes of both parents. The syntype of S. brachyglossus var. elatior closely resembles this hybrid collection and is, I believe, of similar hybrid origin.

4. Senecio gregorii F.v. Muell., Enum. Plant. coll. Gregory 7(1859) (Figure 3.2D).

Erect glabrous glaucescent annual herb (6-)20-40 cm tall. STEMS stout, cylindrical and striate, simple or much branched. LEAVES simple, fleshy, broad-linear, 3-9 cm x 2-5 mm; sessile and entire; reduced in size on base of peduncle. CAPITULA radiate, solitary, terminal, or terminal and axillary; peduncle stout, 6-15 cm long, bracteate, bracts grading into reduced leaves basally, inflated below the capitulum. INVOLUCRE smooth and herbaceous, cylindrical or narrowly campanulate, 6-10x4-6 mm, expanding greatly as achenes mature; phyllaries about 10, fused basally, distal 1-3 mm irregularly free, splitting into 2-4 unequal sections to release achenes. Calyculus absent. RECEPTACLE flat, slightly raised under each floret. RAY FLORETS 8-11(-14); ligule 10-17(-23)x3-6 mm, 4-veined; tube pubescent distally, hairs adpressed to tube, uni- and biseriate, slightly clavate, 3-8 cells long. DISC FLORETS (30-)40-55, corolla 6-8 mm long, glabrous, tubular basally, campanulate on upper third; lobes 5, broad-lanceolate, 0.7x0.4 mm, spreading, without a median duct. STAMINAL FILAMENT up to 0.1 mm wide; collar 0.4x0.2 mm, swollen basally, attenuate distally. ANTHERS 1.8-2 mm long; theca obtuse or acute basally; apical appendage broad-lanceolate, 0.3 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two broad but discrete marginal lines; apex domed with several abaxial rows of spreading papillae; papillae usually longer and often forming a fascicle at distal end of stigmatic surface. PAPPUS white, of many stout persistent bristles in 3-4 rows, uniform; doubling in length and exserted 5-8 mm before involucre splits; barbellate teeth 4-6 times longer than broad; distal cells crowded with teeth up to 15 times longer than broad; apex 2-3 celled, sometimes subplumose. ACHENES cylindrical, truncate basally; densely

pubescent, hairs about 1 mm long, spreading, in 8-10 longitudinal rows, usually dimorphic, ray floret achenes, 5-6x2-3 mm, surface olive-green, disc floret achenes 7-10x2 mm, surface red.

Flowering period: mainly July to December, occasional throughout the year.

Chromosome number: 2N = 40.

General distribution. Most common in central Australia, extending into mallee formations and coastal areas of little rainfall; all states except Tasmania.

Habitat. Most often on deep red sands of the interior among a wide variety of vegetation types, sometimes on clay soil near salt lakes or in and around clay pans, infrequent on stony ground.

Collection sites. South Australia: ML789, ML1010-18: 13.8 km NNE. Whyalla, edge of saline clay pan with S. glossanthus; 11.x.1977. - ML800: 1 km from SW. corner of Lake Gairdner, among grass in red sandy clay; 12.x.1977.

Discussion. S. gregorii has been described as a species "anomalous in its present position" (Nordenstam 1978, p.4) and requiring "further exploration of its status and affinities" (Jeffrey et al. 1977, p. 66). In a second paper, Jeffrey (1979) transferred S. gregorii to his revised group 10, the "Othonnoids", along with Othonna, Europs and Hertia. The group is characterized by ecalyculate involucres with fused phyllaries, achenes with very short, centrally depressed surface cells and (when present) long fine achenal hairs. Nordenstam (1977) considered the character of a fused involucre to have been "over-emphasized" and merged subtribe Othonninae (of which Europs and Othonna are the largest genera) with subtribe Senecioninae. In view of the comments described above, I considered the merits of three possible

treatments for S. gregorii: (1) transfer to another genus (2) placement in a new and monospecific genus (3) leave unchanged in Senecio. Considering the first treatment, transfer to another genus, I looked at genera of the now submerged subtribe Othonninae, and the genus Hertia, and concluded that either Europs or Othonna were the only possibilities. However, all species of Europs have leafless, axillary peduncles and a deciduous pappus with teeth diverging in one plane, whereas S. gregorii has leafy, terminal and axillary peduncles and a persistent pappus with teeth all around. Furthermore, all species of Othonna differ from S. gregorii by their perennial habit and sterile disc florets. It would therefore be necessary to redefine genera with 100 or more species to accomodate S. gregorii. The second treatment, transfer to a new and monospecific genus, depends on the taxonomic value placed on fused involucral bracts. S. gregorii has a number of characters not typical of Senecio (sensu S. vulgaris, the type species) but all are found in at least one other Australian species. For example, S. gregorii's persistent pappus also occurs in S. magnificus and S. spathulatus, the long and dense achenal hairs in S. glossanthus, the ecalyculate involucre in S. magnificus and S. vellioides, the median fascicle of the style apex sometimes in S. amygdalifolius and S. lautus and the solitary capitula in S. daltonii and rosulate alpine species. I therefore propose that S. gregorii remain in the genus Senecio until the boundaries of the genus, particularly with respect to fusion of involucral bracts, are better understood.

5. Senecio magnificus F.v. Muell., Linnaea 25:418(1853) (Figure3.3A).

Erect glabrous glaucous shrub 70-120(-150) cm tall. Stems stout, 3-4 angled when young, older ones striate and basally woody. LEAVES flaccid or somewhat fleshy, oblanceolate to spathulate, 5-9x1.5-2.5 cm, shortly decurrent or stem-clasping, dentate distally or subentire, apex acute. CAPITULA radiate, 20-50 in a lax terminal corymbose panicle; peduncles stout, 2-4 cm long, sparsely bracteate, inflated towards the capitulum. INVOLUCRE slightly campanulate, 9-11x6-7 mm; phyllaries 12-18, free, subequal, faintly 1-2 ribbed dorsally. Calyculus absent. RECEPTACLE flat, faintly pitted. RAY FLORETS 5-8, ligule 7-15x 4-5 mm 4-5(-7) veined; tube pubescent, hairs biseriate, shortly clavate or conical, 1-6 cells long. DISC FLORETS 30-45, corolla 7.5-9 mm long, tubular and pubescent below, campanulate on upper two thirds; lobes 5, spreading, broadly lanceolate, 1x0.7 mm with a median resin duct. STAMINAL FILAMENT up to 0.15 mm wide, collar 0.6-0.7x0.3 mm, swollen basally, tapering distally. ANTHERS 2.5-3 mm long, theca acute basally, apical appendage ovate-lanceolate, 0.5-0.6 mm long. STYLE BRANCHES dorsally glabrous; stigmatic surface largely continuous, shortly divided basally; apex high-domed, with many spreading papillae around abaxial margin. PAPPUS white, of many stout persistent bristles in 1-2 rows, uniform; barbellate with acute teeth up to four times longer than broad; cells somewhat crowded distally with greatly elongated teeth; apex 2-3 celled, subplumose. ACHENES subcylindrical, 5-6x1.5 mm, tapering basally, covered in short spreading hairs most dense between the 10-12 indistinct ridges; 'ray' achenes yellow-green 'disc' achenes red-brown.

Flowering period: August to November, occasional throughout the year.
Chromosome number: 2N = 40.

General distribution. Drier parts (less than 350 mm rainfall) of all states except Tasmania. Uncommon in Victoria.

Habitat. Most frequent near river beds often in deep red sand, occasional on open plains, sometimes locally abundant along roadside ditches.

Collection sites. South Australia: ML795-96:10.5 km NW. Mt. Ive homestead, in red sand with Acacia sowdenii; 12.x.1977.- ML801-1:27 km S. Moonaree homestead, roadside in red sand; 13.x.1977. - ML1032-33: 21 km NE. Koonamore homestead, in red sand of dry watercourse; 4.x.1978.

Discussion. S. magnificus is a widely distributed and quite common shrub of central Australia. I was not able to collect S. megaglossus, a rare but allied species from the southern Flinders Ranges. S. megaglossus has capitula almost twice the size of S. magnificus but in the Adelaide herbarium (AD) the two have sometimes been confused. In the dried state identification is simple as S. megaglossus has 16-20 veins on the ligule whereas S. magnificus usually has 4-5. Willis (1972) commented that S. magnificus and S. velleioides (a wet-sclerophyll forest species) "may eventually prove inseparable at the specific level." I disagree, as the two have different chromosome numbers (Lawrence 1980) and can be morphologically distinguished by achene and leaf base characters.

6. Senecio velleioides A. Cunn. ex. DC., Prodr. 6:374(1838) (Figure 3.3B).

Erect glabrous glaucous annual or (?) short-lived perennial herb 70-120 cm tall. STEMS stout, cylindrical and striate, simple or branched basally. LEAVES flaccid; cauline leaves broadly oblanceolate, 8-16x3.5-7 cm, basally cordate-auriculate, margins finely serrate or shortly and acutely toothed, apex acute or obtuse; leaves below and among the inflorescence shorter, ovate-deltoid and cordate-auriculate, entire or subentire. CAPITULA radiate, 25-60(-130) in a leafy terminal corymbose panicle; peduncles stout, 1.5-3 cm long, bracteate, inflated towards the capitulum. INVOLUCRE slightly campanulate, 7-8x4.5-6; phyllaries 12-15, free, subequal, faintly 1-2 ribbed dorsally. Calyculus absent. RECEPTACLE flat, deeply pitted, pit margins irregularly toothed. RAY FLORETS 7-9; ligule 8-13x3-4 mm, 4-veined; tube pubescent distally, hairs slender, biserrate, 8-12 cells long. DISC FLORETS 25-40, tube 6.5-8 mm long, glabrous, tubular below, campanulate on upper quarter; lobes 5, slightly recurved, broad-lanceolate, 1x0.7 mm with a median resin duct. STAMINAL FILAMENT 0.1 mm wide, collar 0.25-0.3x0.12-0.15 mm, scarcely swollen basally, tapering slightly distally. ANTHERS 1.5-1.8 mm long, theca base acute, apical appendage broadly lanceolate, 0.4 mm long. STYLE BRANCHES minutely papillate on dorsal surface, stigmatic surface separated by a very narrow channel, superficially continuous, apex convex with many papillae around the abaxial margin. PAPPUS white, of many slender caducous bristles in 1-2 rows, uniform, barbellate with acute teeth, cells slightly elongated distally, apex 2-3 celled. ACHENES subcylindrical, dark-brown, 2.6-2.8x0.7 mm, tapering basally; surface with 6-8 pronounced ribs each with a densely hairy median groove (longitudinal segments deeply concave).

Flowering period: September to April.

Chromosome number: 2N = 38.

General distribution. Great Dividing Range and adjacent forested coastal areas, Victoria, New South Wales and Queensland. Also Tasmania.

Habitat. Shaded areas of wet sclerophyll forests, locally abundant along roadsides or after fires, occasional among dense understory.

Collection sites. Victoria: ML1099-1100:1.2 km NNE. Tidal River Resort, Wilsons Promontory N.P., beside track in wet sclerophyll forest; 3.xii.1978. - ML1109-1111:7.6 km SSE. St. Fillan, Dandenong Ranges, roadside in wet sclerophyll forest; 4.xii.1978. -ML1273-75:54.7 km from Mt. St. Bernard on road to Dargo, among bracken in wet sclerophyll forest; 13.xii.1978. New South Wales: ML1367-69: 7.0 km from Mt. Wilson on Bowens Ck. Road, among bracken on hillslope east of creek; 27.xii.1978.

Discussion. S. velleioides superficially resembles S. magnificus but the two are not conspecific (as suggested by Willis, 1972). Apart from differences in distribution, leaf morphology and capitulum size, which are not easily defined, the two can be reliably separated by achene and pappus features as well as shape of the staminal filament collar. S. velleioides has a deeply ribbed achene about 2.7 mm long, a deciduous pappus and a comparatively small and scarcely swollen filament collar. The achenes of S. magnificus are obscurely ribbed and 5-6 mm long, the pappus is persistent and the filament collar is large and basally swollen. Because of vegetative similarities and lack of a calyculus in both, it is likely that S. velleioides and S. magnificus are related. However, the differences mentioned above suggest that evolutionary divergence has been considerable.

Flowering period: September to April.

Chromosome number: 2N = 38.

General distribution. Great Dividing Range and adjacent forested coastal areas, Victoria, New South Wales and Queensland. Also Tasmania.

Habitat. Shaded areas of wet sclerophyll forests, locally abundant along roadsides or after fires, occasional among dense understory.

Collection sites. Victoria: ML1099-1100:1.2 km NNE. Tidal River Resort, Wilsons Promontory N.P., beside track in wet sclerophyll forest; 3.xii.1978. - ML1109-1111: 7.6 km SSE. St. Fillan, Dandenong Ranges, roadside in wet sclerophyll forest; 4.xii.1978.- ML1273-75: 54.7 km from Mt. St. Bernard on road to Dargo, among bracken in wet sclerophyll forest; 13.xii.1978. New South Wales: ML1367-69: 7.0 km from Mt. Wilson on Bowens Ck. Road, among bracken on hillslope east of creek; 27.xii.1978.

Discussion. S. velleioides superficially resembles S. magnificus but the two are not conspecific (as suggested by Willis, 1972). Apart from differences in distribution, leaf morphology and capitulum size, which are not easily defined, the two can be reliably separated by achene and pappus features as well as shape of the staminal filament collar. S. velleioides has a deeply ribbed achene about 2.7 mm long, a deciduous pappus and a comparatively small and scarcely swollen filament collar. The achenes of S. magnificus are obscurely ribbed and 5-6 mm long, the pappus is persistent and the filament collar is large and basally swollen. Because of vegetative similarities and the lack of a calyculus in both, it is likely that S. velleioides and S. magnificus are related. However, the differences mentioned above suggest that evolutionary divergence has been considerable.

7. Senecio pectinatus DC., Prodr. 6:372(1838). (Figure 3.3C).

Rosette or stoloniferous perennial herb, 5-10 cm tall when vegetative, 12-20 cm including flowering scape. Vegetative STEMS almost absent in first year, prostrate laterals 2-8 cm long arising from previous seasons rosette, rooting at the nodes where covered by soil, thickening with age and bearing fibrous remains of sheathing leaf bases. LEAVES forming a rosette; oblanceolate to spathulate, (3-)5-10x0.5-2 cm, attenuate and stem clasping basally, cleft or pinnate with usually serrate or crenate lobes, apex obtuse; glabrous or with long hirsute hairs along the midrib. CAPITULA radiate, solitary and terminal; scape with reduced leaves basally, grading into bracts distally, glabrate at maturity, densely hirsute when young. INVOLUCRE hemispherical or slightly campanulate, 9-13x7-11 mm; phyllaries 20-24, free, subequal, dorsally smooth. Calyculus of 5-8 lanceolate adpressed bracts 5-7 mm long. RECEPTACLE flat, pitted, pit margins obscure. RAY FLORETS 15-22; ligule 9-14x4-6 mm, 4-veined; tube glabrous. DISC FLORETS 110-150, 8-10.5 mm long, glabrous, tubular below, campanulate on upper two thirds; lobes 5, spreading, ovate deltoid, 1.2-1.5x1-1.3 mm, without a median resin duct. STAMINAL FILAMENT up to 0.1 mm wide; collar 0.3-0.4x0.2 mm, swollen basally, tapering distally. ANTHERS 2 mm long; theca acute basally; apical appendage widely ovate-lanceolate, 0.5x0.4 mm. STYLE BRANCHES shortly papillate on dorsal surface, stigmatic surface largely continuous, divided on the basal third, apex rounded with papillae around the abaxial margin. PAPPUS white, of many stout caducous (?) bristles in 1-2 rows, uniform, barbellate with acute teeth, cells somewhat crowded distally, apex 2-3 celled. ACHENES glabrous (other features not known as I have only seen immature material).

Flowering period: January to March.

Chromosome number: 2N = 80.

General distribution. Restricted to alpine areas above the tree-line in Victoria, New South Wales and Tasmania.

Habitat. Alpine herbfields and sod tussock grassland, often along the banks of streams.

Collection sites. New South Wales: ML1397-99: sandy banks of Spencers Ck. near Mt. Kosciusko; 1.i.1979 (plants in bud, grown from cuttings in the glasshouse).

Discussion. In the vegetative state S. pectinatus resembles extreme alpine forms of S. lautus subsp. alpinus, but the two are easily distinguished when flowering. S. pectinatus produces a large solitary capitulum whereas S. lautus subsp. alpinus has a terminal corymbose panicle of 10-20 capitula. In Tasmania, Curtis (1963) recognised DeCandolle's S. leptocarpus as a species distinct from S. pectinatus, as the former has a corymbose inflorescence of 3-5 capitula. Bentham (1866) considered S. leptocarpus to be a variety of S. pectinatus. I have seen very few Tasmanian specimens, but I believe the relationships between S. pectinatus, S. leptocarpus and S. lautus subsp. alpinus require further investigation in this state.

8. Senecio amygdalifolius F. v. Muell., Fragm. phytogr. Austral 1:232(1858). (Figure 3.3D).

Erect glabrous perennial herb 40-70 (-100) cm tall, sometimes stoloniferous. STEMS arising from a subterranean caudex, rarely persisting more than one year, slender, cylindrical and lightly striate, purple towards the base, usually unbranched below the inflorescence. LEAVES simple; petiole slender, 1.5-3 cm long, often purple; blade broadly lanceolate to ovate, 8-11x2.5-4 cm, base often oblique, margin serrate or serrulate, with narrow acute teeth, apex acuminate. CAPITULA radiate, (3-)10-20(-30) in a lax terminal corymbose panicle; peduncles slender, 2.5-6 cm long, bracteate. INVOLUCRE cylindrical or narrowly campanulate, 8.5-9x 4-5 mm; phyllaries 10-12, free, subequal, faintly 2-3 ribbed on dorsal surface. Calyculus spreading irregularly, of 3-5 narrowly triangular bracts 2-6 mm long. RECEPTACLE flat, deeply pitted, pit margins smooth or undulate but not toothed. RAY FLORETS (4-)5(-6); ligule 9-11x3-5 mm, 4(-5) veined; tube pubescent distally, hairs adpressed to the tube, slender, uniseriate, 10-13 cells long. DISC FLORETS 14-23, corolla 6-8 mm long, glabrous, tubular basally, campanulate on upper third; lobes 5, narrowly ovate-lanceolate, 1x0.3 mm, recurved, with a median resin duct. STAMINAL FILAMENT up to 0.15 mm wide; collar 0.3x0.2 mm, slightly swollen basally. ANTHERS 2-2.3 mm long; theca acute or obtuse basally; apical appendage narrowly ovate, 0.45 mm long. STYLE BRANCHES minutely papillate distally on dorsal surface; stigmatic surface divided by a very narrow median groove, superficially continuous; apex domed with several rows of spreading papillae, rarely with a minute median adaxial fascicle. PAPPUS white, of many slender caducous bristles in 2-3 rows, uniform; minutely barbellate with acute teeth, cells somewhat crowded distally

but not enlarged, apex 2-3 celled. ACHENES homomorphic, glabrous, subcylindrical, 4.5-6.5x0.8-1 mm, red-brown; base and apex white callose-annulate, each slightly tapering; surface of 8 longitudinal segments separated by deep narrow channels, each segment with either a shallow or deep median groove hence the achene is either 16- or 8-12 ribbed.

Flowering period: August to October

Chromosome number: 2N = 38.

General distribution. Apparently restricted to the Great Dividing Range. Occurring south of Gaynday (Qld.) to Mt. Lindsay, approximately 70 km south of Sydney (N.S.W.). Locally common north of Newcastle (N.S.W.).

Habitat. In all parts of warm wet sclerophyll forests, sometimes locally weedy along roadsides.

Collection site. ML1477-9 (leg. A. Floyd): Tallawudjah Ck., New South Wales, 23.ix.1979.

Discussion. Although my description of S. amygdalifolius is based on only one population (ML1477-79, leg. A. Floyd) and observations of glasshouse specimens raised from cuttings, it agrees well with the protologue (Mueller 1838). However, Mueller stressed that the receptacle was 'subpaleaceo' whereas I found the receptacle to be lacking minute teeth or scales. I found considerable variation in receptacle scaliness from population studies of discoid species such as S. hypoleucus and S. odoratus; and extreme variation (naked to scaly) in S. lautus. I therefore believe that features of the receptacle are of limited use as diagnostic characters.

In New South Wales S. amygdalifolius is not common south of Newcastle but has been collected south of Sydney. It should therefore have been included in Beadle, Evans and Carolins'(1976) "Flora of the Sydney Region." This omission from a well used text, coupled with what I believe are unjustified alterations to Mueller's protologue, has led to frequent misidentifications - S. amygdalifolius as S. linearifolius in the southern extremes of the former's range and S. linearifolius as S. amygdalifolius in the northern extremes of the latter's distribution. I could find no evidence to support Bentham's (1866) amendment of Mueller's description to include specimens with "smaller and more densely corymbose" capitula. Bailey's (1900) inclusion of "branching" shrubs for the Queensland Flora also seems unjustified. I was not able to visit the herbarium at Brisbane (BRI) but Queensland specimens at Sydney (SYD) show close agreement with the protologue (Mueller, 1838). Although S. amygdalifolius and S. linearifolius are very different in features of the leaf base, filament collar, style branches and achene, S. linearifolius superficially resembles a 'branched' form of S. amygdalifolius with "smaller and more densely corymbose" capitula. I therefore believe the description of S. amygdalifolius should be restricted to plants with stems largely unbranched below the inflorescence and with 3-30 capitula in a lax terminal corymbose panicle.

9. Senecio macranthus A. Rich., Voy. Astrol. 2:127(1834). (Figure

non S. macranthus Clark, Compos. Ind. 205(1876) nom. illeg.

Erect glabrous perennial herb 70-120 cm tall. STEMS stout, cylindrical, striate, much branched and woody basally. LEAVES simple, coriaceous; narrowly lanceolate, 8-14x4-7 mm, tapering basally with 2-4 linear lobes 6-10 mm long at the stem, denticulate, rarely with distant acute teeth, apex acuminate. CAPITULA radiate, 5-35 in a lax terminal corymbose panicle; peduncles stout, 2-5 cm long, bracteate. INVOLUCRE broadly campanulate, 9-11x9-9.5 mm; phyllaries 20-22, free, equal, distinctly 1-ribbed on dorsal surface. Calyculus radiating, apically incurved, bracts in 8-11 in one row, linear, 6.5-8x0.6-1 mm. RECEPTACLE flat, faintly pitted, with obscure pit margins. RAY FLORETS 11-13, ligule 20-21x4 mm, 4-veined; tube distally pubescent, hairs slender, uniseriate, 4-6 cells long. DISC FLORETS 65-80; corolla 8-10 mm long, tubular basally, campanulate and sparsely hairy on upper half (hairs as in ray florets); lobes 5, spreading, broad-lanceolate, 1.2x0.7 mm, without median resin duct. STAMINAL FILAMENT up to 0.15 mm wide; collar 0.6x0.3 mm, bulbous basally, attenuate distally. Anthers 2 mm long, theca acute or obtuse basally, apical appendage narrowly oblong-ovate, 0.5 mm long. STYLE BRANCHES dorsally glabrous; stigmatic surface largely continuous, shortly divided basally; apex high-domed with many short radiating papillae around the abaxial margin. PAPPUS white, of many stout caducous bristles in 2-3 rows, uniform, barbellate with acute teeth, cells not crowded distally, apex 2-celled. ACHENES glabrous, cylindrical, rounded at both ends, surface of 12 very pronounced broad rounded ribs; 'ray' achenes red- to dark-brown, 3-3.5x1.5 mm; 'disc' achenes

light-yellow, 4.2-4.6x1.5 mm.

Flowering period: August to November.

Chromosome number: 2N = 40.

General distribution. Apparently restricted to the Great Dividing Range. Occurs in New South Wales from Tallong, 100 km south of Sydney to Wollomombi near Armidale.

Habitat. Wet sclerophyll forests, occasional near rocky streams or on shale or rocky hillsides nearby, infrequent on ridgetops.

Collection site. New South Wales: ML1393-95: near mouth of Colong Caves, southern Kangara Boyd National Park, next to stream at base of steep shale slope; 29.xii.1978. Plants not flowering, raised from cuttings in the glasshouse.

Discussion. Senecio macranthus is easily distinguished from all other Australian Senecio species by its very long ligules and long radiating calyculus. It is not allied to S. lautus, as suggested by Bentham (1866), although both species do have ray florets. The abundance of S. macranthus is difficult to determine, as it is found in very inaccessible deep valleys. A number of collectors' notes on herbarium specimens describe the species as "locally abundant," but there are only 24 specimens in the Sydney herbarium (SYD). I therefore consider S. macranthus to be a comparatively rare species.

10.1 Senecio vagus F.v. Muell., Trans. Phil Soc. Vict. 1:46 (1855) subsp. vagus. (Figure 3.4A).

Erect glabrate perennial (?) herb 1-1.5 m tall. STEMS stout, cylindrical and striate; branched and purplish basally. LEAVES thin and flexible, usually compound; widely ovate-lanceolate, 9-21x6-14 cm; petiole 0.5-2 cm long, basal leaflets 2-5, lanceolate and irregularly toothed, terminal leaflet sometimes as wide as leaf, deeply cut basally, toothed distally, apex acuminate; rarely simple and then blade deeply and acutely lobed or slashed. CAPITULA radiate, 15-60 in a lax terminal corymbose panicle; peduncles stout, 2-5(-9) cm long, bracteate, inflated below the capitulum. INVOLUCRE broadly campanulate, 9-11x6-7 mm; phyllaries 12-15, free, subequal, dorsal surface faintly 2-3 ribbed and with numerous stout, black or purplish biseriate glandular hairs. Calyculus spreading, distally incurved, bracts 8-13, narrow-lanceolate, 5-8x1-1.5 mm, dorsally and marginally glandular-hairy. RECEPTACLE flat, faintly pitted. RAY FLORETS 7-11; ligule 10-17x4-6 mm, 7-veined; tube glabrous. DISC FLORETS 35-50, 8.5-10 mm long, glabrous, tubular below, campanulate on upper half; lobes 5, spreading, broadly lanceolate, 1x0.8 mm with a median resin duct. STAMINAL FILAMENT up to 0.15 mm wide, collar 0.5-0.6x0.3 mm, swollen basally, tapering distally. ANTHERS 2-2.7 mm long, theca acute basally, apical appendage narrowly oblong-ovate, 0.3-0.5 mm long. STYLE BRANCHES shortly papillate dorsally, stigmatic surface continuous, apex convex with many spreading papillae around the abaxial margin. PAPPUS white, of many slender caducous bristles in 2-3 rows, uniform, barbellate with acute teeth, cells not crowded distally, apex of 2 slightly inflated cells. ACHENES shortly cylindrical, black, 4x1.5-2mm; rounded at both ends, surface of 9 broad and pronounced ribs,

each triangular in section, with a row of slender black hairs on top, superficially glabrous.

Flowering period: December to March, occasionally October to December.

Chromosome number: 2N = 98.

General distribution. Mountainous areas of Victoria from the Grampians to the Great Dividing Range, occasional in south-eastern New South Wales (not in Tasmania).

Habitat. Shaded areas of wet sclerophyll forests, often emergent among dense understory.

Collection sites. Victoria: ML1112-14: 7.6 km SSW. St. Fillan, Dandenong Ranges, wet sclerophyll forest; 4.xii.1978.- ML1276-78: 14.1 km N. Dargo, wet sclerophyll forest; 13.xii.1978.

10.2 Senecio vagus subsp. eglandulosus Ali, Kew Bull. 19:427-29 (1965). (Figure 3.4B).

Differs from the typical subspecies in having eglandular phyllaries and calycular bracts.

Flowering period: August to April.

Chromosome number: 2N = 98.

General distribution. Great Dividing Range in New South Wales from Sydney to Lismore.

Habitat. As for typical subspecies.

Collection site. New South Wales: ML1343, ML1349-50: near entrance gate to Barrington Tops National Park, next to rocky stream; 24.xii.1978.

Discussion (both subspecies). My descriptions are based on collections from only three populations, but I consider them to be representative of all specimens examined. S. vagus is vegetatively and florally very distinctive. The leaves vary considerably in size and degree of dissection, but are unlike leaves of any other Australian species. The two subspecies are clearly defined both morphologically and geographically. To my knowledge there are no intermediate forms.

11. Senecio linearifolius A. Rich., Voy. Astrolabe (Bot.)2: 129(1834). (Figures 3.5A-C).

S. australis A. Rich., l.c. 131.t.39 (1834).

non S. australis G. Forst. ex. Willd., Sp. Pl. Ed. 4. 3(3):1981(1803) = S. lautus.- sensu Benth., Fl. Austral. 3:668(1866) = S. linearifolius e. descr.

S. macrodontus DC., Prodr. 6:373(1838).

S. dryadeus Sieb. ex. F.v. Muell., Key Syst. Vict. Plants 1:339(1888).

Based on field and herbarium observations I recognised four forms of S. linearifolius for comparative cytological work (Lawrence 1980). I have now combined two of these, the "typical" and "glaucous" forms, as they are not readily distinguished in a dried state.

Key to varieties of S. linearifolius

1a.Leaves glabrous or sparsely arachnoid beneath

2a.Leaves broad-linear to broad-lanceolate, coriaceous, narrowed or subpetiolate basally . . . . . var. linearifolius

2b.Leaves ovate-lanceolate to ovate, usually membranous, sometimes scarcely narrowed basally . . . . . var. A (alpine)

1b.Leaves densely white tomentose beneath . . . var. B (Grampians)

11.1 S. linearifolius var. linearifolius (Figure 3.5A).

Erect glabrate sometimes glaucous perennial herb 70-120 cm tall. STEMS stout, cylindrical and striate, new growth arising from a common base, sparingly branched below the inflorescence. LEAVES simple, coriaceous, lanceolate to broad-lanceolate, rarely broad-linear, 7-10(-16)x(0.4-)0.8-3 cm, narrowed basally, sometimes subpetiolate, usually expanded and auriculate at the stem, margin subentire, denticulate or serrate, apex acuminate; glabrous or sparsely arachnoid below. CAPITULA radiate, 60-300 in a dense terminal corymbose panicle; peduncles slender, 4-10 mm long, bracteate. INVOLUCRE cylindrical, 3.5-5.5x2-3 mm; phyllaries 7-8(-11), free, subequal, dorsally 1-2 ribbed. Calyculus of 2-4 linear adpressed bracts 1-2 mm long. RECEPTACLE flat, pitted, pit margins raised into slender scales. RAY FLORETS (4-)5(6-8), ligule 3-6x2-3 mm, 4-veined; tube pubescent, hairs uniseriate, rarely biseriate, slender, 6-10 cells long. DISC FLORETS 9-15, exserted 2-3 mm beyond the involucre; corolla 4-6 mm long, glabrous, tubular below, campanulate on upper half; lobes 5, spreading, broad-lanceolate, 0.6-0.8 mm long with a faint median resin duct. STAMINAL FILAMENT up to 0.07 mm wide, collar 0.2-0.4x0.1-0.2 mm, swollen basally, tapering distally. ANTHERS 1.2-1.5 mm long, theca with tails up to two thirds the filament collar length, apical appendage narrowly ovate, 0.2-0.3 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two broad but discrete marginal lines, apex slightly convex with spreading papillae around abaxial margin. PAPPUS white, of many slender caducous bristles in 2-3 rows, dimorphic - some bristles 'fluked', others barbellate with acute teeth, cells not crowded distally, apex 2-celled. ACHENES subcylindrical, 1.7-2.8x0.4-0.6 mm, basally rounded; surface of 7-10 flat or slightly concave segments

separated by narrow grooves, glabrous or with short adpressed hairs in and around the grooves; all red-brown or those of ray florets white.

Flowering period: October to March.

Chromosome number: 2N = 60.

General distribution. Great Dividing Range and adjacent coastal areas in Victoria and as far north as Coffs Harbour in New South Wales. Also Tasmania.

Habitat. Understory of wet sclerophyll forests, coastal plains, occasional behind coastal dunes, often becoming weedy along roadsides in agricultural districts.

Collection sites. Victoria: ML1090-92: 11.5 km NW. Forster, in roadside grass near small creek; 3.xii.1978.- ML1133-35: 11 km NE. Cape Otway lighthouse, locally abundant in wet sclerophyll forest; 5.xii.1978.- ML1302: 7 km E. Marlo, base of coastal dune; 15.xii.1978.- ML1314-16: Genoa Peak summit, in sclerophyll forest; 15.xii.1978.- New South Wales: ML1330-32: 22.9 km N. Wingham on road to Comboyne, wet sclerophyll forest; 24.xii.1978.- ML1351-53: 6 km SW Martinsvale, Wattagang State Forest, open forest on ridge top; 26.xii.1978.- ML1373-75: 8.6 km NE. Mt. Wilson, dry sclerophyll forest; 27.xii.1978;- ML1386-88: 33.1 km SW. Hartley, embankment above pastures; 28.xii.1978.- ML1412-14: 15.4 km from Thredbo on road to Khancoban; wet sclerophyll forest; 31.xii.1978.

11.2 S. linearifolius var. A (alpine) (Figure 3.5B).

Differs from the typical form in having leaves thin and sometimes membranous, broad lanceolate to ovate, not or scarcely narrowed basally, broadly auriculate and stem-clasping, denticulate or minutely lacerate. Regenerates annually from a subterranean caudex.

Flowering period: December to April.

Chromosome number: 2N = 60.

General distribution. Subalpine regions of Victoria, New South Wales and (?) Tasmania.

Habitat. Forested slopes near or above the snowline, absent from higher alpine meadows, often locally abundant along roadsides.

Collection site. Victoria: ML1237-79: road to Mt. Buffalo summit, 14 km from Bushland Valley Rd., roadside in wet sclerophyll forest; 10.xii.1978. New South Wales: ML1409-11: Pilot Lookout, 10.4 km SW. Thredbo, wet sclerophyll forest; 31.xii.1978. -ML1436-38: 16 km SW. Cabramurra, wet sclerophyll forest; 31.xii.1978.

11.3 S. linearifolius var. B (Grampians) (Figure 3.5C).

Differs from the typical form in having leaves usually subentire without auricles, densely white tomentose beneath, glabrous above.

Flowering period: November to February.

Chromosome number: 2N = 60.

General distribution. The Grampians, Victoria.

Habitat. Understory of wet sclerophyll forests or along roadsides.

Collection site. Victoria: ML1191-93: road to Mafeking via Jimmy's Creek, wet sclerophyll forest; 7.xii.1978.

Discussion. Willis (1957) discussed nomenclatural problems associated with the common Fireweed Groundsel. He concluded that S. dryadeus Sieb. and S. australis A. Rich were both illegitimate names. S. dryadeus Sieb. is a herbarium name and was published validly only in 1888 by Mueller. S. australis A. Rich. is synonymous with S. linearifolius A. Rich. but is a later homonym of S. australis F. Forst. ex. Willd. Willis therefore decided that S. linearifolius, published by A. Richard in 1834, is the earliest available name. Although Willis mentioned S. macrodontus DC. (1838) in his discussion, he did not include it with synonyms of S. linearifolius. Bentham (1866) included S. macrodontus in synonymy with his S. australis var macrodontus, but did not clearly distinguish this variety from var. australis. I believe S. macrodontus DC. is representative of the more pubescent forms of S. linearifolius var. linearifolius and have placed it in synonymy with S. linearifolius.

I have recognised two forms of S. linearifolius other than the typical variety. The first, var. A, corresponds to plants of alpine and subalpine regions, the second, var. B, to a form from the Grampians in Victoria. These varieties represent diversification in extreme or marginal conditions, and are therefore similar to some subspecies of S. lautus. Like the S. lautus complex, intermediate forms can also be found between the varieties of S. linearifolius. Willis's comment concerning this problem was "S. linearifolius varies considerably in its degree of hariness, development of leaf-teeth and basal auricles, so much so that I find it impractical to recognise any clear-cut varieties." I believe, however, that subspecific (and specific) distinctions must be consistent within a genus, even if the distinctions are not always "clear-cut". As I chose to retain Ali's subspecific division of the S. lautus complex, I believe S. linearifolius must also be subdivided, as it is an equally variable species.

12. Senecio sp. A (early herbarium specimens annotated "S. garlandi" by F. v. Mueller). (Figure 3.5D).

Erect woolly perennial shrub 70-120 cm tall. STEMS stout, cylindrical and striate; new growth often arising from a common base, sparingly branched below the inflorescence; densely white-tomentose on most parts, sometimes glabrate on distal inflorescence axes. LEAVES simple, coriaceous; ovate-lanceolate to widely obovate; 8-16(-25)x5-8(-11) cm, narrowed basally, expanded at the stem and broadly cordate-auriculate or broadly stem-clasping, margins denticulate, serrate or irregularly biserrate, apex acute or obtuse; densely white-tomentose beneath, white-tomentose at first above, becoming arachnoid then glabrate at maturity. CAPITULA radiate, 10-60 in a rather dense terminal corymbose panicle; peduncles slender, 4-10 mm long, bracteate, glabrous or white tomentose. INVOLUCRE campanulate, 6-7x4-5 mm glabrous or white-tomentose; phyllaries 12-16, free, subequal, dorsally 1-2 ribbed. Calyculus of 3-5 narrowly triangular adpressed bracts 2-3 mm long. RECEPTACLE flat, pitted, pit-margins minutely toothed. RAY FLORETS 8-9; ligule 5-6x3-4 mm, 4-5 veined; tube densely pubescent distally, hairs uniseriate, clavate, 5-8 cells long. DISC FLORETS 26-35, exserted 2-4 mm beyond the involucre; corolla 6-8.5 mm long, glabrous, tubular below, campanulate on upper half; lobes 5, spreading, ovate deltoid, 0.5-0.7 mm long with a faint median resin duct. STAMINAL FILAMENT up to 0.08 mm wide, collar 0.45x0.2-0.25 mm long. ANTHERS 2 mm long, theca acute basally, apical appendage narrowly ovate, 0.4 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two broad but discrete marginal lines, apex rounded with several rows of spreading papillae around the abaxial margin. PAPPUS white, of many slender caducous bristles in 2-3 rows, uniform, barbellate

with acute teeth, sometimes obtuse distally, apex 1-2 celled. ACHENES subcylindrical, red-brown, 2-2.5x0.6 mm, basally rounded, apically white callose annulate; surface of 8 flat segments separated by narrow grooves; pubescent, hairs short, in narrow rows in grooves.

Flowering period: (?) occasional throughout the year.

Chromosome number: 2N = 60 or 120.

General distribution. Isolated inland occurrences from Gidinbung (70 km N. Wagga Wagga) to Gerogery (90 km S. Wagga Wagga). One collection from Tilba Tilba on the coast. Endemic in New South Wales.

Habitat. Known to me only from Hanging Rock, south of Wagga Wagga. Plants growing on uppermost slopes immediately below rocky summit outcrop; with Eucalyptus, Casuarina and Callitris on lower slopes.

Collection site. New South Wales: ML1445-47: N. facing slope below rocky summit of Hanging Rock, 3 km W. The Rock, 26 km SSW. Wagga Wagga; 1.i.1979. Plants not flowering, raised from cuttings in the glasshouse.

Discussion. Senecio sp. A is genuinely rare, as there are only eight collections corresponding to six localities in the Melbourne (MEL) and Sydney (SYD) herbaria. Mueller was unsure whether to treat S. sp. A as a variety of S. linearifolius or as a distinct species. He annotated early herbarium specimens "S. garlandi" and similarly titled a page of manuscript notes. At the bottom of the page he noted "probably only an extreme form of S. dryadeus" and then changed the title to read "S. macrodontus var. garlandi." (S. dryadeus and S. macrodontus are both synonymous with S. linearifolius). The only published reference I have

seen is in Maiden and Betche((1916) "A census of New South Wales plants" as "S. dryadeus Sieb. var. Garlandi F.v.M. in MS. in Melb. Herb." This, however, is a nomen nudum and not a valid publication.

Although S. linearifolius is vegetatively very variable, it has uniform capitulum features that suggest affinities with discoid species such as S. hypoleucus. S. sp.A is vegetatively unlike any form of S. linearifolius and has a higher number of phyllaries, ray and disc florets. I agree that S. linearifolius and S. sp. A are related, as they both have distinctively short, elliptical ligules and similar achenes, but I believe the differences in the capitulum morphology of S. sp. A, warrant specific recognition.

Fig. 3.1 Senecio lautus subspecies. A. subsp. dissectifolius. B. subsp. maritimus. C. subsp. lanceolatus. D. subsp. alpinus. All figures at same magnification. Scale 10 cm.

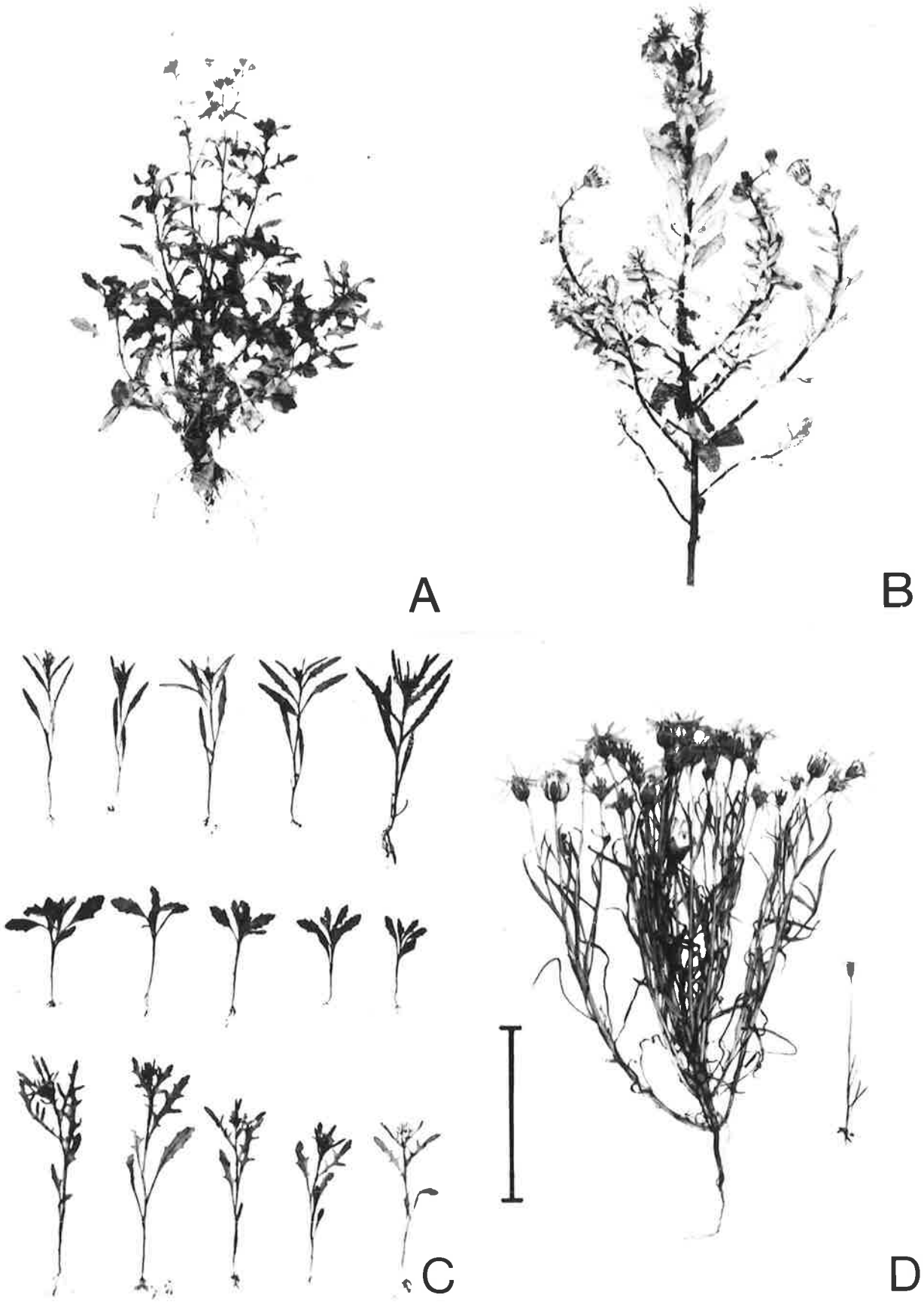

Fig. 3.2 A. Senecio lautus subsp. lautus. B. S. spathulatus. C. S. glossanthus, rows 1 and 2 tetraploid (2N=40), row 3 octoploid (2N=80). D. S. gregorii. All figures at same magnification. Scale 10 cm.

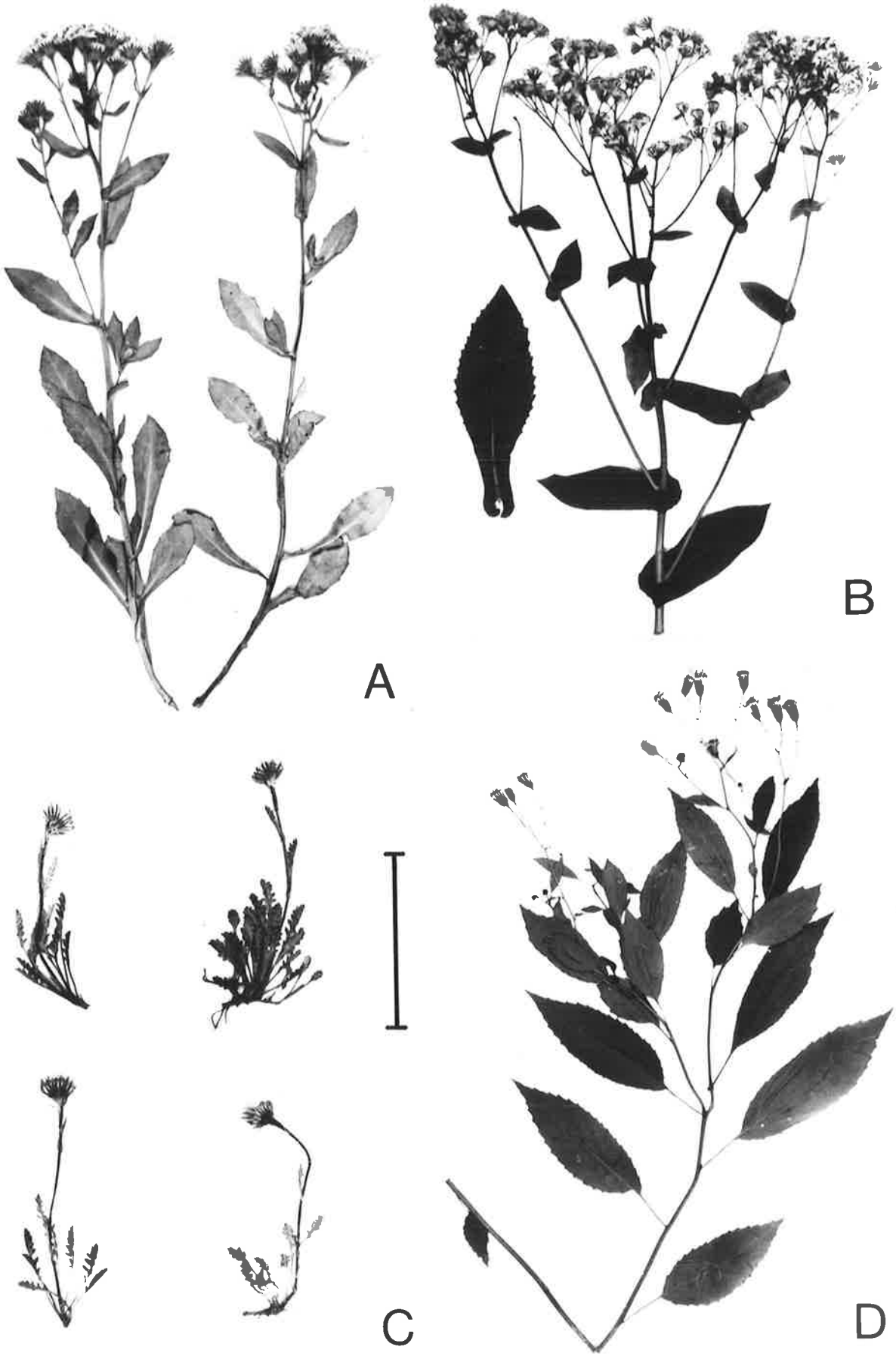

Fig. 3.3 A. Senecio magnificus. B. S. velleioides. C. S. pectinatus. D. S. amygdalifolius. All figures at same magnification. Scale 10 cm.

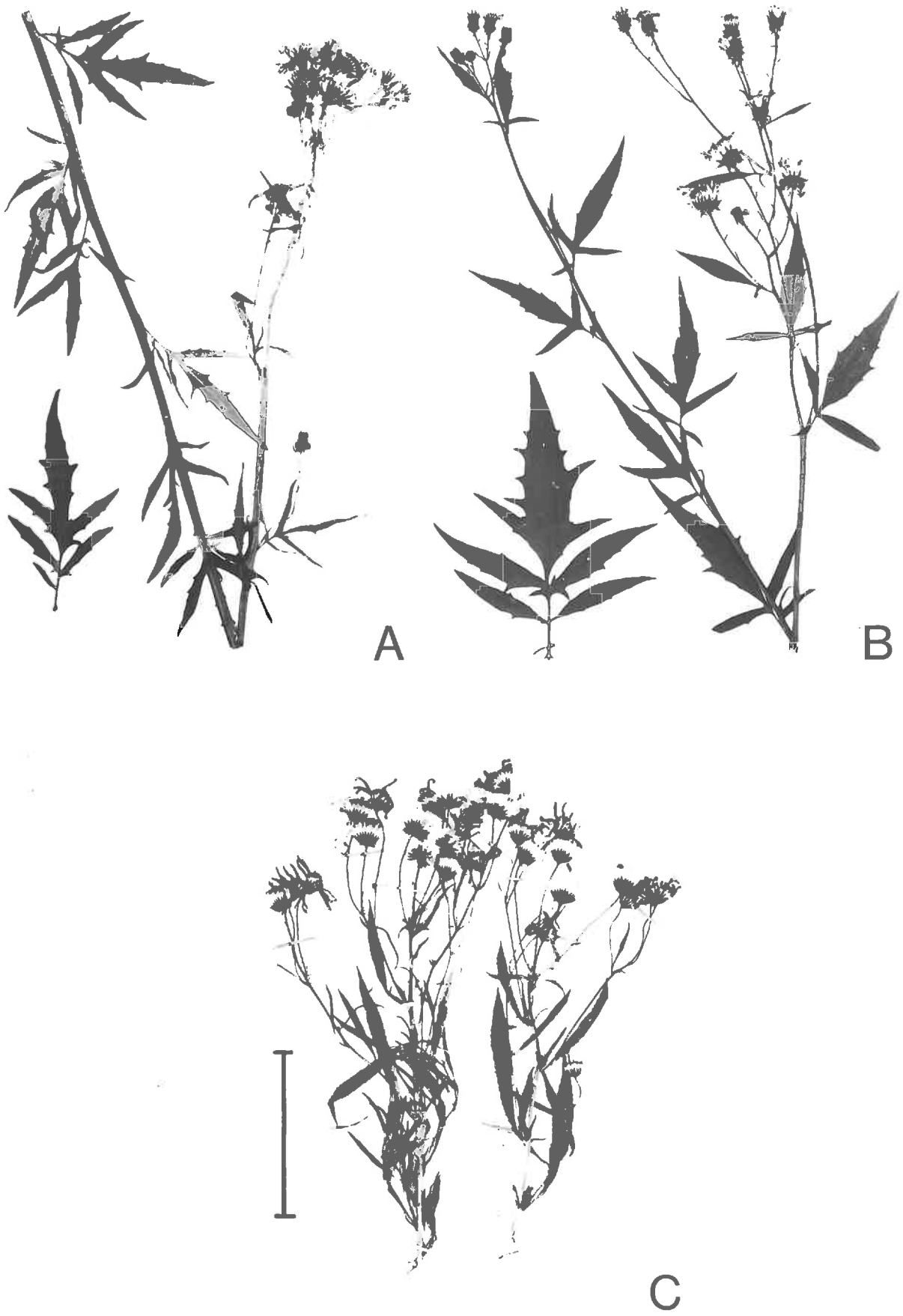

Fig. 3.4 A. Senecio vagus subsp. vagus. B. S. vagus subsp. eglandulosus. C. S. macranthus. All figures at same magnification. Scale 10 cm.

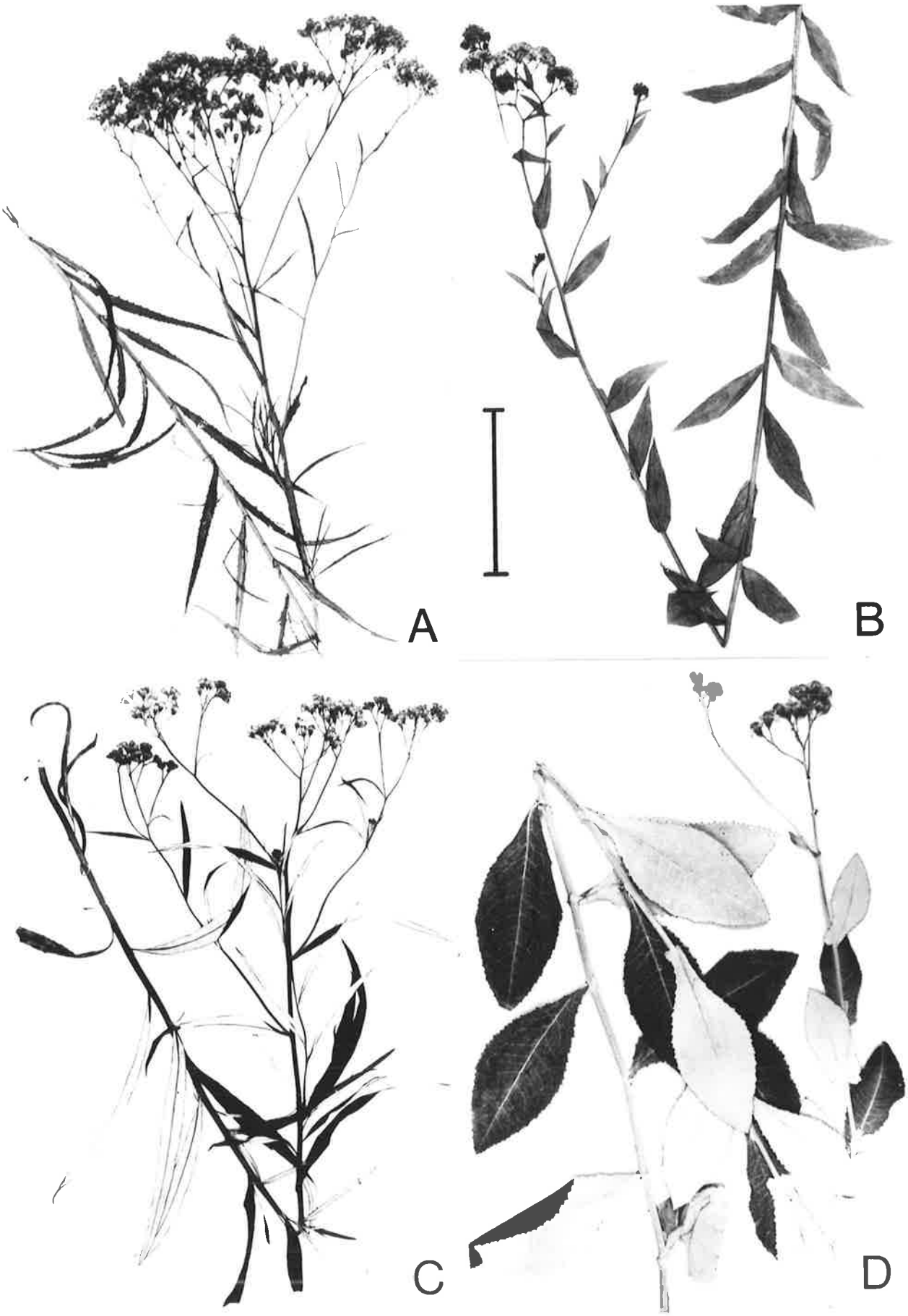

Fig. 3.5 A. Senecio linearifolius var. linearifolius.

B. S. linearifolius var. A. C. S. linearifolius var. B.

D. S. sp. A. All figures at same magnification. Scale 10 cm.

3.4.2 Discoid Species of *Senecio* (Group 2 of key to species)

Species of this group are vegetatively variable, but have many floral characteristics in common. To avoid unnecessary repetition I have described common characters below and have given only dimensions and numbers in the following specific descriptions.

Floral features common to all discoid species

CAPITULA homogamous discoid; peduncles slender, bracteate. INVOLUCRE cylindrical; phyllaries free, subequal, dorsal surface 1-2 ribbed. Calyculus of 2-4(-5) narrowly triangular adpressed bracts 1-3 mm long. RECEPTACLE flat, pitted, pit margins raised into short scales. FLORETS all perfect and bisexual. STAMINAL FILAMENT 0.1 mm wide collar 0.4-0.5x0.2 mm, swollen basally, tapering distally. STYLE BRANCHES flattened, dorsal surface glabrous, stigmatic surface of two broad but discrete marginal lines, apex rounded with spreading papillae around the abaxial margin. PAPPUS white, of many slender caducous bristles in 2-3 rows, either uniform, and then all bristles minutely barbellate with acute teeth, apex 2-celled, or dimorphic with some bristles fluked.

13. Senecio hypoleucus F. v. Muell. ex. Benth., Fl.Austral. 3:672(1867). (Figure 3.6A).

S. odoratus Hornem. var.hypoleuca F. v. Muell., unpublished herbarium name (pre 1853)

S. odoratus var. petiolata Sond., Linnaea 25:526(1853).

Erect woolly perennial shrub 80-120 cm tall. STEMS stout, cylindrical, striate, new growth often arising from a common base, sparsely to densely arachnoid on all but oldest part, woody basally, little branched below the inflorescence. LEAVES simple, coriaceous; petiole stout, arachnoid, 1-3 cm long; blade broad- to ovate-lanceolate, 6-15x1.5-4 cm, denticulate or shortly bi-seriate, rarely with a few denticulate lobes basally, densely white-tomentose beneath, arachnoid above. CAPITULA 100-600 in a congested terminal corymbose panicle; peduncles 2-5 mm long. INVOLUCRE 4.5-6x2-3 mm; phyllaries 7-10. FLORETS 11-14, exserted 3-4 mm beyond the involucre; corolla 5-7 mm long, glabrous, tubular below, campanulate on upper half; lobes 5, spreading, broad-lanceolate, 1 mm long with a faint median resin duct. ANTHERS 1.5-1.8 mm long, theca basally tailed, tails sometimes as long as filament collar, apical appendage ovate, 0.3 mm long. PAPPUS dimorphic. ACHENES homomorphic, red- or dark-brown, sub-cylindrical, 2x0.6 mm; basally rounded; surface of 9-10 flat segments separated by narrow grooves, hairs short, adpressed, in a sparse or dense row in each groove.

Flowering period: October to January.

Chromosome number: 2N = 60.

General distribution. Mt. Lofty Ranges in South Australia. Mt. Arapiles, Black and Dundas Ranges in Victoria.

Habitat. Understory of dry sclerophyll forests, in clay or clay-loam soil of rocky hillsides or in cracks of rocky outcrops, locally abundant along roadsides.

Collection sites. South Australia: ML646-8: 0.6 km W. Kangaroo Ck. Dam wall, Mt. Lofty Ranges; 23.xi.1976. Victoria: ML1224-26: among rocks near summit of Mt. Arapiles; 8.xii.1978.

Discussion. Although the varietal epithet petiolata Sond. was validly published before Bentham's S. hypoleucus, Article 60 of the International Code of Botanical Nomenclature states that "In no case does a name or an epithet have priority outside its own rank." Bentham's return to Mueller's unpublished herbarium name is therefore valid, although contrary to Recommendation 60A.2. I believe S. hypoleucus was justifiably treated as a variety of S. odoratus by both Mueller and Sonder. However, as for S. sp. A (description 12), arguments to justify elevation to specific rank are equally strong.

14. Senecio odoratus Hornem., Hort. bot. hafn. 2:809(1815) (Figure 3.6B).

non S. odoratus var petiolata Sond., Linnaea 25:525(1853)

= S. hypoleucus

14.1 Senecio odoratus var. odoratus

Erect glabrous or sparsely hairy glaucous perennial shrub 70-130 cm tall. STEMS stout, cylindrical, striate, woody basally, branched below the inflorescence, new growth often arising from base. Largest cauline LEAVES coriaceous, usually fleshy, lanceolate to ovate-lanceolate, 5-12x(1-)2-4 cm, auriculate and stem-clasping, narrowed or subpetiolate basally, margins denticulate or irregularly serrate, apex acute, glabrous or sparsely arachnoid beneath. Upper leaves shorter, sometimes ovate-triangular or ovate-deltoid, subentire. CAPITULA (50-)100-400 in congested terminal corymbose panicles; peduncles 4-9 mm long. INVOLUCRE 5-7x2-3.5 mm; phyllaries (7-)8(-10). FLORETS 10-14(-16), exserted 3-4 mm beyond the involucre; corolla 4.5-8 mm long, outermost with a few uniseriate hairs 6-8 cells long, tubular below, campanulate on upper half; lobes 5, spreading, broad-lanceolate, 0.8-1.2x0.6-0.8 mm, with a faint median resin duct. ANTHERS 1.3-1.7 mm long, theca shortly tailed, tails not more than half filament collar length, apical appendage ovate, 0.2-0.4 mm long. PAPPUS dimorphic ACHENES homomorphic, light yellow or light brown, subcylindrical, 1.8-2.5x0.5-0.7 mm, basally rounded; surface of 8-10 flat segments separated by narrow grooves, hairs short, adpressed, in broad rows over grooves.

Flowering period: October to January.

Chromosome number: 2N = 60.

General distribution. Coastal areas from southern Fleurieu Peninsula (including Kangaroo Island) in South Australia, to Wilsons Promontory in Victoria. Isolated occurrences in the southern Flinders Ranges (S.A.) and The Grampians and at Telowie (Vict.). Also northern coastal areas of Tasmania (Curtis, 1963).

Habitat. Among stable coastal vegetation on sandy loam or clay not more than about 10 km inland, often around rocky outcrops, uncommon on drifting sand. Inland occurrences (see above) are usually on rocky hillslopes or in gorges.

Collection sites. South Australia: ML644: on low dune next to boat harbour, Robe; 6.xi.1976. - ML657: coastal shrubland on clay soil at Parson's Beach, c. 15 km SW. Victor Harbour; 1.xii.1976. - ML692-94: under Casuarina sp. on hillslope facing ocean 1 km S. Pennashaw, Kangaroo Isl.; 4.iii.1977. - ML703-11 on emergent limestone, Sapphiretown, Kangaroo Isl.; 5.iii.1977. - ML715: roadside rubble, base of Mt. Thisby, Kangaroo Isl.; 6.iii.1977. - ML717-19: among emergent limestone, 200 m from beach, Bay of Shoals, Kangaroo Isl.; 6.iii.1977. - ML734-35: grassy dune 50 m from beach, Seal Bay, Kangaroo Isl.; 6.iii.1977. Victoria: ML1106-08: along cliff top, 4 km SW Inverloch; 3.xii.1978. - ML1152-53: sandy soil at edge of mallee scrub, summit Mt. Richmond; 6.xii.1978. - ML1218-20: rocky roadside hillslope, 2.4 km SE. Zumstein, The Grampians; 8.xii.1978.

14.2 Senecio odoratus var. obtusifolius Black, Trans. Roy. Soc. S. Austral. 36:24, plate 3(1912). (Figure 3.6C).

Differs from the typical variety in having leaves less than 1.8 times longer than broad, apex obtuse or acute. Otherwise identical.

General distribution. Encounter Bay, The Coorong and Robe in South Australia.

Habitat. Among ocean facing granite outcrops, less common on clay or sandy-loam flats near the beach.

Collection sites. South Australia: ML609-13: among granite rocks, SE. face of the Bluff, Victor Harbour; 3.x.1976. - ML643: 34 km eastern edge of The Coorong; 34 km S. Meningie; 12.iv.1976.

Discussion (both varieties). My description of S. odoratus corresponds with those in current floras, however, I have ammended the distribution considerably. Black (1929) gave a distribution encompassing most of South Australia, but there are no specimens from either York or Eyre Peninsulas, or further north than Wilmington (60 km N. Port Pirie) in the Adelaide herbarium (AD). Willis (1972) included New South Wales, Queensland and Central Australia in his distribution of S. odoratus, but again, I could find no specimens to support this. I believe Willis may have confused the woolly inland form of S. cunninghamii with S. odoratus, but the two are readily distinguished. The most northerly forms of S. odoratus (South Australia) have ovate-deltoid leaves up to 7x4.5 cm towards the inflorescence. Northern and inland forms of S. cunninghamii have lanceolate to oblanceolate leaves not more than 1.5 cm broad towards the inflorescence. Specimens labelled S. odoratus have been collected from Pearson's Island off the

coast of Eyre Peninsula, but I believe these are more closely related to S. cunninghamii.

The leaves of S. odoratus vary considerably in length/width ratio and vestiture. Forms from Kangaroo Island have leaves up to 7 times longer than broad and are often arachnoid beneath. Black's variety obtusifolius represents the opposite extreme, with glabrous leaves less than 1.8 times longer than broad. S. hypoleucus, originally described as var. petiolata Sond. of S. odoratus superficially resembles a tomentose form of S. odoratus. However, the leaves of S. hypoleucus have a well developed petiole and are dark green above; all forms of S. odoratus have sessile and distinctively glaucous leaves.

15. Senecio cunninghamii DC., Prodr. 6:371(1838).

15.1 S. cunninghamii var. cunninghamii (Figure 3.7A).

Erect glabrous perennial shrub 40-60(-100) cm tall sometimes stoloniferous. STEMS slender, cylindrical, lightly striate, thickened and woody basally, branched below the inflorescence, new growth sometimes arising from a subterranean caudex. LEAVES usually glaucescent (never glaucous) and slightly fleshy, linear to oblanceolate, 2-6(-11)x0.2-1 cm, entire or distantly toothed, with or without paired minute teeth at the stem, reduced towards the inflorescence. CAPITULA 6-30 in terminal corymbose panicles on the upper branches, panicles rarely combined in a lax irregular corymb; peduncles 6-15 mm long. INVOLUCRE 4-6.5x2-3.5 mm; phyllaries 8. FLORETS 9-12, exserted 3-5 mm beyond the involucre; corolla 6-8 mm long, with scattered uniseriate hairs 6-8 cells long, tubular below campanulate on upper half; lobes 5, spreading, broad-lanceolate, 1.2-1.8 mm long with a median resin duct. ANTHERS 1.5 mm long, theca bases acute, apical appendage ovate-lanceolate, 0.3 mm long. PAPPUS dimorphic. ACHENES homomorphic, light brown, subcylindrical, 2-2.5x0.5 mm, tapering basally; surface of 8-12 flat or rounded segments, hairs short, adpressed in rows between the segments.

Flowering period: September to April, occasional throughout the year.

Chromosome number: 2N = 60.

General distribution. Most frequent along the River Murray, its tributaries and associated lakes and lagoons in South Australia Victoria and New South Wales. Less frequent in South Australia on Fleurieu Peninsula and northern York Peninsula. Also

Western Australia (Grieve and Blackall (1975)).

Habitat. Frequent along clay banks and floodplains of River Murray system. Isolated bushes at roadside or along railway lines elsewhere. Unknown for Western Australian specimens.

Collection sites. South Australia: ML520-23: 1.3 km NE. Port Victoria on road to Maitland, roadside in agricultural region; 10.viii.1976. - ML524: 500 m SW. Kaina-Paskerville road on road to Thrington, 1 bush among roadside grass; 11.vii.1976. - ML525-27: 15 km ENE. Moonta, among roadside grass; 11.viii.1976.- ML770-78: collections 7-35 km NNE Renmark along banks River Murray, clay soil, open Eucalyptus woodlands; 4-6.vi.1977. - Victoria: ML1489: among roadside grass, near NNE. corner of Lake Charm; 4.i.1979.

15.2 Senecio cunninghamii var. A. (Figure 3.7B).

Differs from the typical variety in having leaves lanceolate to broadly oblanceolate, (1-)2-4(-8)x0.6-1.2 cm; tapering or subpetiolate basally, usually auriculate but auricles sometimes minute or wanting; margins acutely toothed or irregularly bi-serrate, apex acute; densely covered with an adpressed sometimes floccose tomentum, sometimes glabrate or glabrous at maturity and then only the youngest shoots appearing white. Tomentum sometimes extending to the stems and involucral bracts, or only on the latter. Capitula 6-30, in rather dense corymbose panicles, terminal and axillary on short or long leafy branches, never massed in a compound corymbose panicle.

General distribution. Central Australia, South Australia north of Quorn, north-western New South Wales, Northern Territory south of Alice Springs; (?) Queensland and Western Australia.

Habitat. Most frequent near river beds, dams and temporary water catchment areas, on sand or sandy clay; less frequent on hillsides or open stony plains.

Collection sites. South Australia: ML764-68: roadside floodway 37 km NE Quorn on road to Hawker; 11.iv.1977.

Discussion (both varieties). S. cunninghamii is distinguished by its linear to oblanceolate leaves and relatively few capitula in corymbose panicles at the ends of leafy branches. The related S. odoratus has very different leaves, and more or less leafless upper branches that are part of a larger compound inflorescence. The two varieties of S. cunninghamii differ both in morphology and distribution. Var. cunninghamii corresponds to glabrous riverine forms and 'var. A' to variously pubescent

and inland forms. Intermediate forms can be found north of Port Pirie and south of Quorn in South Australia. It is interesting to note that the collections of 'var A' in the herbaria at Adelaide (AD) and Sydney (SYD) are much larger than for var. cunninghamii. At Adelaide the specimens of var. A had been classified with equal frequency as either S. odoratus or S. cunninghamii, because of the auriculate leaves of most 'var. A' specimens.

I collected a third form related to S. cunninghamii from the Ravine Des Casoars on Kangaroo Island and have seen similar herbarium specimens from Pearson Island (both in South Australia). The leaves are lanceolate, dark green (not glaucous) and up to 15 cm long. The inflorescence is like that of S. cunninghamii. Unfortunately time has prevented detailed study of these plants.

16. Senecio anethifolius A. Cunn. ex. DC., Prodr. 6:371 (1838). (Figure 3.6D).

Erect glabrate perennial shrub 50-100 cm tall. STEMS slender at first, cylindrical and striate, new growth mainly from woody upper branches, rarely from a subterranean caudex. LEAVES glaucescent, slightly fleshy and flaccid; ovate to broadly ovate in outline 5-8x2-6 cm, pinnatisect into 7-15 linear or filiform distant lobes, lobes entire or again pinnatisect, sessile, glabrous or with a few long hairs on the youngest parts. CAPITULA 18-60(150) in a very dense terminal corymbose or spherical panicle; peduncles slender, 3-12 mm long. INVOLUCRE 6-8x2.5-3 mm; phyllaries 7-8. FLORETS 10-13, exserted 3-5 mm beyond the involucre; corolla 7.5-10 mm long, glabrous, tubular below, upper two thirds campanulate; lobes 5, spreading, broad-lanceolate, 0.8 mm long with a median resin duct and trace. ANTHERS 2-2.5 mm long, theca acute or shortly tailed basally, apical appendage narrowly oblong-ovate, 0.4-0.5 mm long. PAPPUS uniform. ACHENES homomorphic, straw-coloured, subcylindrical, 3-4x0.5-1 mm, tapering basally; surface of 7-9 flat or concave segments separated by narrow grooves, hairs short, erect in rows in the grooves.

Flowering period: August to November, occasional throughout the year.

Chromosome number: 2N = 60.

General distribution. The Flinders Ranges and east thereof to the border in South Australia. Hills around Broken Hill in eastern New South Wales; hills north of Griffith and south of Cobar in central New South Wales.

Habitat. Most often on rocky outcrops or cliffs associated with arid zone gorges, sometimes in sandy soil near creek beds

or floodways.

Collection sites. South Australia: ML1004-6 (collected by P. Lang): cliffs at base of Streak Gorge about 300 m N. of Junction Waterhole, Gammon Ranges; 13.xiii.1978. New South Wales: ML1452: in cracks between rocks, summit Mt. Waabalong, c. 40 km W. Lake Cargelligo; 13.i.1979.

Discussion. S. anethifolius is distinguished from all other discoid species by its pinnatisect leaves with filiform or linear segments. The herbarium collections are a relatively uniform assemblage with no forms clearly intermediate between S. anethifolius and other species. The distribution of S. anethifolius suggests that it is a relict species now confined to hills and mountain ranges of southern central Australia.

17. Senecio gawlerensis Lawrence nom. nov.

S. georgianus DC. var latifolius Black, Fl. S. Austral. 613(1929). (Figure 3.7C).

Erect glabrate perennial shrub 80-120 cm tall, slender at first, becoming stout and woody with age, cylindrical and striate; new growth mainly from woody upper branches, sometimes from a subterranean caudex. LEAVES coriaceous; broad-lanceolate to widely ovate in outline, 4-8(-12)x1.5-4(-9) cm, attenuate and subpetiolate basally, deeply toothed or pinnatifid with 4-5 lobes on each side; lobes obtuse, entire or irregularly toothed, or lanceolate and acute, glabrous at maturity, often densely arachnoid on youngest parts. CAPITULA 30-80 in very dense terminal spherical or corymbose panicles; peduncles 4-9 mm long. INVOLUCRE 6-8x3-4 mm; phyllaries 11-14(-16). FLORETS 15-25, exserted 1-2(-3) mm beyond the involucre; corolla 6-9 mm long, outermost with a few scattered uniseriate hairs 4-7 cells long, tubular below, distal two thirds campanulate; lobes 5, erect or spreading slightly, ovate-deltoid, 0.3-0.6 mm long, with a median resin duct and trace. ANTHERS 1.5-1.8 mm long, theca basally acute or with tails up to one third the filament collar length, apical appendage narrowly oblong-ovate, 0.3-0.6 mm long. ACHENES homomorphic usually straw-coloured, sometimes dark-brown; subcylindrical, 2-3x0.5-0.8 mm. tapering basally; surface of 8-10 flat segments separated by narrow grooves, hairs short, adpressed, in broad rows in and around the grooves.

General distribution. Endemic in South Australia. Throughout the Gawler Ranges, northern Eyre Peninsula; also Caralue Bluff and Carappee Hill, central Eyre Peninsula.

Habitat. Among rocky outcrops usually towards the summit of hills, occasional on lower slopes among rocks or near watercourses.

Collection sites. South Australia: ML792-4: base of Corunna Hill next to small creek bed; 12.x.1977. - ML807-9: among rocks at top of hill 9 km E. Yardea Station homestead; 13.x.1977. - ML812-14: among rocks at top of Mt. Yardea; 13.x.1977. - ML821-3: among rocks near summit Scrubby Peak; 14.x.1977. - ML851-3; among rocks towards top of hill 5.2 km. S. Scrubby Peak; 14.x.1977. - ML838-40: among rocks towards top of hill immediately N. Hiltaba Station homestead; 14.x.1977. - ML856-58: roadside rocky outcrop 5 km S. Mt. Double; 16.x.1977. - ML860-65: among rocks towards summit of Caralue Bluff; 17.x.1977. - ML866-69: among rocks on E. face of Carappee Hill; 17.x.1977.

Discussion. Black (1929) described this taxon as variety latifolius of Senecio georgianus but I could find no reason to justify his treatment. As the epithet "latifolius" has been used several times at the specific level in Senecio, I chose the epithet "gawlerensis" to reflect the restricted distribution of this species in the Gawler Ranges. Black may have treated S. gawlerensis as a variety of S. georgianus as the latter is the only discoid species with a high floret number (35-40) per capitulum occurring in South Australia. The floret number of S. gawlerensis (15-25) is higher than in other South Australian species (9-14) but is numerically closer to these, than to S. georgianus. Furthermore, the leaves of S. georgianus are linear or lanceolate, entire or shortly toothed and arachnoid beneath at maturity. S. gawlerensis has broad-lanceolate to ovate leaves which are deeply toothed or pinnatifid and glabrate at maturity. I consider S. gawlerensis to be intermediate between discoid species with high and low floret numbers, and not closely related to S. georgianus.

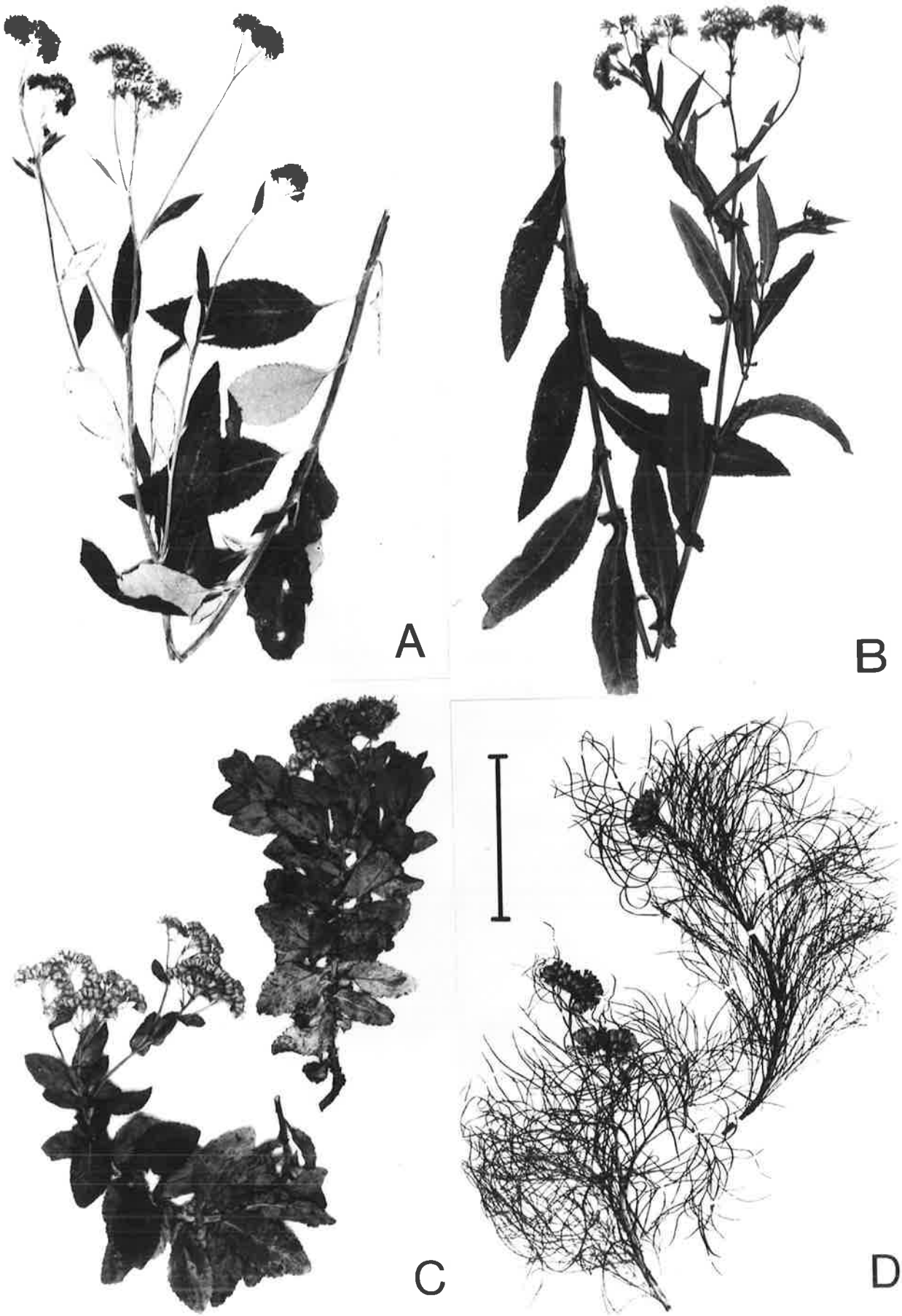

Fig. 3.6 A. Senecio hypoleucus. B. S. odoratus var. odoratus. C. S. odoratus var. obtusifolius. D. S. anethifolius. All figures at same magnification. Scale 10 cm.

3.4.3. Erechthitoid species of Senecio (Group 3 of key to species).

The term "erechthitoid", coined by Belcher (1956), alludes to the superficial resemblance of some Australian species to the genus Erechtites. These species were all classified as Erechtites by Bentham (1866), but Belcher considers there are no species of Erechtites native in Australia and transferred erechthitoid species to Senecio. I have seen only one of the five species of Erechtites (E. valerianaefolia), and agree that Australian erechthitoid taxa are more closely related to Senecio. Like discoid species (group 2), erechthitoid species share many features of capitulum and floral morphology. I have mentioned these in a general treatment below, to avoid unnecessary repetition.

Floral features common to all erechthitoid species

CAPITULA heterogamous discoid; peduncles slender, bracteate. INVOLUCRE subcylindrical, widest basally, tapering distally; expanding basally as achenes mature. RECEPTACLE flat, pitted, pit margins shortly toothed or scaled. OUTERMOST FLORETS female, in 2-3 rows, corolla tubular throughout and filiform, sometimes pubescent and then hairs slender, 6-10 cells long; central florets bisexual, corolla glabrous, shortly campanulate distally. STAMINAL FILAMENT 0.05-0.07 mm wide, collar 0.3-0.5(-0.6)x0.08-0.1 mm. ANTHERS 0.6-0.9 mm long, theca basally obtuse or acute, apical appendage narrowly deltoid, 0.2 mm long. STYLE BRANCHES dorsally glabrous, stigmatic surface of two narrow marginal lines, apex truncate or slightly rounded with a few erect papillae around abaxial margin. PAPPUS white, of many slender caducous bristles in 2-3 rows; uniform, all bristles minutely barbellate with acute teeth, apex 2-celled, uniform or dimorphic, and then some bristles "fluked".

18. Senecio quadridentatus Labill., Nov. Holl. Pl. Spec. 2:48, tab 194,(1806). (Figure 3.8B)

E. quadridentata (Labill.) DC., Prodr. 6:295(1838). - and var. glabrescens (DC.) Benth., Fl. Austral. 3:660(1866) pro parte. - non var. gunnii l.c. = S. gunnii.

Erect perennial herb 40-100 cm tall. STEMS stout, cylindrical and striate; simple in first year, several to many arising annually from a subterranean base in later years; densely covered in long white adpressed hairs basally, glabrate or arachnoid on inflorescence axes. LOWER CAULINE LEAVES flexuous, broad-linear to lanceolate, up to 14x1 cm, sessile or shortly stem-clasping; entire, denticulate or with 1-3 distant lobes; densely white tomentose at first, arachnoid above at maturity; shrivelling but persisting at the flowering stages. Leaves reduced towards the inflorescence; margins entire or denticulate and recurved; white tomentose above and below. CAPITULA 60-400 in a terminal corymbose panicle, dense at first, lax at maturity; peduncles 7-14 mm long, green or purplish. INVOLUCRE 7.5-10x2-3 mm, green or purplish, arachnoid in bud, glabrate at maturity; phyllaries 11-13. Calyculus of 1-4 linear adpressed bracts 1-1.5 mm long. FEMALE FLORETS 20-30, corolla sparsely pubescent, lobes 3-4, erect, deltoid, 0.3 mm long. BISEXUAL FLORETS 4-10, corolla glabrous; lobes 4(-5), erect, deltoid 0.3 mm long, without a median resin duct. PAPPUS dimorphic. ACHENES slender, 2-3.5x 0.3-0.4 mm, constricted just above base, usually attenuate or sometimes tapering distally; surface of 8-10 flattened ribs separated by channels, hairs short, adpressed, scattered along channels; colour heteromorphic, outermost 'females' olive-green, remaining 'females' red-brown, 'bisexuals' black, rarely red-brown.

Flowering period: October to March

Chromosome number: 2N = 40.

General distribution. Widespread in all states, uncommon in deserts and northern tropical regions. Also New Zealand and Timor (Belcher 1956).

Habitat. Most frequent in temperate regions with rainfalls of more than 150 mm, uncommon in extreme coastal conditions, not at altitudes of more than 1,300 m (Australian alps).

Collection sites. South Australia: ML469-73: among grass on gypsum, WSW. margin Marion Lake; 8.viii.1976. - ML546-51: roadside in dry sclerophyll forest, 2 km N. Williamstown; 20.viii.1976. - ML595-97: weedy in sandy cleared paddock, 4.3 km S. Monarto South; 15.ix.1976. - ML790: roadside with Atriplex vesicaria, 3 km W. Middleback Station homestead; 12.x.1977. - ML849-51: roadside on clay with Eucalyptus diversifolia, 23 km NW. Port Kenny; 15.x.1977. - recently burnt shrubland, on sand, 17 km W. Verran Hill; 19.x.1977. - ML887-89: on limestone soil, 1 km E. Mt. Hope; 19.x.1977. - ML894-96: among weeds in paddock; 15 km from Edilillie on road to Warrow; 20.x.1977. - ML911: lower rocky slope of Mt. Greenly; 21.x.1977. - ML940-42: hilltop among rocky outcrops, 7.4 km N. Cleve; 23.x.1977. Victoria: ML1117: roadside grass, 1.1 km SW. Deans Marsh; 5.xii.1978. - ML1167-68: dry sclerophyll forest, 10.7 km E. Nelson; 6.xii.1978. - ML1189-90: dry sclerophyll forest, 6 km S. Dergholm; 6.xii.1978. - ML1197-1205: among grass in Eucalyptus woodland, H.G.H. Corner, c. 40 km E. Halls Gap; 7.xii.1978. New South Wales: ML1376-78: roadside grass, 3.7 km S. Hartley; 28.xii.1978. - ML1427-28: roadside in wet sclerophyll forest, 19.5 km from Thredbo on road to Khancoban; 31.xii.1976. - ML1456-58: under Callitris trees on

dry clay soil, 10 km E.Merriwagga; 3.i.1979.

Discussion. The complex nomenclatural history of Senecio quadridentatus preceeding Bentham's (1866) "Flora Australiensis" is described in detail by Belcher (1956). When Bentham placed S. quadridentatus in the genus Erechtites, he retained Labillardiere's epithet quadridentata. The identity of S. quadridentatus was therefore maintained by later Australian flora writers- unlike many other erechthitoid species of Senecio. Belcher (1956) suggested that variation within S. quadridentatus might be due to introgression with S. hispidulus, but hybrids between these species would be sterile as the 'parental' chromosome numbers are very different (Lawrence 1980). I have treated the S. hispidulus x S. quadridentatus plants described by Belcher as a species related to, but distinct from S. quadridentatus (see S. aff. apargiaefolius, description 20). I therefore consider S. quadridentatus to be a natural and distinctive species that varies in size in different environments.

19. Senecio gunnii (Hook.f.) Belcher, Ann. Mo. bot. Gdn. 43:60(1956). (Figure 3.8A).

Erechtites gunnii Hook.f., Lond. J. Bot. 6:122(1847)

E. quadridentata var. gunnii (Hook.f.) Benth., Fl. Austral. 3:660(1866).

Erect perennial herb 60-100 cm tall. STEMS stout, cylindrical and striate, one to several arising from a woody subterranean caudex, unbranched below the inflorescence, velutinous and white when young, becoming arachnoid with age. LOWER CAULINE LEAVES oblanceolate 7-15x1.5-3.5 mm, basally attenuate, margins denticulate or irregularly serrate, velutinous beneath, glabrate or arachnoid above. Upper leaves smaller, sessile, margins denticulate, minutely lobed at the stem, velutinous on both surfaces, sometimes glabrate with age. CAPITULA heterogamous discoid, 100-400 in a terminal corymbose panicle, dense at first, lax at maturity; peduncles 6-15 mm long, velutinous or arachnoid. INVOLUCRE 7-8x2.5-3 mm, arachnoid in bud, distally glabrous at anthesis; phyllaries 12-14. Calyculus of 2-4 linear adpressed bracts 1.5-2.5 mm long. FEMALE FLORETS 10-20; corolla glabrous, lobes 3-4, spreading, deltoid, 0.3 mm long. BISEXUAL FLORETS 9-18, corolla glabrous, lobes 4-5, spreading, deltoid, 0.3 mm long, with a faint median resin duct. PAPPUS dimorphic, rarely uniform. ACHENES slender, subcylindrical, 2.5-3x0.4-0.5 mm, constricted just above base, tapering distally; surface of 8-10 rounded ribs separated by equally wide channels; hairs short, adpressed, scattered along channels; colour heteromorphic, outermost 'females' light-green, remaining 'females' red-brown, 'bisexuals' black.

Flowering period: December to February.

Chromosome number: 2N = 40.

General distribution. Alpine regions of Victoria, New South Wales and Tasmania, at altitudes of more than 1,200 m.

Habitat. Most frequent in Eucalyptus woodlands near alpine meadows, also in wet sclerophyll forests at lower altitudes but above the snow line.

Collection sites. Victoria: ML1234-36: among rocks under Eucalyptus sp, Mt. Buffalo summit; 10.xii.1978. - ML1240-42: roadside near Eucalyptus forest, 16 km from Falls Creek on road to Omeo; 10.xii.1978. - ML1264-66: edge of alpine meadow, 6.5 km from Mt. St. Bernard on road to Dargo; 13.xii.1978. New South Wales: ML1403-5: rocky slope above Leptospermum shrubs; point where Mt. Kosciusko summit road crosses Thredbo River; 31.xii.1978. - ML1406-8: roadside near Eucalyptus forest, 10.4 km SW. Thredbo on road to Khancoban; 31.xii.1978. - ML1433-35: roadside in wet sclerophyll forest, 27 km from Khancoban on road to Cabramurra; 1.i.1979.

Discussion. I have followed Belcher (1956) and treated S. gunnii as a species distinct from S. quadridentatus. It could be argued that S. gunnii is an alpine form of S. quadridentatus and therefore should be treated as a variety of the latter. However, unlike alpine forms of S. lautus and S. linearifolius, there is no intergradation between the alpine and typical variety. S. quadridentatus and S. gunnii grow at similar altitudes at the extremes of their ranges, but under these conditions the two are still morphologically very distinct. I therefore treated S. gunnii as a species related to, but distinct from S. quadridentatus.

20. Senecio aff. apargiaefolius Walp., Linnaea 14:309(1840).

S. hispidulus x S. quadridentatus Belcher, Ann. Mo. bot. Gdn. 43:71(1956).

20.1 Senecio aff.apargiaefolius Form 1. - typical (Figure 3.8C).

Erect perennial herb 30-60 cm tall. STEMS slender, cylindrical and striate, one to several arising from a common subterranean caudex, arachnoid basally, glabrous distally. LEAVES mainly basal, broadly oblanceolate, 6-12x0.7-1.5 mm; basally attenuate and subpetiolate, margins entire, irregularly crenate or minutely denticulate, apex obtuse; sparsely tomentose or arachnoid and mauve beneath, minutely hispid, becoming scabrous and green above. Cauline leaves smaller, lanceolate to broad-linear, sessile, entire or minutely denticulate with revolute margins towards the inflorescence. CAPITULA 30-60(-100) in a lax terminal corymbose panicle; peduncles 10-25 mm long. INVOLUCRE 7.5-9.5x2-2.5 mm; phyllaries 8-10(11-12). Calyculus of 1-3 narrowly triangular adpressed bracts 1-1.5 mm long. FEMALE FLORETS 10-15; corolla pubescent, lobes 3-4, deltoid, 0.3-0.4 mm long. BISEXUAL FLORETS 4-10, corolla lobes 4-5, deltoid, 0.5 mm long without a median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 2.7-4x0.3-0.5 mm, tapering at both ends, constricted just above the base; surface of 8-10 flat ribs separated by narrow channels, hairs short, adpressed, scattered along the channels; colour heteromorphic, outermost 'females' olive green, remaining 'females' red-brown, 'bisexuals' black.

Flowering period: September to February.

Chromosome number: 2N = 40.

General distribution. Most frequent in the Great Dividing Range from Victoria to central New South Wales. Also adjacent coastal and inland areas. One specimen from near Keith

in the southeast of South Australia.

Habitat. Among understory of sclerophyll forests on clay or clay-loam soil.

Collection sites. Victoria: ML1249-51: wet sclerophyll forest, 5 km from Harrietville on road to Mt. Hotham summit. - ML1186-88: open Eucalyptus woodland, 6 km S. Dergholm. New South Wales: ML1383-85: top of roadside cutting among stones, 35.1 km from Hartly on road to Jenolan Caves;23.xii.1978.

20.2 Senecio aff. apargiaefolius Form 2. - lobed (Figure 3.8D).

Differs from form 1 in having acutely toothed or irregularly lobed basal leaves that are often broad lanceolate and deep purple beneath. Plants often larger, up to 100 cm tall and with as many as 130 capitula per inflorescence.

General distribution and habitat. Of the typical form.

Collection sites. Victoria: ML1172: sclerophyll forest with low open understory, 16.4 km E. Nelson; 6.xii.1978. - ML1194-96: roadside clearing in sclerophyll forest, 6.7 km from Halls Gap/ Dergholm road along track to Mafeking; 7.xii.1978. - ML1243-45: roadside in wet sclerophyll forest, East Kiewa River crossing on the Falls Creek/Mt. Beauty road; 10.xii.1978. New South Wales: ML1364-66: roadside in sclerophyll forest, ca. 3 km W. Katoomba town center; 27.xii.1978. - ML1419, ML1425-26: roadside in sclerophyll forest, 19.5 km from Thredbo on road to Khancoban; 31.xii.1978.

Discussion. Belcher (1956) treated S. apargiaefolius as a synonym of a hypothetical hybrid complex between S. hispidulus and S. quadridentatus. In 1968, however, Belcher determined a number of herbarium specimens in the Melbourne (MEL) and

Sydney (SYD) herbaria as "S. aff. apargiaefolius". I adopted this name for a variety of field collections of similar habit, and listed their chromosome numbers under Senecio sp. C (Lawrence 1980) None of the forms of Senecio sp. C had chromosome numbers of 2N = 50, the expected number if they were hybrids of S. hispidulus (2N = 60) and S. quadridentatus (2N = 40). Having made detailed comparisons of capitulum and achene morphology I now consider that the four forms of Senecio sp. C (Lawrence 1980) represent three different species. Forms 1 and 2 correspond to Walper's description of S. apargiaefolius and are described above as S. aff. apargiaefolius; form 3 belongs to S. hispidulus and form 4 represents a new species treated in this study as Senecio sp. C (description 30).

My description of S. aff. apargiaefolius corresponds to Walper's protologue of S. apargiaefolius, but Walper gave few details of achene morphology - describing them as cylindrical and glabrous. Achene morphology is most important in the taxonomy of S. aff. apargiaefolius as both forms have long slender achenes similar to S. quadridentatus. The achenes of S. hispidulus are short and plump, and differ in surface sculpturing and vestiture. I consider it possible, but unlikely, that Walper's S. apargiaefolius is a taxon related to S. hispidulus. The plants I have described as S. aff. apargiaefolius are related to S. quadridentatus by achene morphology and chromosome number, and differ from the latter in habit and leaf pubescence. According to Belcher (personal communication) the type of S. apargiaefolius is still not accessible. Once the holotype is located, an examination of the achenes will quickly determine if my S. aff. apargiaefolius is, in fact, S. apargiaefolius Walp.

21. Senecio runcinifolius Willis, Proc. Roy. Soc. Queensl. 62:106, pl. 7, figs 34-37(1952). (Figure 3.9A).

Erechtites mixta Benth., Fl. Austral. 3:659(1866) pro majore parte. - non (A. Rich.) DC., Prodr. 6:297(1838) = Arrhenechtites mixta.

Erect glabrate perennial (superficially annual) herb 25-50 cm high. STEMS slender, cylindrical and striate; one to several arising from a common base, white tomentose on youngest shoots, glabrous on older parts. LEAVES thin and flexuous, broadly lanceolate in outline, largest 8-12x2-4 cm, subpetiolate, pinnatisect with up to 8 retrorse coarsely toothed lobes on either side, apex acuminate; purplish and glabrous or with a few scattered hairs beneath, pale green and glabrous above; upper floral leaves smaller, less dissected with long sometimes filiform apices. CAPITULA 20-60 in a lax terminal irregularly corymbose panicle; peduncles 8-25 mm long, frequently at 90° or more to the floral axis before anthesis. INVOLUCRE 8.5-10x3-3.5 mm, sparsely covered by long hairs, white tomentose basally; phyllaries 12-14. Calyculus of 3-6 narrowly triangular adpressed bracts 1-2.5 mm long. FEMALE FLORETS 35-55, corolla glabrous or sparsely pubescent, lobes (3-)4, deltoid, 0.3 mm long. BISEXUAL FLORETS 9-15, corolla usually glabrous, lobes 5, deltoid, 0.3 mm long without a median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 1.8-2.6x0.3-0.4 mm, rounded basally, shortly attenuate distally; surface of 8-9 slightly concave longitudinal segments separated by narrow grooves, hairs short, erect, in rows corresponding to the elevated grooves; colour heteromorphic, 'females' light-brown, 'bisexuals' red-brown.

Flowering period: August to December, occasional throughout the year.

Chromosome number: 2N = 40.

General distribution. Most frequent in the River Murray system, north and east of Blanchetown in South Australia, north-western Victoria and the western plains of New South Wales.

Habitat. On clay soil at edge of rivers, creeks or lagoons. Plants luxuriant in muddy soil, sometimes persisting on dry clay pans. Often irregularly branched after grazing by stock.

Collection sites. South Australia: ML1079: locally frequent on moist clay by creek, 200 m from eastern junction of Chowilla Creek with River Murray; 8.xi.1978. - ML1065-67: dry clay-pan, near N. bank of Chowilla Creek, 1 km from eastern junction with River Murray; 10.vi.1978. - ML1071-76: moist clay soil next to small lagoon, locality as for ML1065-67; 10.xi.1978.

Discussion. When Bentham (1866) described Erechtites mixta (Senecio runcinifolius) he included Richard's Senecio mixtus in synonymy. S. mixtus is now synonymous with Arrhenechtites mixta (Belcher 1956), a species with large capitula, but very different leaf and floral morphology. S. runcinifolius is easily distinguished from all other erechthitoid species of Senecio by its retrorsely lobed leaves and comparatively large capitula. I have described S. runcinifolius as perennial, although field plants are superficially annual, being herbaceous and drying rapidly with the outset of summer. Plants grown in the glasshouse have produced shoots from a common base for two years at the time of writing. Two potted plants produced new shoots some distance from the main clump, but I did not observe stoloniferous growth in the field. I agree with both Willis (1952) and Belcher (1956) that S. runcinifolius is comparatively rare, but my observations are that the species can be locally quite common east of Renmark in South Australia.

22. Senecio biserratus Belcher, Ann. Mo. bot. Gdn.43:43(1956) (Figure 3.9B).

Erechtites prenanthoides Benth., Fl Austral. 3:658(1866) pro parte = S. minimus pro majore parte. - non var. picridioides l.c. = S. picridioides.

Erect glabrate annual herb (60-)80-100 cm tall. STEMS stout, cylindrical and striate; simple, branched only at the inflorescence, or branched basally as well; generally glabrous, minutely hispid basally. LEAVES thin, sometimes membranous, broadly lanceolate or ovate in outline, 6-14x2.5-5 cm, sessile with lacerate auricles, margins irregularly biserrate with primary teeth cut up to halfway to the midrib, glabrous or with a few long hairs around the veins. CAPITULA 100-400 in a rather dense, terminal, irregularly corymbose panicle; peduncles 5-8 mm long. INVOLUCRE 6.5-7x2-3 mm, glabrous; phyllaries 7-9. Calyculus of 2-5 narrowly triangular adpressed bracts 0.8-1.3 mm long. FEMALE FLORETS 12-17, corolla sometimes sparsely pubescent, lobes 3-4, deltoid, 0.2 mm long. BISEXUAL FLORETS 6-8, corolla rarely pubescent, lobes 5, deltoid, 0.3 mm long with a faint median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 2-3x 0.3-0.4 mm, tapering slightly at both ends; surface of 8-10 rounded ribs separated by narrow or equally wide channels, hairs short, adpressed or spreading, in rows corresponding to channels; colour heteromorphic, 'females' olive-green, 'bisexuals' dark brown.

Flowering period: October to March.

Chromosome number: 2N = 100.

General distribution. Occasional in the south-east of South Australia, locally abundant in coastal regions of Victoria, scattered occurrences in the Great Dividing Range in New South

Wales. Also Tasmania, New Zealand and Stewart Island (Belcher 1956).

Habitat. Most frequent in areas of more than 600 mm rainfall Usually near the coast in wet sclerophyll forests on clay or sandy clay, or near the beach on coastal sand. Less frequent inland.

Collection sites. Victoria: ML1101-03: among tree ferns, Lilly Pilly Gully, Wilsons Promontory National Park; 3.xii.1978.- ML1136-38: 11 km N. Cape Otway lighthouse, wet sclerophyll forest; 5.xii.1978.- ML1149-51: among roadside weeds, N. boundary of Mt. Richmond National Park, 18 km NW. Portland; 6.xii.1978.- ML1296-98: marshy ground between Lake Killary and Lake Victoria; 14.xii.1978. New South Wales: ML1415-17: 16.9 km from Thredbo on road to Khancoban, 1 km N. Snowy Creek, roadside in wet sclerophyll forest; 31.xii.1978.

Discussion. Belcher (1956) commented that "Bentham's reduction of this perfectly good species to Erechtites prenanthoides DC.(=Senecio minimus) is unjustified, despite several points of similarity." I agree with Belcher and have treated S. biserratus as a separate species. S. biserratus can be distinguished from S. minimus var. minimus by leaf shape and margin, and from Belcher's S. minimus var. picridioides (treated here as S. picridioides) by leaf pubescence and stem pigmentation Belcher used achene morphology to separate S. minimus and S. biserratus in his key to species. I do not consider this to be a reliable character, and have discussed the achene morphology of both under S. minimus.

2 . Senecio sp. B (Figure 3.9C).

Corresponds to the "unnamed species" in Beadle, Evans and Carolin (1976, p. 466), and to specimens in the Sydney (SYD) herbarium annotated "Senecio cahallii" by R. O. Belcher.

Erect glabrous annual (?) herb 70-90 cm tall. STEMS stout, cylindrical, striate; branched basally and towards the inflorescence. LEAVES coriaceous, broad-linear to lanceolate, 6-9x 0.5-0.8 cm, sessile with short lanceolate stipules, margins irregularly denticulate or serrate. CAPITULA 100-250 in a rather dense terminal corymbose panicle. INVOLUCRE 6-7x2-2.7 mm, glabrous; phyllaries 7-9, sometimes distally recurved. Calyculus of 2-4 narrowly triangular adpressed bracts 1-1.5 mm long. FEMALE FLORETS 10-13; corolla pubescent. lobes 3-4, deltoid 0.2 mm long. BISEXUAL FLORETS 5-7; corolla glabrous, lobes 4-5, deltoid, 0.3 mm long without a median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 2.5-3x0.4-0.5 mm, minutely attenuate basally; surface of 8-10 rounded ribs separated by equally wide channels, hairs short, adpressed or spreading, scattered along the channels; colour heteromorphic, 'females' olive-green, 'bisexuals' red- or dark-brown.

Flowering period: December to March, occasional throughout the year.

Chromosome number: 2N = 60.

General distribution. Great Dividing Range and adjacent coastal areas as far north as Byron Bay and south to Sydney in New South Wales. Also subalpine areas of New South Wales and Victoria.

Habitat. Known to me only from areas of wet sclerophyll forests. Herbarium sheet collection data suggest the species also occurs in pastures and on or near coastal dunes in New South Wales.

Collection sites. Victoria: ML1255-57; roadside on clay by wet sclerophyll forest, 6.9 km S. Cobungra River Crossing, N. Omeo; 12.xii.1978. New South Wales: ML1324-26: among roadside weeds near wet sclerophyll forests, 12.1 km N. Cedar Party Creek on road from Wingham to Comboyne; 24.xii.1978.

Discussion. Senecio sp. B corresponds to some of the herbarium specimens annotated "S. cahallii" by R. O. Belcher at Sydney (SYD) and also to the "undescribed species" listed by Beadle, Evans and Carolin (1976). The plants I collected can be distinguished from most erechthitoid species by their glabrate aspect, and from S. biserratus by leaf shape and morphology. I have not attempted to describe my collections as S. cahallii as Belcher (personal communication) plans to publish a description in the near future. I believe, however, that Belcher's S.cahallii and my Senecio sp. B will be conspecific.

24. Senecio squarrosus A. Rich., Voy. Astrolabe (Bot.) 2:107 t. 35(1834). (Figure 3.9D).

Erechtites hispidula Benth., Fl. Austral. 3:660 (1866) pro parte. - = undescribed species pro majore parte.

Erect or ascending perennial (?) herb 30-40 cm tall. STEMS slender, cylindrical, lightly striate; usually simple, branched only at the inflorescence, sometimes branched basally; glabrous or sparsely arachnoid distally. LOWER CAULINE LEAVES narrow-lanceolate, 6-10x0.5-1.2 cm, sessile and subpetiolate, coarsely toothed or distantly and shortly lobed, sparsely arachnoid below, hispid above; upper leaves reduced, sessile with coarsely toothed auricles. CAPITULA few, 4-16 in a very lax, terminal, cymose or corymbose panicle; peduncles 1-4 cm long. INVOLUCRE 8.5-10x 3.5-4(-7) mm, sparsely covered in long hairs, white tomentose basally; phyllaries (14-)16-19(21). Calyculus of 8-13 narrowly lanceolate slightly spreading bracts 2-4.5 mm long. FEMALE FLORETS 30-50; corolla glabrous or pubescent, lobes 4-5, deltoid, 0.3-0.4 mm long. BISEXUAL FLORETS 11-17; corolla glabrous, lobes 5, deltoid, 0.5 mm long, without a median track. PAPPUS dimorphic. ACHENES subcylindrical, 2.3-2.7x0.4-0.5 mm, rounded basally; surface of 8-9 rounded ribs separated by narrow channels, hairs short, adpressed, in dense rows in and around channels; colour superficially homomorphic and dark grey or black, but outermost "females" dark olive-green, remaining "females" dark brown, "bisexuals" black.

Flowering period: December to March.

Chromosome number: 2N = 60.

General distribution. An uncommon species. Occurs in Victoria west of Cape Otway and as far inland as The Grampians, in the south-east of South Australia and the Mt. Lofty Ranges.

Habitat. Most often on open rocky or grass-covered ground in wet sclerophyll forests or woodlands, never (?) associated with moist leaf litter.

Collection sites. Victoria: ML1178-81: on clay soil in dry sclerophyll forest, 6 km SSW. Dergholm; 6.xii.1978. - ML1209-11: among grass in Eucalyptus woodland, H.G.H. Corner, c. 40 km E. Halls Gap; 7.xii.1978.

Discussion. S. squarrosus can be distinguished from all other erechthitoid species by its high phyllary number and comparatively short, dark achenes. I have ammended Belcher's (1956) description of S. squarrosus to include plants with smaller capitulum diameters. According to Belcher (1956), Bentham's (1866) description of Erechtites hispidula is a mixture of two separate elements, - plants with relatively large capitula and short dark achenes (S. squarrosus) and plants with extremely large capitula and long attenuate-rostrate achenes like those of S. quadridentatus. My collections do not include specimens with attenuate-rostrate achenes, and therefore correspond to Richard's S. squarrosus. The status of specimens with extremely large capitula is still unresolved, but they most probably represent a new and undescribed species.

25. Senecio bipinnatisectus Belcher, Ann. Mo. bot. Gdn. 43:41(1956). (Figure 3.10A).

Erechtites Atkinsoniae F.v. Muell., Frag. Phytogr. Austral. 5:88(1865)

S. Atkinsoniae F.v. Muell., l.c. nom. nud.

Erect glabrate annual herb 0.8-1.5 m tall. STEMS stout, cylindrical and striate, usually simple, branched only at the inflorescence; glabrous. LEAVES coriaceous, ovate or widely ovate in outline, 7-11(-16)x4-6(-10) cm, sessile with bipinnatisect auricles; margins bipinnatisect, primary and secondary segments linear to broad-linear, entire or toothed; sparsely arachnoid below, glabrate or minutely scabrous above. CAPITULA 100-250 in a terminal corymbose panicle, dense at first, becoming lax at maturity; peduncles 6-10 mm long. INVOLUCRE 5.5-7x2-2.5 mm, glabrous; phyllaries 7-11. Calyculus of 2-3 narrowly triangular adpressed bracts 1-1.5 mm long. FEMALE FLORETS 13-18, corolla glabrous, lobes 3-4, deltoid, 0.2 mm long. BISEXUAL FLORETS 4-6; corolla glabrous, lobes 5, deltoid, 0.3 mm long with a faint median resin duct. PAPPUS uniform. ACHENES homomorphic, dark red-brown, subcylindrical, 1.6-2x0.5 mm, basally rounded; surface of 8-10 flat or slightly concave longitudinal segments separated by narrow grooves, hairs minute, adpressed in grooves.

Flowering period:

Chromosome number 2N = 60.

General distribution. Apparently confined to the Great Dividing Range in northern New South Wales and southern Queensland.

Habitat. Confined to warm wet sclerophyll forests and rainforests, sometimes locally abundant along roadsides.

Collection sites. New South Wales: ML1336-38: roadside at margin of wet sclerophyll forest, 22.9 km N. Wingham on road to Comboyne; 24.xii.1978.- ML1348: roadside in wet sclerophyll forest, 8 km W. of NE entrance to Barrington Tops National Park; 24.xii.1978. - ML1396: among roadside weeds, 8.4 km SW. Kangaroo Valley township on road to Nowra; 30-xii.1978.

Discussion. S. bipinnatisectus has leaves unlike any other erechthitoid species. Belcher (1956) suggested that S. bipinnatisectus is "undoubtedly related to S. minimus," because of the spiralled appearance of immature phyllaries and the quite large leaf auricles found in both. My observations are that phyllary arrangement is not a consistent character and that the auricles of these species are no larger than those of, for example, S. biserratus and S. glomeratus. Although I do not accept Belcher's evidence, I agree that S. minimus and S. bipinnatisectus are related.

26. Senecio minimus Poir. in Lam., Ency. Meth. Bot. Suppl. 5:130(1817). (Figure 3.10B).

Erechtites minima (Poir.) DC., Prodr. 6:437(1838)

E. prenanthoides DC., Prodr. 6:295 (1838). - non var. picridioides (Turcz.) Benth., Fl. Austral 3:658 (1866) = S. picridioides.

Erect annual herb 50-100 cm tall. STEMS stout, cylindrical, striate; unbranched below the inflorescence or branched basally; usually glabrous. LEAVES coriaceous or somewhat membranous, lanceolate to broad lanceolate 6-9(-15)x1-2(-4) cm, sessile and auriculate, margins denticulate; glabrous or sparsely arachnoid below, glabrous above; youngest leaves sometimes densely covered in minute hairs. CAPITULA 100-400 in a terminal corymbose panicle, dense at first, rather lax at maturity; peduncles 5-10 mm long. INVOLUCRE 6-8.5x1.5-2 mm, glabrous; phyllaries 8-10. Calyculus of 2-3 narrowly triangular adpressed bracts 1-2 mm long. FEMALE FLORETS 10-15, corolla glabrous, lobes 3-4, deltoid, 0.2 mm long. BISEXUAL FLORETS 3-6; corolla glabrous, lobes 5, deltoid, 0.2-0.3 mm long without a median resin duct. PAPPUS dimorphic. ACHENES homomorphic, red- or dark-brown, subcylindrical, 1.5-2.5x0.4-0.5 mm, shortly tapering at both ends; surface of 7-8 concave longitudinal segments separated by narrow grooves, hairs short, adpressed, in elevated rows corresponding to the grooves.

Flowering period: December to April.

Chromosome number: 2N = 60.

General distribution. Occasional in the Mt. Lofty Ranges and southeast of South Australia, frequent in most parts of Victoria except northwestern mallee and all but western plains of New South Wales. Also occurs in Western Australia (Grieve and

Blackall 1975), Tasmania (Curtis 1963), and New Zealand (Belcher 1956). Adventive weed in California and Oregon in the United States (Belcher 1956).

Habitat. Temperate regions with more than 600 mm annual rainfall. In shaded forest understory or locally abundant along roadsides.

Collection sites. Victoria: ML1104-05: among ferns in wet sclerophyll forest, Lilly Pilly Gully Nature Walk, Wilsons Promontory National Park; 3.xii.1978. - ML1126-28: roadside clearing in open Eucalyptus forest, 1 km NE. Wye River township, Otway Ranges; 5.xii.1978. - ML1143-45: among roadside weeds, N. boundary Mt. Richmond National Park; 6.xii.1978. New South Wales: ML1333-35: roadside at edge of wet sclerophyll forest, 22.9 km N. Wingham on road to Comboyne; 24.xii.1978. - ML1347: roadside in wet sclerophyll forest, 8.4 km W. of NE. entrance to Barrington Tops National Park; 24.xii.1978. - ML1370-72: roadside at creek crossing in wet sclerophyll forest, Bomans Creek Rd., NE. Mt. Wilson; 27.xii.1978. - ML1429-31: roadside in wet sclerophyll forest, 19.5 km from Thredbo on road to Khancoban; 31.xii.1978.

Discussion. In his key to species, Belcher (1956) distinguished S. biserratus from S. minimus by "hairs in grooves between broad low ribs" and "hairs on sharp narrow ribs." I found that the achenal hairs of both are in rows corresponding to grooves. In S. minimus the achene surface between the grooves is usually concave so that the grooves (and hairs) are elevated. Occasionally, however, the achene surface is almost flat and the hairs not elevated. The latter is particularly true of S. minimus var. picridioides, treated here as a distinct species. I therefore do not consider the position of achenal hairs as a precise

character in this case. Leaf morphology alone is sufficient to distinguish S. minimus from all other erechthitoid species.

27. Senecio picridioides (Turcz.) Lawrence comb. nov. (Fig.3.10C).

Erechtites picridioides Turcz., Bull. Soc. Imp. Nat. Mosc.24:200 (1851). - non Sond. and F.v. Muell., Linnaea 25:253 (1852) = S. runcinifolius

E. prenanthoides DC. var. picridioides (Turcz.) Benth., Fl. Austral. 3:658 (1866).

Senecio minimus Poir. var. picridioides (Turcz.) Belcher, Ann. Mo. bot. Gdn. 43:48 (1956).

Erect annual herb (15-)30-80(-100) cm tall. STEMS stout, cylindrical, striate and hispid, dark purple throughout or greenish towards the peduncles, usually unbranched below the inflorescence. LEAVES coriaceous; broadly oblanceolate in outline, 7-10(-16)x2-4(-7) cm; sessile with coarsely toothed auricles; margins of about 5 broad, sometimes overlapping lobes cut at least half way to the midrib, lobes acutely toothed with acute or obtuse apices; dark purple and hispid below, green or purplish and hispid above. CAPITULA (40-)100-500 in a terminal corymbose panicle, dense at first, rather lax at maturity; peduncles 4-13 mm long. INVOLUCRE 6.5-7.5x1.5-2.5 mm, glabrate; phyllaries 8-10. Calyculus of 2-4 narrowly triangular adpressed bracts 1-1.5 mm long. FEMALE FLORETS 15-17(-19), corolla glabrous, lobes 2-4, deltoid, 0.3 mm long. BISEXUAL FLORETS 4-6, corolla glabrous, lobes 4-5, deltoid, 0.3 mm long without a median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 1.7-2.2x0.4-0.5 mm, shortly tapering at both ends; surface of 8-11 flat, concave, or slightly rounded segments separated by narrow grooves, hairs short, adpressed in rows corresponding to the grooves.

Flowering period: October to January.

Chromosome number: 2N = 60.

General distribution. Southern Eyre, York and Fleurieu Peninsulas, Kangaroo Island and the southeast of South Australia; from The Grampians to Wyperfeld National Park in Victoria. Also the Swan River in Western Australia (Belcher 1956).

Habitat. In dry sclerophyll forests or mallee vegetation, occasional in coastal shrubland, on clay or sandy soil

Collection sites. South Australia: ML652-56: roadside mallee shrubland, 2.5 km inland from Parsons Beach; 1.xii.1976. - ML685-91: among grass under Casuarina stricta, 1.5 km S. Pennashaw Post Office; 4.iii.1977. - ML897-99: among weeds in roadside paddock at base of South Block, Eyre Peninsula; 20.x.1977. Victoria: ML1212-14: among grass in Eucalyptus woodland, H. G. H. Corner, c. 40 km E. Halls Gap; 7.xii.1978. - ML1227-29: W. bank of Wimmera River, 7.5 km S. Dimboola; 8.xii.1978.

Discussion. Belcher (1956) followed Bentham (1866) and treated S. picridioides as a variety of S. minimus (Erechtites prenanthoides of Bentham). I consider this treatment to be inconsistent whem compared with other varieties and species within the genus. The leaf morphology and hispid vestiture of S. picridioides is very different to that of S. minimus, and the degree of purple pigmentation on the leaves and stems of S. picridioides is approached only by Arrhenechtites mixta in Australia. Although the floral morphology of S. picridioides and S. minimus is similar, on these grounds alone, S. bipinnatisectus and perhaps S. biserratus should also have been treated as varities of S. minimus. I have therefore maintained S. picridioides as a distinct species. Belcher (1956) cited only Western Australian specimens for his S. minimus var. picridioides and commented that he had not seen specimens from South Australia. However, S. picridioides is quite widespread in South Australia, and also occurs in western Victoria.

28. Senecio glomeratus Desf. ex Poiret in Lam., Ency. Meth. Bot. Suppl. 5:130 (1817). (Figure 3.10D).

S. glomeratus Desf., Cat. Hort. Paris. 124(1815) nom. nud.

S. argutus A. Rich., Fl. Nouv. Zel. 258(1832)

Erechtites arguta (A. Rich.) DC., Prodr. 6:296(1838). - Benth., Fl. Austral. 3:659(1866) pro parte.

Erect annual herb 80-120 cm tall. STEMS stout, cylindrical and striate; usually branched basally and at the inflorescence; sparsely to densely arachnoid on younger parts. LEAVES coriaceous, lanceolate to ovate-lanceolate in outline, 5-9(-12)x1-3(-5) cm, sessile with toothed auricles; lower leaves with obovate and serrate lobes cut at least half way to the midrib; median leaves with broad-lanceolate, serrate lobes; upper leaves acutely lobed or toothed; all densely arachnoid or tomentose below, sparsely arachnoid or glabrate above. CAPITULA 100-400 in a rather dense terminal corymbose panicle; peduncles 4-9 mm long, arachnoid. INVOLUCRE 4-5.5x2.5-3.5 mm, white tomentose basally, arachnoid on lower third; phyllaries 11-13. Calyculus of 4-8 narrowly triangular adpressed bracts 1.5-2.5 mm long. FEMALE FLORETS 24-33; corolla pubescent, lobes 3-4, deltoid, 0.2 mm long. BISEXUAL FLORETS 7-12; corolla glabrous, lobes 4-5, deltoid, 1.3 mm long, without a median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 1.3-1.7x0.4-0.5 mm, narrowed basally; surface of 8-10 flat longitudinal segments separated by narrow grooves, hairs short, adpressed, in rows corresponding to grooves; colour usually homomorphic and dark-brown, rarely outermost 'females' light green.

Flowering period: September to January.

Chromosome number: 2N = 60.

General distribution. Occasional on southern Eyre and Fleurieu Peninsulas, and the southeast of South Australia; widespread in all but the northwest mallee of Victoria; occasional in southeast New South Wales. Also Tasmania, southwest Western Australia and New Zealand (Belcher 1956). Adventive in California, United States of America (Belcher 1956).

Habitat. Temperate regions with more than 600 mm annual rainfall. In clearings or margins of sclerophyll forests, around inland marshes or locally abundant along roadsides.

Collection sites. South Australia. ML677,683: with Gahnia trifida in estuarine marsh, 6 km N. Coffin Bay Township; 23.i.1976. - ML648-51, roadside under Eucalyptus obliqua, 4 km NW. Mt. Compass; 1.xii.1976. - ML906-8: S. margin of Lake Greenly, 30 km N. Coffin Bay; 21.x.1977. Victoria: ML1087-89: among grass under Eucalyptus obliqua, 1.3 km SE. Lang Lang; 3.xii.1978. - among roadside grass, 1 km S. Deans Marsh; 5.xii.1978. - ML1140-42: with Senecio minimus and S. biserratus, roadside at N. boundary of Mt. Richmond National Park; 6.xii.1978. - ML1283-85: roadside by wet sclerophyll forest, 11 km N. Fernbank on road to Dargo; 13.xii.1978.

Discussion. S. glomeratus was not recognised as a separate identity by Australian flora writers until Belcher's 1956 revision of erechthitoid species of Senecio. Even today S. glomeratus is frequently misidentified as S. hispidulus, and vice versa. As my comments concerning these species are interdependent, I have discussed the problems of identification only once, after the description of S. hispidulus.

29. Senecio hispidulus A. Rich., Voy. Astrolabe (Bot.)2:92 t. 34(1834). (Figure 3.11A, B).

Erechtites arguta Benth., Fl. Austral. 3:659(1866) pro majore parte.

29.1 Senecio hispidulus var. hispidulus

Erect annual herb (20-)40-120 cm tall. STEMS stout, cylindrical and striate; usually branched basally, minutely hispid on younger parts, scabrous at maturity. LEAVES coriaceous; lanceolate to broadly lanceolate, 6-10(-15)x1-3(-4.5) cm, sessile with coarsely toothed or lacerate auricles, or the lowest leaves subpetiolate with minute auricles; coarsely toothed or pinnately parted, lobes more or less triangular irregularly toothed and acute, densely hispid below, sparsely hispid or scabrous above. CAPITULA 100-300 in a terminal corymbose panicle, dense at first rather lax at maturity; peduncles 6-15 mm long. INVOLUCRE 6-8.5 x2-2.5 mm, glabrous; phyllaries (9-)11-14. Calyculus of 1-4 narrowly triangular adpressed bracts 1-1.7 mm long. FEMALE FLORETS 12-19; corolla pubescent, lobes (3-)4, deltoid, 0.1-0.3 mm long. BISEXUAL FLORETS 4-7; corolla glabrous, lobes 5, deltoid 0.3-0.4 mm long, without a median resin duct. PAPPUS dimorphic. ACHENES homomorphic, usually red-brown, sometimes dark-brown, subcylindrical, 1.5-2.7x0.4-0.6 mm, basally rounded; surface of 8-10 flat or slightly concave longitudinal segments separated by narrow grooves, hairs short, adpressed, in sparse or dense rows corresponding to each groove, rarely absent.

Flowering period: September to February.

Chromosome number: 2N = 60.

General distribution. Occasional on southern Fleurieu Peninsula, Kangaroo Island and the southeast of South Australia,

frequent in the Great Dividing Range and adjacent coastal areas from Victoria to Southern Queensland. Also southwest Western Australia, Tasmania and New Zealand (Belcher 1956).

Habitat. Temperate to subtropical regions with more than 600 mm annual rainfall. Most frequent in clearings or margins of forests, often locally abundant along roadsides.

Collection sites. Victoria: ML1083-85: roadside under Eucalyptus obliqua, 1.3 km SE. Lang Lang; 3.xii.1978. - ML1129-31: clearing in wet sclerophyll forest, 1 km NE. Wye River township; 5.xii.1978. - ML1286-89: among grass by entrance to Strathfield Sage Sanctuary, 22 km SE. Stratford; 13.xii.1978. - ML1317: beside track in sclerophyll forest, 4 km SW. Mallacoota airport; 16.xii.1978.

New South Wales: ML1380: cleared roadside area by pine forest, 34 km S. Hartley; 28.xii.1978. - ML1422-24: roadside margin of wet sclerophyll forest, 19.5 km from Thredbo on road to Khancoban; 31.xii.1978.

29.2 Senecio hispidulus var. dissectus (Benth.) Belcher, Ann. Mo. bot. Gdn. 43:69(1956).

Erechtites arguta var. dissecta Benth., Fl. Austral. 3:659(1866).

Differing from the typical variety in having leaves ovate-lanceolate or ovate in outline; pinnatisect, lamina of primary lobes always broader than rachis and coarsely toothed or irregularly denticulate. Involucre usually shorter, 5-6 mm long, and length/width ratio greater. Total floret number higher, 26-35. Achenes not more than 1.6 mm long.

Flowering period: September to February.

Chromosome number: 2N = 60.

General distribution. Great Dividing Range and adjacent coastal areas from Victoria to central New South Wales. Some populations around rocky inland outcrops on western side of the Great Dividing Range.

Habitat. As for typical variety.

Collection sites. Victoria: ML1215-17: roadside margin of wet sclerophyll forest, 3 km from Halls Gap on road to Horsham; 7.xii.1978. - ML1221-23: among rocks in Eucalyptus woodland, N. slope of Mt. Talbot; 8.xii.1223. - ML1231-33: among rocks in Eucalyptus woodland, 7 km N. Glenrowan; 9.xii.1978. - ML1280-82: roadside margin of wet sclerophyll forest, 11 km N. Fernbank; 13.xii.1978. - ML1289-92: swampy margin of Lake King at Painsville; 13.xii.1978. - ML1318-20: clifftop heath formation 6 km SW. Mallacoota airport; 16.xii.1978.

New South Wales: ML1448-51: soil pockets between rocks of low granite outcrop 12 km ENE Gidginbung; 2.i.1979.

Discussion. I have combined the discussions of S. hispidulus and S. glomeratus as it is possible they represent one polymorphic species complex. Bentham (1866) treated S. hispidulus and S. glomeratus together as Erechtites arguta (his E. hispidula applies mainly to S. squarrosus). The separate identity of these taxa was not recognised until Belcher's 1956 review of erechthitoid species. However, Belcher commented in his discussion of hybrids that "Senecio glomeratus and S. hispidulus appear to hybridize so freely over much or all of their largely overlapping range that determination of material in this complex is exceedingly difficult." Although I had no difficulty identifying plants in the field, I agree there are some apparently intermediate specimens in herbaria. I do not, however, consider that S. hispidulus and S. glomeratus "hybridize freely over much of their range," as mixed populations occur only in southern Victoria on the Australian mainland. In this area I found intermediate plants at only one locality. The plants strongly resembled S. hispidulus var. hispidulus, but I classed them as intermediate because the capitula were minutely tomentose basally. I could find no genetic evidence of hybridization (see Chapter 8), but if S. glomeratus and S. hispidulus belong to one species complex, these 'hybrids' might occur without irregularities at meiosis.

S. glomeratus can be distinguished from both varieties of S. hispidulus by leaf and involucral pubescence (see Table 3.3) S. hispidulus var. hispidulus can also be separated by total floret number per capitulum, and to a lesser degree, by the length/width ratio of the capitulum. The capitula of S. hispidulus var. dissectus and S. glomeratus, however, differ only in pubescence. Belcher (1956) commented that "it is not impossible that genetic analysis will reveal this variety (var. dissectus)

TABLE 3.3

Differences between *S. glomeratus* and Varieties of *S. hispidulus*

	S. glomeratus	*S. hispidulus* var. *hispidulus*	*S. hispidulus* var. *dissectus*
involucre length (mm)	5.3-6.8 $\bar{x}$ = 5.8	5.9-8.3 $\bar{x}$ = 6.8	5.2-5.9 $\bar{x}$ = 5.7
length/ width	1.9-2.5 $\bar{x}$ = 2.3	2.4-3.3 $\bar{x}$ = 2.8	1.6-1.9 $\bar{x}$ = 1.8
total floret no./capitulum	27 - 45 $\bar{x}$ = 36	14 - 26 $\bar{x}$ = 19	26 - 35 $\bar{x}$ = 33
seed length (mm)	1.3-1.6 $\bar{x}$ = 1.5	1.4-2.7 $\bar{x}$ = 2.0	1.3-1.6 $\bar{x}$ = 1.5
involucre vestiture	basally white tomentose	usually glabrous	glabrous
leaf vestiture, lower surface	white tomentose	hispid	hispid
upper surface	arachnoid (soft to touch)	hispid or scabrous (rough to touch)	hispid or scabrous (rough to touch)

(The mean and range of values are given for numerical characters.)

as another hybrid, with S. glomeratus the other parent." Although I agree this is likely, genetic analysis will not resolve the problem as both 'parents' have effectively identical karyotypes (see Chapter 7). A more sensitive indicator, such as electrophoretic techniques employed by Gottlieb(1971) might clarify the position of S. hispidulus var. dissectus.

In view of the morphological differences present, I have followed Belcher and maintained S. glomeratus and S. hispidulus as separate species. I am not entirely satisfied with this treatment, but consider that greater taxonomic confusion would arise if they were to become varieties of one species complex.

30. Senecio sp. C (Figure 3.11C).

Ascending annual (?) herb 40-50 cm tall. STEMS slender, cylindrical and striate, several arising from a common subterranean base, green or purplish and densely hispid basally, dark purple and glabrate distally. LOWER CAULINE LEAVES rather crowded but not radical, thin and flexible, obtusely oblanceolate, 4-10x1-2.5 cm, sessile and shortly stem clasping, serrate with denticulate teeth, or shortly and distantly lobed, both surfaces densely hispid, becoming scabrous above with age. Middle cauline leaves similar, but shorter and lanceolate; upper leaves further reduced and with small serrate auricles. CAPITULA 20-40 in a lax terminal corymbose panicle; peduncles 15-25 mm long, dark purple. INVOLUCRE 7.5-9x3-3.5, dark purple; phyllaries 11-14, distal 1 mm strongly recurved. Calyculus of 3-5 narrowly triangular adpressed bracts 1.5-2.5 mm, sometimes recurved distally. FEMALE FLORETS 14-20, corolla pubescent, lobes (3-)4, deltoid, 0.2-0.3 mm long. BISEXUAL FLORETS 8-15, corolla glabrous, lobes 5, deltoid, 0.3 mm long, without a median resin duct. PAPPUS dimorphic. ACHENES subcylindrical, 2-2.5x0.5-0.6 mm, basally rounded; surface of 8-9 flat ribs separated by narrow grooves, hairs short, adpressed, in narrow or broad rows corresponding to grooves; colour heteromorphic, 'females' olive-green, 'bisexuals' red brown.

Flowering period: December (largely unknown).

Chromosome number: 2N = 60.

Known to me from only one collection in Victoria: ML1162-66: 10.7 km E. Nelson in Lower Glenelg River National Park. Scattered but quite common among sclerophyll understory of Eucalyptus forest; 6.xii.1978.

Discussion. Apart from my own collection, I have seen only one herbarium specimen corresponding to Senecio sp. C. I originally classified this species as Senecio sp. C (S. aff. apargiaefolius) form 4 (Lawrence 1980) but the achenes of this species are comparatively short and resemble those of S. hispidulus. The achenes of S. aff. apargiaefolius are long and slender like those of S. quadridentatus. Senecio sp. C differs from all Australian species in having an almost black involucre and distally recurved phyllaries. The phyllaries of Senecio sp.B are occasionally, but not consistently recurved. The affinities of Senecio sp. C are therefore obscure, but because of similarities in pubescence and achene morphology I believe they are closest to S. hispidulus.

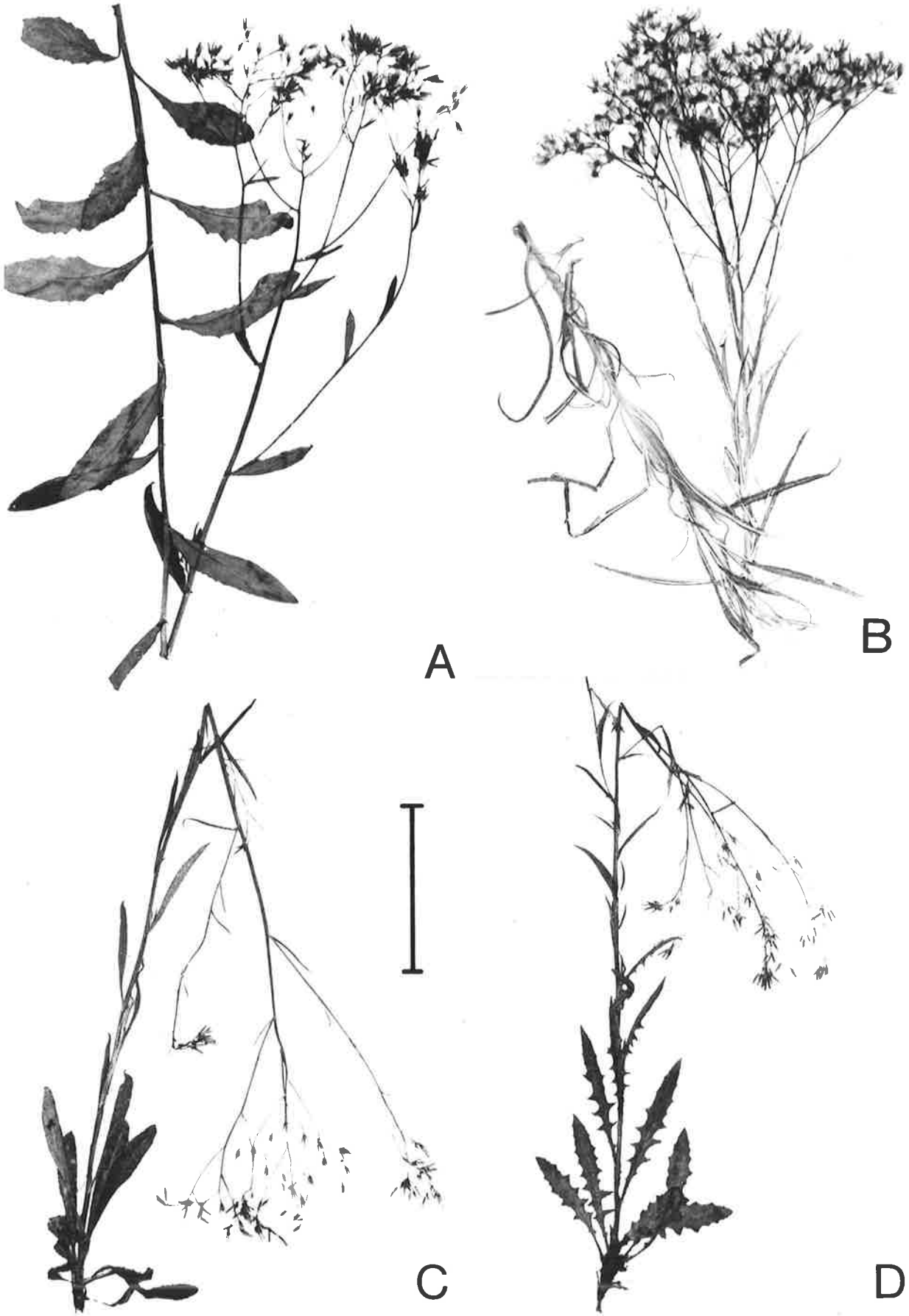

Fig. 3.8 A. Senecio gunnii. B. S. quadridentatus. C. S. aff. apargiaefolius form 1. D. S. aff. apargiaefolius form 2.

All figures at same magnification. Scale 10 cm.

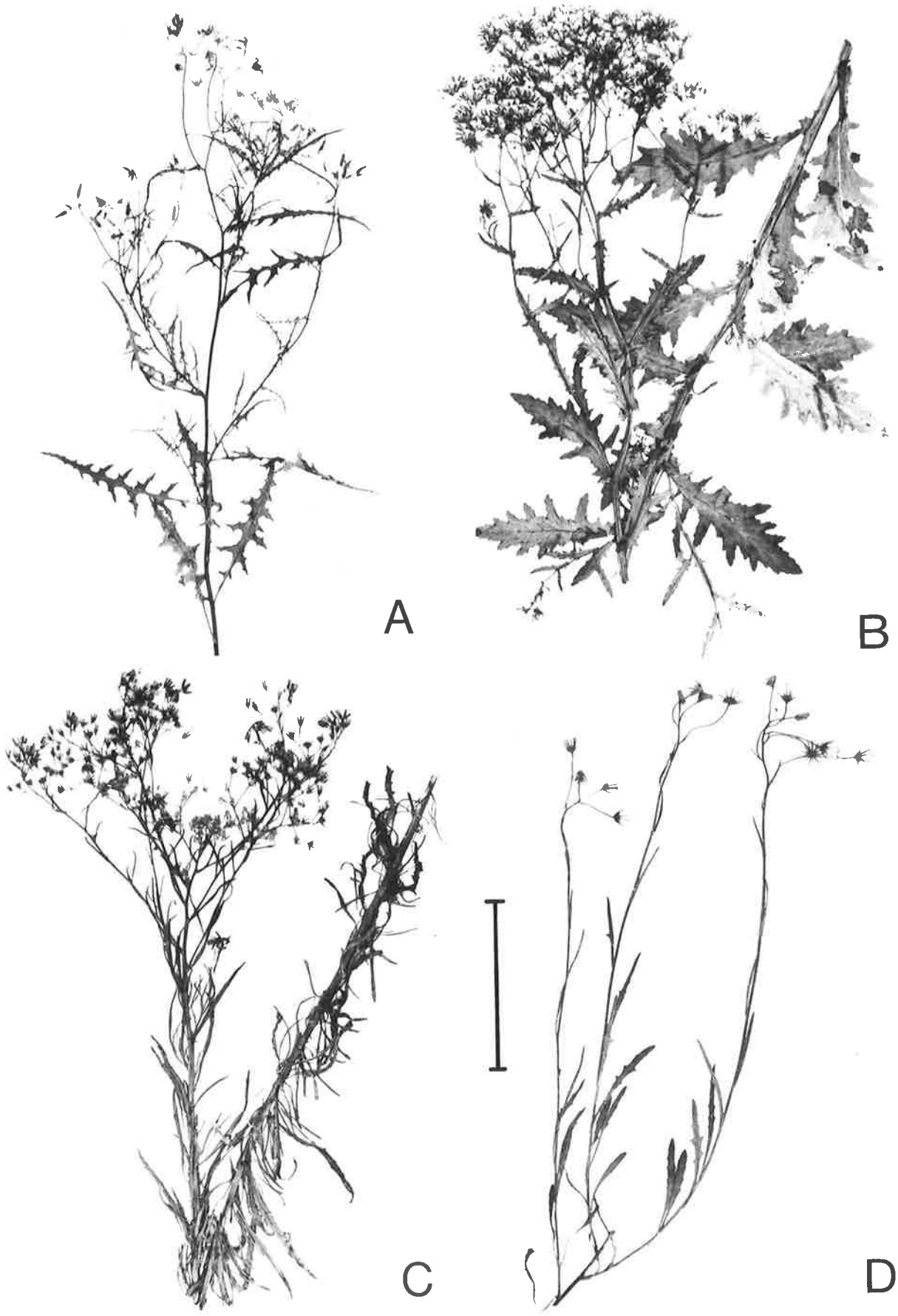

Fig. 3.9 A. Senecio runcinifolius. B. S. biserratus. C. S. sp. B. D. S. squarrosus. All figures at same magnification. Scale 10 cm.

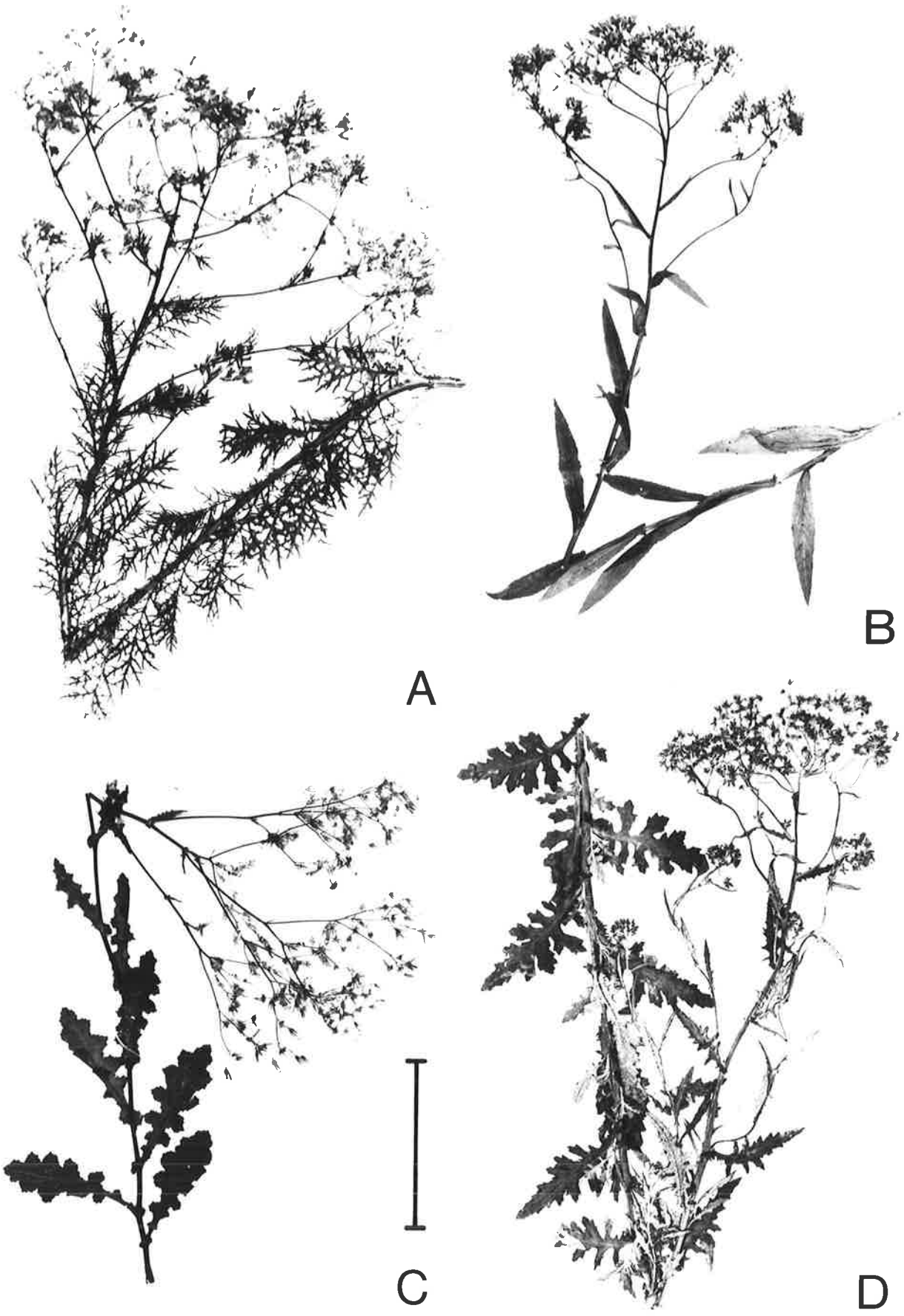

Fig. 3.10 A. Senecio bipinnatisectus. B. S. minimus. C. S. picridioides. D. S. glomeratus. All figures at same magnification. Scale 10 cm.

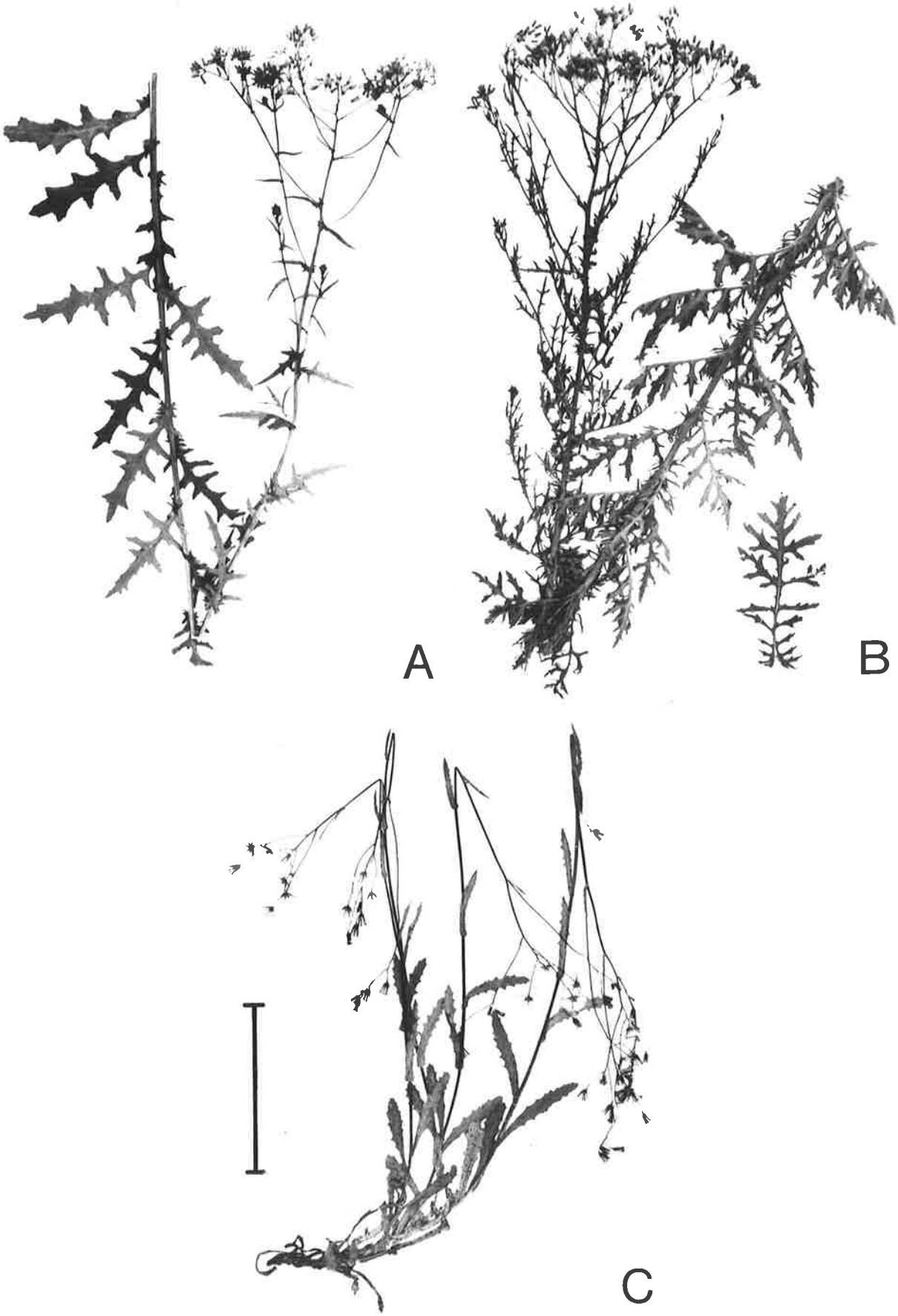

Fig. 3.11 A. Senecio hispidulus var. hispidulus. B. S. hispidulus var. dissectus. C. S. sp. C.

3.4.4 Exotic species of *Senecio*.

The four species described in this section were included for comparative purposes. *S. discifolius* occurs only in Africa, but *S. pterophorus*, *S. mikanioides* and *S. vulgaris* are introduced weeds in Australia.

31. Senecio discifolius Oliver, Trans. Linn. Soc. 29:100(1873). (Figure 3.12A).

Erect annual herb 30-50 cm tall. STEM stout, cylindrical and striate; branched only at the inflorescence; densely arachnoid at first, sparsely arachnoid on older parts. LEAVES thin and flexible, broadly oborbicular, 5-7x2.5-3.5 cm; sessile, attenuate and entire basally, coarsely dentate distally; both surfaces densely hispid at first, sparsely hispid at maturity. CAPITULA heterogamous radiate, 6-8 in a very lax terminal corymb; peduncles slender, 12-14 cm long, without bracts. INVOLUCRE broadly campanulate, 8x6.5 mm, basally truncate; phyllaries 12, free, subequal and dorsally smooth. Calyculus absent. RECEPTACLE flat, deeply pitted, pit margins minutely toothed. RAY FLORETS 12-14; ligule yellow, 6.5-7x3 mm, 5-8 veined, upper surface papillose; tube distally pubescent, hairs clavate, biseriate, 6-8 cells long. DISC FLORETS 80-110; corolla 6-7 mm long, glabrous, tubular below, upper half narrowly campanulate; lobes 5, ovate-lanceolate, spreading, with a faint median resin duct. STAMINAL FILAMENT 0.07 mm wide, collar 0.5x0.2 mm, swollen basally, tapering distally. ANTHERS 1.7 mm long, theca basally acute, apical appendage narrowly oblong-ovate, 0.3 mm long, endothecal tissue 'radial'. STYLE basally swollen, placed on a short cylindrical nectary; branches shortly papillate on dorsal surface, stigmatic surface of two broad discrete marginal lines, apex truncate or rounded with a row of spreading papillae around the abaxial margin and a median fascicle of longer papillae at the distal end of the stigmatic surface. OVARY WALL CRYSTALS numerous; uniform, comparatively large flat hexagonal plates up to 33x7 μm. PAPPUS uniform, white, of many slender caducous bristles in 2 rows, minutely barbellate with acute teeth, apex 2-celled.

ACHENES subcylindrical, 2.5x0.5-0.6 mm, basally narrowed, apically white callose annulate; surface of 5 longitudinal segments, each marginally ridged, flat or convex centrally, hairs short, adpressed in elevated grooves between the segments; colour dimorphic, 'females' grey-green, bisexuals dark-brown.

Flowering period: October to January.

Chromosome number: 2N = 10.

General distribution. Nairobi and Rhodesia in Africa, largely unknown.

Habitat. Largely unknown, see seed source information below.

Collection site (seed source). ML1008; Leg. Th. Müller: "flowering out of season in an irrigated woodland area of the National Botanic Gardens," Salisbury, Rhodesia; 23.xiii.1978.

Discussion. I obtained seed of S. discifolius to determine the karyotype of a species with 2N = 10, the lowest chromosome number known in the tribe Senecioneae. The description above is therefore based entirely on glasshouse-raised plants. S. discifolius corresponds to most of my general description of Australian species of Senecio, but differs in two important respects. Firstly, there are no bracts on either the involucre or the peduncles. A few Australian species lack a calyculus (bracts on the involucre base) but all have bracteate peduncles. The second difference is that S. discifolius has a papillose ligule epidermis. This condition is normally associated with non-yellow (white or purple) ligule colour in Senecioneae. Nordenstam (1978) discussed the monospecific genus Dorobaea, and commented "it is the only example known to me in the tribe of a yellow-rayed taxon with a papillose ligule epidermis." Dorobaea

pimpinellifolia and Senecio discifolius are similar in floral morphology, but have any different involucres, peduncles and general habits. As I am largely unfamiliar with taxa outside of Australia, I am unsure of the affinities of S. discifolius.

32. Senecio mikanioides Otto ex Walp. in Otto and Dietr., Allg. Gautenztg. 13:42(1845). (Figure 3.12D).

Twining glabrous perennial herb covering other vegetation to heights of up to 5 m. STEMS much branched, slender, cylindrical and striate, new growth often purplish, becoming woody with age. LEAVES simple, slightly fleshy; petiole slender, 4-7 cm long; blade cordate-hastate in outline, 4-6(-8) cm in diameter, palmately 3-7 nerved and lobed, lobes deltoid, sinuses broad and shallow; stipules reniform, up to 1 cm wide. CAPITULA homogamous discoid, 15-40(-60) in dense terminal and axillary corymbose panicles; peduncles slender, bracteate, 3-8 mm long. INVOLUCRE cylindrical 3.5-5x2-2.5 mm; phyllaries 8-10, free, subequal and dorsally smooth. Calyculus of 2-3 oblanceolate bracts 1.5 mm long. RECEPTACLE flat, deeply pitted, pit margins raised into scales up to one quarter the involucre length. FLORETS 10-12, tubular and bisexual, exserted 3-4 mm beyond involucre; corolla yellow, glabrous, 6-7 mm long, tubular basally, distal third broadly campanulate; lobes 5, spreading, narrowly deltoid, 1.5 mm long, with or without a median resin duct. STAMINAL FILAMENT 0.08 mm wide, collar 0.4x0.2 mm, swollen basally, attenuate distally. ANTHERS 1.3-1.5 mm long, theca with tails up to one third the filament collar length, apical appendage narrowly triangular, 0.3 mm long, endothecal tissue 'radial'. STYLE slightly swollen basally, placed on a short cylindrical nectary; dorsal surface of branches glabrous or shortly papillate distally, stigmatic surface of two broad marginal lines, apex truncate with spreading papillae around abaxial margin. OVARY WALL CRYSTALS absent, or few and then irregular hollow ovoid plates up to 5x2.5 μm. PAPPUS white, uniform, of many stout caducous bristles in 1-2 rows, barbellate with acute teeth, apex 2-celled.

ACHENES glabrous and red-brown when immature, mature achenes not seen.

Flowering period: June to September.

Chromosome number: 2N = 20.

General distribution. Native to South Africa. Introduced to the Adelaide Hills in South Australia and coastal regions of Victoria, New South Wales and Tasmania.

Habitat. Most frequent in disturbed areas of moist gullies and forest margins.

Collection site. South Australia: ML1007: covering roadside fence, lower Torrens Gorge, Mt. Lofty Ranges; 2.xiii.1978.

Discussion. Although the inflorescence of Senecio mikanioides resembles that of native discoid species, it is vegetatively very different. S. mikanioides is a climbing plant with palmately veined leaves, whereas all Australian species of Senecio are erect herbs or shrubs with pinnate venation. The poor ovary wall crystal development is also unknown among Australian species. I therefore do not consider S. mikanioides to be closely related to any Australian species in this study.

33. Senecio pterophorus DC. Prodr. 6:389(1837). (Figure 3.12B).

Erect perennial herb or shrub 0.8-1.5(-3) m tall. STEMS stout, cylindrical and striate; much branched, new growth predominantly distal, rarely basal. LEAVES coriaceous; lanceolate, 5-8(-12)x0.7-1.5(-2.5) cm; decurrent, stem wings 1-4 cm long, usually conspicuous and denticulate or toothed, rarely narrow and entire; tapering or subpetiolate basally; margins coarsely and acutely toothed, rarely denticulate or almost entire; reduced in size towards inflorescence. CAPITULA heterogamous radiate, 40-200 in a terminal corymbose panicle, peduncles slender, 10-25 mm long, bracteate. INVOLUCRE campanulate 4.5-6x 4-4.5 mm, sparsely arachnoid basally; phyllaries 18-22, free, subequal, dorsal surface obscurely 2-ribbed. Calyculus of 12-18 lanceolate adpressed bracts 1.5-2.5(-3) mm long. RECEPTACLE flat, pitted, pit margins raised in slender scales. RAY FLORETS 9-13; ligule yellow, 4-7x2-3 mm, 4-veined, cells of upper surface smooth; tube distally pubescent, hairs slender, uni- and biseriate 8-15 cells long. DISC FLORETS 60-95; corolla 3.6-5 mm long, glabrous, tubular below, upper third campanulate, lobes 5, spreading, 0.3-0.5 mm long, without a median resin duct. STAMINAL FILAMENT 0.07 mm wide; collar 0.3-0.4x0.15 mm, abruptly swollen basally, attenuate distally. ANTHERS 1.2-1.5 mm long, theca basally acute, apical appendage ovate-lanceolate, 0.2 mm long, endothecal tissue 'radial'. STYLE base not swollen, placed on a short conical nectary; branches glabrous on dorsal surface; stigmatic surface of two broad, discrete marginal lines; apex rounded with short spreading papillae around the abaxial margin. OVARY WALL CRYSTALS numerous, uniform, flat hexagonal plates up to 20x5 μm. PAPPUS white, of many slender caducous bristles in 2-3 rows, dimorphic, a few bristles 'fluked', others minutely barbellate with acute teeth, apex 2-celled. ACHENES

homomorphic, red- or dark-brown; cylindrical, 1.5-1.7x0.5 mm, basally rounded, apically white callose annulate; surface of 8-10 obscure longitudinal segments, sparsely covered by minute white hairs.

Flowering period: November to March.

Chromosome number: 2N = 20.

General distribution. Eastern regions of the Cape Province, South Africa. Eyre Peninsula south of Cummins, the Mount Lofty Ranges and near the River Murray east of Renmark in South Australia. Reported from Victoria (Willis 1972) but now eradicated.

Habitat. Most frequent in disturbed areas such as roadsides, agricultural land and recently burnt areas.

Collection sites. South Australia: ML647-49: understory of dry sclerophyll forest, 0.6 km below Kangaroo Creek Dam wall, Mt. Lofty Ranges; 23.xi.1976. - ML678: roadside by estuarine marsh 5.9 km N. Coffin Bay township; 23.i.1977. - ML910: SW. slope of Mt. Greenly; 21.x.1977. - ML1068-70: along southern bank of Chowilla Creek, 1 km from W. intersection with River Murray; 7.xi.1978.

Discussion. Senecio pterophorus is best distinguished from Australian perennial species by its decurrent leaf bases. All other aspects of leaf and floral morphology can be found among Australian taxa. S. pterophorus var. apterus differs in having no raised wings on the petioles. Although this variety is listed in the Flora of South Australia (1965), I could find no field or herbarium specimens, and do not believe it occurs in South Australia.

34. Senecio vulgaris L., Spec. Plant. 2:(1753). (Figure 3.12C).

Erect annual herb 10-40 cm tall. STEM stout, cylindrical and striate, glabrous or with long scattered hairs on younger parts, usually purplish basally, branched towards the inflorescence. LOWER LEAVES glabrate, broadly oblanceolate in outline, 4-6x1.5-2.5 mm, narrowed basally or subpetiolate, pinnatifid, lobes sinuate and coarsely toothed. UPPER LEAVES with a few long hairs around the veins, ovate in outline up to 8x3.5 cm, slightly narrowed basally with toothed or lacerate auricles, pinnatifid, lobes lanceolate to oblanceolate and coarsely toothed. CAPITULA homogamous discoid, 8-25 in terminal corymbose panicles; peduncles slender, sparsely arachnoid, without bracts, 1-3 mm long at first, elongating as achenes mature. INVOLUCRE broadly cylindrical or slightly campanulate, 6-7x4 mm, phyllaries 18-23, free, subequal, faintly 2-ribbed dorsally. Calyculus of 16-20 lanceolate adpressed bracts 1-2 mm long, black on upper half. RECEPTACLE flat, pitted, pit margins not raised. FLORETS 55-70, all tubular and bisexual; corolla 4.5-5 mm long, glabrous, exserted about 1 mm beyond the involucre, tubular below, upper third narrowly campanulate; lobes usually 5, sometimes 4 in outermost florets, spreading slightly, deltoid, 0.3-0.4 mm long without a median resin duct. STAMINAL FILAMENT 0.06 mm wide, collar 0.3x0.1 mm, swollen basally, tapering distally. ANTHERS 0.5-0.6 mm long, theca basally obtuse, apical appendage triangular, 0.2 mm long, endothecal tissue 'radial'. STYLE slightly swollen basally, placed on a short cylindrical nectary; branches dorsally glabrous, stigmatic surface of two broad discrete marginal lines, apex truncate or rounded with many spreading papillae around the abaxial margin. PAPPUS white, of many slender caducous bristles in 2-3 rows, dimorphic, many bristles 'fluked', other minutely barbellate with acute teeth, apex

2-celled. ACHENES homomorphic, light-brown, subcylindrical, 2x0.4 mm, narrowed basally, white callose-annulate distally; surface of 9-11 rounded ribs separated by channels of equal width, hairs short, adpressed or spreading, in dense rows in the channels.

Flowering period: July to November, occasionally throughout the year.

Chromosome number: 2N = 40.

General distribution. Native in Europe, introduced in most temperate regions of the world. Occurs in all Australian states but is uncommon in South Australian gardens.

Habitat. Occasional in or near garden areas in South Australia, uncommon roadside plant. Described as a "weed of settled" areas in other states (Curtis 1963; Willis 1972; Beadle, Evans and Carolin 1976).

Collection sites. South Australia: ML552-60: roadside ditch 0.3 km from eastern end of Gores Rd., Mt. Lofty Ranges; 30.viii.1976. - ML949: garden bed in Royal Adelaide Hospital grounds; 16.i.1978.

Discussion. As Senecio vulgaris is the type species of Senecio, its morphology characterises Senecio sensu stricto. Of all taxa included in this study, S. lautus subsp. lautus from New Zealand most closely resembles S. vulgaris both in capitulum and vegetative morphology. Australian subspecies of S. lautus approach S. vulgaris in capitulum morphology, but all have conspicuous ray florets and basally woody stems. The florets of S. vulgaris are all tubular and bisexual, but I found that some of the outermost florets were 4-lobed. This observation suggests a link with Australian erechthitoid species, which, like S. vulgaris, are inbreeding and have 3- to 4-lobed marginal corollas.

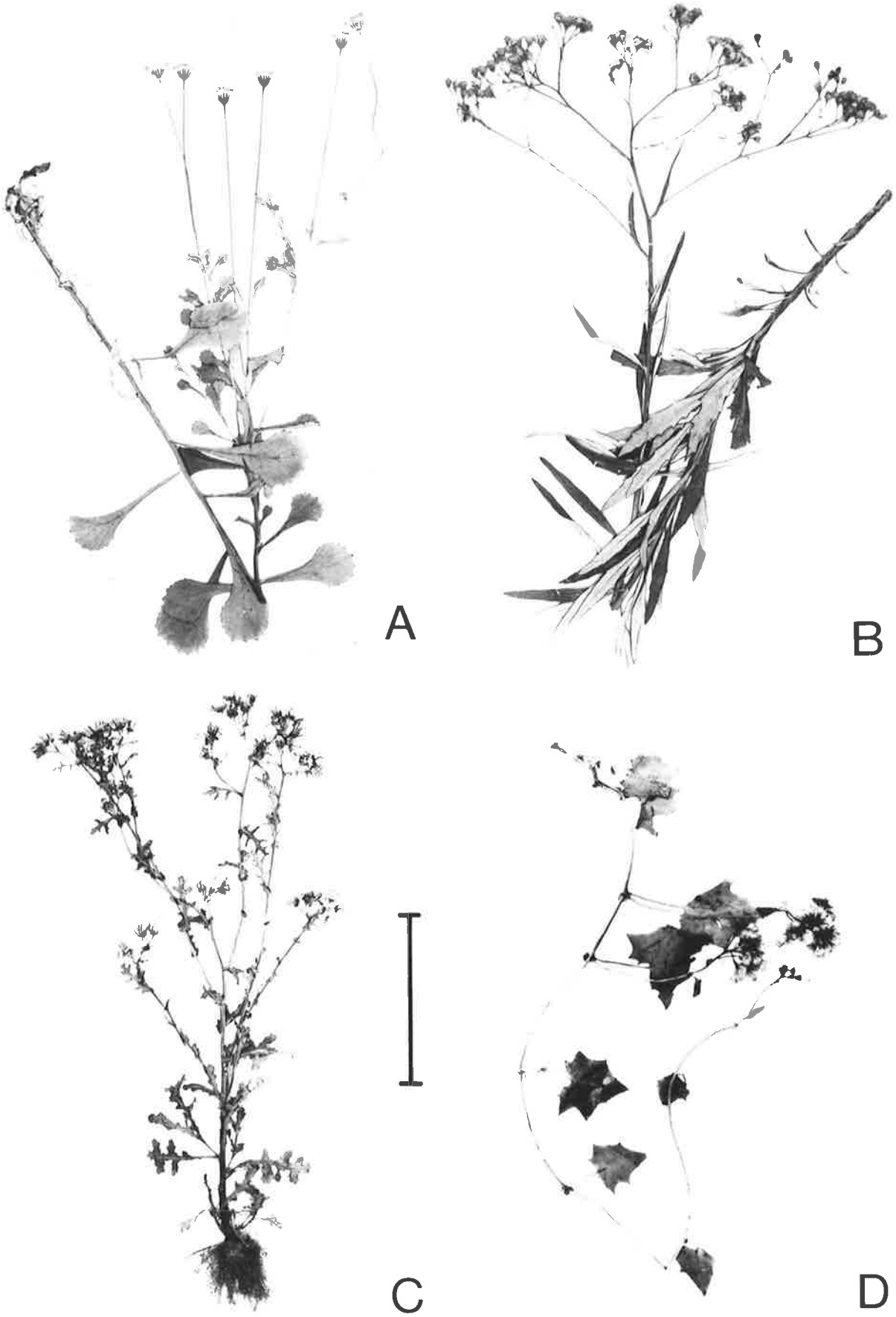

Fig. 3.12 A. Senecio discifolius. B. S. pterophorus. C. S. vulgaris. D. S. mikanioides. All figures at same magnification Scale 10 cm.

3.4.5 Sterile Hybrids Wrongly Given Taxonomic Status

35. Senecio lautus G. Forst. ex. Willd. subsp. dissectifolius Ali x S. biserratus Belcher.

S. orarius Black, Trans. Roy. Soc. S. Aust. 52:230(1928)
S. brachyglossus F.v. Muell. var. major Benth. (treated as a synonym of S. orarius by Black l.c.).

Morphological characteristics of S. lautus x S. biserratus are given with characteristics of other hybrids in Chapter 8. However, S. lautus x S. biserratus is included in this chapter as it is the only sterile F1 hybrid occurring with sufficient frequency to have been mistakenly recognised at the specific level. Current floras of South Australia (Black 1965) and Victoria (Willis 1972) recognise the hybrid as S. orarius Black. In his protologue, Black (1928) wrongly included S. lautus Sol. var. lanceolatus Benth. in synonymy. The status and author citation of the latter has since been changed to S. lautus Forst. f. ex. Willd. subsp. lanceolatus (Benth.) Ali by Ali (1969), but he made no mention of S. orarius. Although S. lautus x S. biserratus and S. lautus subsp. lanceolatus are superficially similar, the capitula are quite distinct. S. lautus x S. biserratus has 4-10 generally recurved ligules 2-4 mm long, 24-30 disc florets and an involucre 2 to 2.5 times longer than broad. S. lautus subsp. lanceolatus has 8-14 radiating ligules 7-12 mm long, 55-80 disc florets and an involucre 1 to 1.3 times longer than broad.

Eleven collections determined S. orarius and lodged in the Melbourne herbarium (MEL) were examined. All correspond with Black's protologue and all have shrivelled pollen grains and

white and shrivelled achenes indicative of hybrid origins. A syntype of S. brachyglossus (= S. glossanthus) var. major collected by F. von Mueller in 1853 from Wilson's Promontory and later described by Bentham (1866) is also S. lautus x S. biserratus. S. glossanthus (see description 3) is a slender annual of drier parts of Australia. The reduced ligules of S. glossanthus are associated with an autogamous breeding system, but do resemble the short ligules of a number of hybrids between radiate and non-radiate taxa. In fact, variety elatior of S. brachyglossus (= S. glossanthus) also described by Bentham appears to be another hybrid, probably between S. linearifolius and an erechthitoid species (see discussion after description of S. glossanthus).

3.5 Species From Other Genera

Three species from genera other than Senecio were included for comparative purposes. These are Arrhenechtites mixta, Erechtites valerianaefolia and Bedfordia salicina. As only one species from each genus was studied, generic descriptions are omitted and the reader is referred to the most recent literature for the genus. General features of each genus are included in the discussions following each description.

3.5.1 Arrhenechtites Mattfeld, Bot. Jahrb. Syst. 69:288 (1938). Description and revision: Belcher, Ann. Mo. Bot. Gdn. 43:74-79 (1956).

36. Arrhenechtites mixta (A. Rich.) Belcher, l.c. pp 75-77. Figure 3.13A).

Senecio mixtus A. Rich., Voy. Astrolabe (Bot.)2:112,t.36(1834)

Erechtites mixta (A. Rich.) DC., Prodr. 6:297; non sensu Benth., Fl. Austral. 3:659 (1866) = S. runcinifolius.

Erect annual (?) herb 30-90 cm tall. STEMS slender, cylindrical, faintly striate and purple, simple or sparingly branched, one to several arising from a common base, sparsely tomentose at first, glabrate at maturity but with purple multicellular hair bases remaining adpressed to stem. LEAVES thin and flexible; lower surface purple, densely scabrous, hairs stout, multicellular and purple basally; upper surface purplish or green, sparsely arachnoid, hairs basally multicellular, purple and stout, apical cell long, slender and flexuous. Lower leaves narrowly oval, up to 14x4 cm, subpetiolate, basally pinnatifid with 2-5 lanceolate and dentate segments on each side, distally lobed. Upper leaves oval to ovate, 4-9 x 1.5-5 cm, pinnatifid throughout with 8-10 narrowly lanceolate toothed segments on each side at right angles

to midrib. CAPITULA heterogamous radiate, 10-40 (-80) in a very lax terminal cymose or corymbose panicle; peduncles slender, 2-5 cm long, with several linear bracts 5-7 mm long towards the capitulum. INVOLUCRE slender, 13-17 x 3-3.5 mm, tapering gradually distally, arachnoid in bud, the purple multicellular hair bases persisting at maturity; phyllaries 7-9, free, subequal, faintly 2-ribbed dorsally. Calyculus of 2-5 linear more or less adpressed bracts 4-6 mm long. Receptacle flat, deeply pitted with entire pit margins. MARGINAL FLORETS female 8-12 in 2-3 rows, minutely ligulate; ligules 1.5-2x1mm, obscurely 2-3 veined, scarcely exceeding the involucre; tube pubescent distally, hairs few, slender, uniseriate, 6-10 cells long. Style branches like those of disc florets, but dorsally glabrous and with a few elongate papillae towards the apex. DISC FLORETS bisexual, 2-5, exserted 2-4 mm beyond the involucre; corolla 10-16 mm long, with few to many biseriate hairs 6-10 cells long on the upper third, tubular below, shortly campanulate distally; lobes 5, recurved, narrowly deltoid, 1-1.5 x 0.5 mm, with a faint median resin duct. STAMINAL FILAMENT 0.1 mm broad, collar 0.6-0.8 x 0.15-0.2 mm, slightly swollen basally, tapering distally. ANTHERS 1.5-1.8 mm long, theca acute basally, apical appendage deltoid, 0.4 mm long. Endothecal tissue irregular, both "polarized" and "radial" cells present. STYLE slightly swollen basally, placed on a minute cylindrical nectary; shortly bilobed, branches covered with long hairs on the dorsal surface, stigmatic surface of two broad but discrete stigmatic lines, apex convex with several rows of very long hairs around the abaxial margin. OVARY WALL CRYSTALS few, small and irregular; oval plates up to 3μm long predominant. PAPPUS white, of many slender deciduous bristles in 2-3 rows, uniform, minutely barbellate with acute teeth, cells not crowded distally, apex

2-celled. ACHENES homomorphic, red-brown, subcylindrical, 5.5-7 x 0.7-1 mm; tapering basally, tapering or shortly attenuate distally, white callose-annulate at both ends; surface glabrous, with 11-14 rounded ribs separated by equally wide channels.

Flowering period: December to March.

Chromosome number: 2N = 100.

General distribution. In New South Wales - most common on ridge tops of the Blue Mountains east of Sydney, one collection from Gloucester Tops about 200 km north of Sydney, occasional in coastal ranges south of Sydney. In Victoria - relatively common in the eastern highlands as far west as Mt. Phipps.

Habitat. Sclerophyll forests with comparatively dry open understories, often on rocky ground, locally abundant after fires. From about 200-1,200 m altitude.

Collection sites. Victoria: ML1308-1313: 2.6 km from Princes Highway along road to summit of Genoa Peak, locally abundant in recently burnt forest area; 15.xii.1978. New South Wales: ML1361-63: 3 km W. Katoomba city center, on rocky ground in open sclerophyll forest understory; 17.xii.1978. - ML1390-92: 5 km S. Jenolan Caves, in open sclerophyll forest understory; 28.xii.1978.

Discussion. The genus Arrhenechtites contains five species endemic in the higher mountains of New Guinea, and one species, A. mixta endemic in south-eastern Australia. I confirmed my identification of A. mixta by examination of herbarium specimens determined by R. O. Belcher. However, I disagree with a number of points in Belcher's (1956) descriptions of Arrhenechtites and A. mixta. Firstly, Belcher described the genus as "characterized by functionally staminate disc florets with style arms reduced,

astigmatic, and papillose over the outer faces." I found the disc florets of A. mixta matured fertile fruit, and the style arms had short but well-developed stigmatic surfaces. Secondly, I could find no evidence to support Belcher's description of Arrhenechtites as a genus of perennials. Glasshouse-raised plants of A. mixta behaved as annuals, and the habit of field populations is suggestive of an annual life form. Thirdly, Belcher described the involucre of A. mixta as ecalyculate. All of my collections had calyculate involucres, but the elongate receptacle shrivels as it dries. Belcher may therefore have mistaken the calyculus for bracts on the peduncle.

When Belcher transferred Senecio mixtus A. Rich. to Arrhenechtites, he amended Mattfeld's diagnosis to admit "pistillate florets subligulate, and more numerous than the phyllaries." In view of my findings, Mattfeld's diagnosis should be further amended to include plants with bisexual disc florets, stigmatic style arms and (possibly) an annual life form. It may therefore be preferable to place Arrhenechtites mixta in a new and monospecific genus. However, I have not seen specimens of other species of Arrhenechtites (known only from the holotype collections according to Belcher) and am unsure of the merits of creating a new genus for A. mixta.

3.5.2 Erechtites Rafinesque, Fl. Ludov. 65 (1817)

Description and revision - Belcher, Ann. Mo. bot. Gdn. 43:10-37 (1956).

37. Erechtites valerianaefolia (Wolf) DC., Prodr. 6:295 (1838) f. valerianaefolia. (Figure 3.13B).

Erect glabrate annual herb 0.8-2 m tall. STEMS stout, cylindrical and deeply striate, glabrous or sparsely hispid on younger parts, simple basally, much branched towards the inflorescence. LEAVES thin and flexible; broadly lanceolate to ovate in outline, 12-22x4-10 cm, pinnatifid, lobes 4-7 on either side, lanceolate to ovate-lanceolate, coarsely and acutely toothed; reduced towards the inflorescence; glabrous or sparsely hispid along the veins. CAPITULA homogamous discoid, 100-300 in dense terminal and axillary corymbose panicles; peduncles slender, 5-12 mm long, bracteate. INVOLUCRE slightly or very bulbous on lower quarter, cylindrical above, 9.5-10.5x3.5-4 mm, sparsely hispid basally; phyllaries 12-15, free, subequal, dorsally smooth. Calyculus of 4-9 linear adpressed bracts 2-4 mm long. RECEPTACLE flat, deeply pitted, pit margins minutely toothed. MARGINAL FLORETS female, filiform, scarcely exceeding the involucre, 20-25 in 1-2 rows; corolla glabrous, 7-9 mm long, tubular below, shortly campanulate distally; lobes 5, spreading, deltoid, 0.5 mm long. Style like that of disc florets or with reduced marginal papillae at apex. DISC FLORETS bisexual, 35-55, exserted 1-2 mm beyond the involucre; corolla 8-10 mm long, glabrous, tubular below, upper third campanulate; lobes 5, spreading, deltoid, 0.5 mm long with a median resin duct. Staminal filament 0.07 mm wide, collar 0.4-0.5x0.1 mm, slightly swollen basally, tapering distally. ANTHERS 0.9 mm long, theca bases acute, apical appendage triangular, 0.2 mm long, endothecal tissue "radial".

STYLE slightly swollen basally, placed on a minute cylindrical nectary; arms glabrous on dorsal surface; stigmatic surface of two narrow marginal lines; apex with a sterile conical appendage longer than the basal papillae, papillae spreading, in several rows towards the base of and on the abaxial side of the appendage. OVARY WALL CRYSTALS numerous, rhombic plates commonly 10-12x5 μm. PAPPUS mauve or pink, of many slender flexuous caducous bristles in 2-3 rows, uniform; minutely barbellate with acute or obtuse teeth, or cells elongate distally, apex 1-2 celled. ACHENES homomorphic, light brown, subcylindrical, 3-3.5x0.5-0.7 mm, tapering at both ends, apex white callose-annulate; surface with 11-12 narrow rounded ribs separated by deep channels, hairs sparse, slightly curled, scattered along the channels.

Flowering period: October to May, occasional throughout year. Chromosome number: 2N = 40.

General distribution. Native to central South America. Introduced and spreading in southern Queensland, occasional in coastal areas north of Gosford, New South Wales.

Habitat. Margins of rainforests and roadside areas, usually on organically-rich soils.

Collection sites. New South Wales: ML1321-23: 1 km SW. Berkley Vale, c. 5 km NW. Gosford, roadside margin of rainforest; 23.xii.1978. - ML1339:29 km N. Wingham on road to Comboyne, roadside margin of rainforest.

Discussion. Although Erechtites valerianaefolia superficially resembles Australian erechthitoid species of Senecio, it differs in having a sterile conical appendage at the apex of each style arm. According to Belcher (1956), there are five species in the genus, all of which are native to America. E. valerianaefolia, however, is an agressive weed that has spread into tropical Asia, many of the Pacific islands, and north eastern Australia.

3.5.3 Bedfordia A.P. de Candolle in Guillemin, Arch. Bot. 4: 332 (1933).

Other descriptions: Benth., Fl. Austral. 3: 673 (1866). - Curtis, Student's Fl. Tasm. 2:371 (1963).

38. Bedfordia salicina (Labill.) DC., Prodr. 6:441 (1838). (Figure 3.13C).

Cacalia salicina Labill., Nov. Holl. pl. 2:37, t. 179(1807)

Senecio bedfordii F. v. Muell., Key Syst. Vict. Plant. 1:340 (1888).

Large shrubs or small tree 2-5 m tall. BRANCHLETS stout, woody, with numerous raised leaf scars, densely covered in a long cream-coloured tomentum distally, becoming glabrous with age. LEAVES coriaceous, crowded at ends of branchlets; petiole stout, tomentose, 1.5-2.5 cm long; blade elliptical-lanceolate, 15-22x 2.5-4.5 cm, margins entire or obscurely crenate, apex obtuse; densely white tomentose and floccose (not stellate hairy) beneath; sparsely tomentose above at first, becoming arachnoid and finally glabrous at maturity. CAPITULA homogamous discoid, 15-30 in lax axillary panicles much shorter than the leaves, floral axes densely tomentose; peduncles stout, 5-9 mm long, sparsely bracteate. Involucre cylindrical, 6.5-8x4.5-5 mm, densely tomentose; phyllaries 8, broadly overlapping, free, subequal. Calyculus of 0-2 lanceolate bracts 1.5-2.5 mm long. RECEPTACLE slightly convex, deeply pitted, pit margins extended into distally filiform scales up to half as long as phyllaries. FLORETS all perfect and bisexual, 12-16, exserted 2-3 mm beyond the involucre; corolla 6-8 mm long, glabrous, tubular below median trace. STAMINAL FILAMENT 0.1 mm wide, collar not swollen, 0.2-0.3x0.1 mm. ANTHERS 1.3 mm long, theca with tails as long as the filament collar, apical appendage triangular, 0.4-0.5 mm long, endothecal

tissue 'polarized'. STYLE base slightly swollen, placed on a shortly conical nectary; branches dorsally papillate, stigmatic surface continuous, apex rounded with spreading papillae around the abaxial margin. OVARY WALL CRYSTALS numerous, hexagonal and octagonal plates 10-12x5 µm predominant. PAPPUS white, of many stout, persistent bristles in 2-3 rows; barbellate basally with acute teeth, cells enlarged distally with spreading teeth 4-6 times longer than broad; apex 2-4 celled, subplumose. ACHENES homomorphic, red-brown, subcylindrical, 2.5-3x0.6 mm; surface glabrous, with 5 narrow longitudinal grooves (achenes rarely maturing).

Flowering period: November to February.

Chromosome number: 2N = 60.

General distribution. The Otway Ranges, the Great Dividing Range as far North as the Australian Capital Territory and adjacent coastal mountains. Common in Tasmania.

Habitat. Cool, wet sclerophyll forests, frequently in gullies.

Collection sites. Victoria: ML1096-98: wet-sclerophyll forest, Lilly Pilly Gully nature walk, Wilson's Promontory National Park; 3.xii.1978. - ML1132: wet-sclerophyll forest, 9 km N. Cape Otway lighthouse; 5.xii.1978. New South Wales: ML1432: roadside margin of wet-sclerophyll forest, 53.6 km from Thredbo on road to Khancoban; 31.xii.1978.

Discussion. The genus Bedfordia is endemic in Australia and contains only two species, B. salicina and B. linearis. B. salicina is the only truly cacalioid (sensu Nordenstam 1977) species included in this study. It has a continuous stigmatic surface, a cylindrical filament collar, "polarized" endothecal tissue and a chromosome number of 2N = 60. Some of these

characters occur singly in other species investigated but never combined as in B. salicina.

Bentham (1866) wrongly described the tomentum of Bedfordia as more or less stellate. Willis (1957) recognised the error and correctly described the tomentum as consisting of simple cirriform hairs intertwined in little groups. Bentham's error, perpetuated until as recently as 1963 (Curtis, Students Fl. Tasm. 2:287) was most significant as stellate hairs are genuinely rare in Senecioneae (Nordenstam 1977).

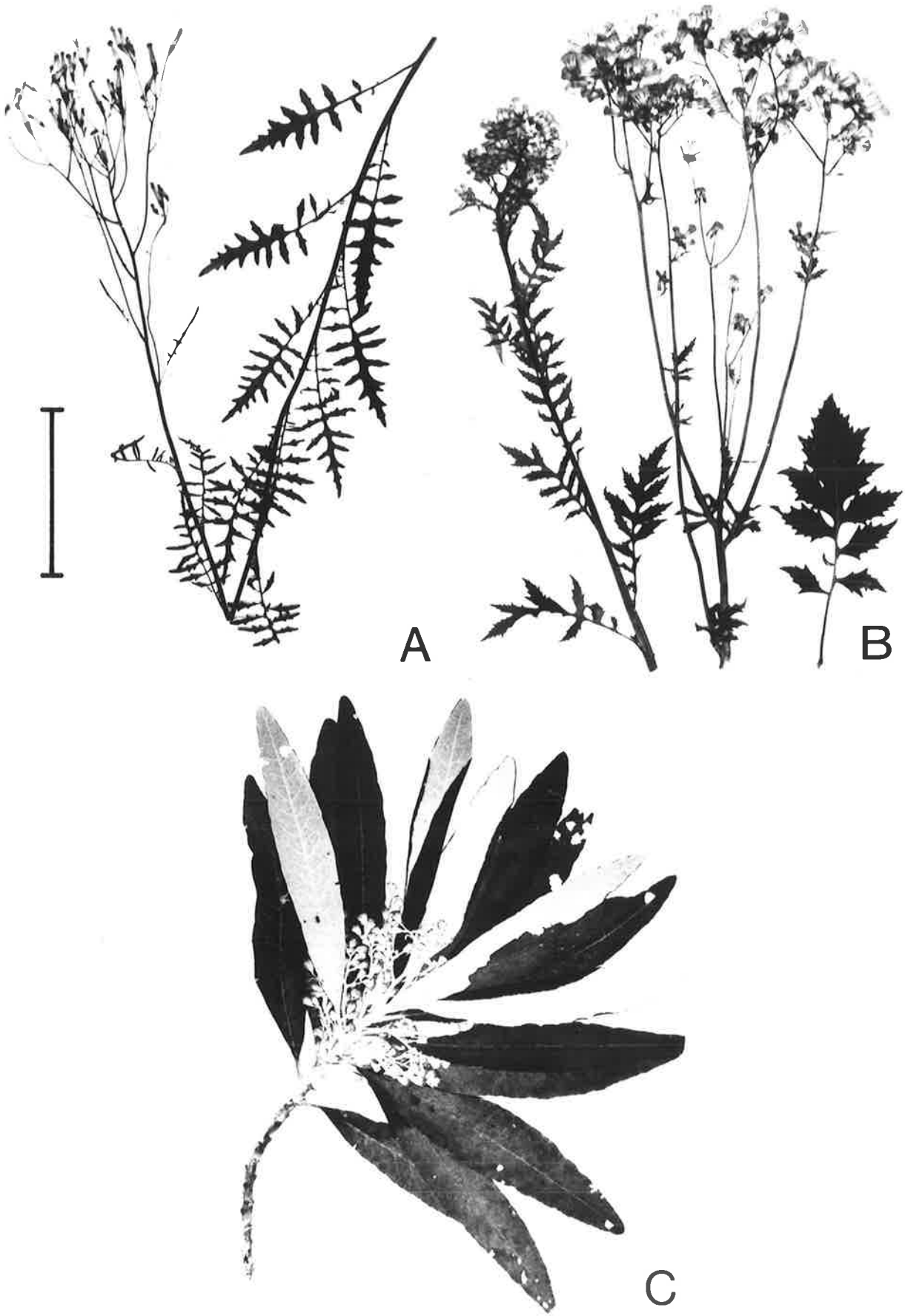

Fig. 3.13 A. Arrhenechtites mixta. B. Erechtites valerianaefolia. C. Bedfordia salicina. All figures at same magnification. Scale 10 cm.

3.6 Relationships Deduced From Morphological Evidence

The purpose of this discussion is to indicate as objectively as possible relationships apparent from morphological evidence alone. In later chapters the validity of such a scheme will be tested with further evidence.

3.6.1 Primitive Character Status

To construct a phylogeny for any group of related species it is first necessary to determine which character states are primitive. In recent years, Senecio and Senecioneae have received considerable attention (Jeffrey et al. 1977, Jeffrey 1979, Nordenstam 1977, 1978), but studies have concentrated on phenetic rather than phylogenetic relationships. In order to determine primitive character states in Senecio I therefore combined evidence from the following sources:

1. phylogenetic relationships of tribes of Compositae (Cronquist 1953, 1977, Carlquist 1976, Stebbins 1974, Jeffrey 1977);

2. general evolutionary trends observed among angiosperms (Eames 1951, Davis and Heywood 1963);

3. basic principles applied in the choice of primitive character states (Maslin 1952, Crisci and Stuessy 1980).

To simplify the discussion I have only considered characters that vary among Australian species. For example, opinions differ as to whether opposite or alternate leaves are primitive (Carlquist 1976, Cronquist 1977). Both states occur in Senecioneae (Nordenstam 1977) but all Australian species of Senecio have alternate leaves.

There is considerable agreement concerning a number of characters within the Compositae. Carlquist (1976) and Cronquist (1955, 1977) agree that the following features are probably primitive.

1. heads few, each with many flowers
2. involucre leafy, several-seriate
3. receptacle chaffy
4. disc flowers perfect and fertile
5. lobes of disc corolla with midvein
6. anthers without tails
7. stigmatic surface not differentiated
8. growth form "shrubby"

All Australian species of Senecio have uniseriate involucral bracts but most have a number of reduced bracts at the base of the involucre which are collectively called a calyculus. If the calyculus is interpreted as a vestigial row or rows of involucral bracts, then a calyculus of many long bracts is most primitive and absence of the calyculus is most advanced. The general trends of free parts being more primitive than fused parts and uniform structures more primitive than dimorphic structures (Davis and Heywood 1963) can be applied respectively to the involucre and pappus of Australian species of Senecio.

There are three basic capitulum forms in Australian species of Senecio, but opinions differ as to the primitive capitulum form in Compositae. Carlquist (1976) commented that "I tend to believe that all flowers were discoid in ancestors of Asteraceae, with a tendency towards production of zygomorphic flowers at the periphery of the head." The opinion of Cronquist (1977) is that "differentiation of marginal flowers of the head as rays may have accompanied or even preceeded the origin of the Compositae as a distinctive group, so that even the discoid tribes may well have

a radiate ancestry." A third view presented by Jeffrey (1977) is that the primitive floret form was bilabiate (Fig.3.14A) and that discoid and ray florets are both derived. On morphological grounds alone, I do not believe that capitula of either the radiate or discoid species of Senecio can be said to be most primitive. However, it is possible to suggest an evolutionary scheme for erechthitoid species.

Australian species of Senecio were divided into three groups in the key to species on the basis of floret distributions within capitula. Briefly reviewed these are as follows:

1. Radiate species - outer row of florets female and radiate (Fig. 3.14E), inner florets bisexual and discoid (Fig. 3.14C).
2. Discoid species - all florets bisexual and discoid
3. Erechthitoid - outer 2-3 rows female, filiform and lobed (Fig. 3.14D) inner florets bisexual and discoid.

Capitula of radiate and erechthitoid species are both heterogamous, therefore it might be concluded that erechthitoid capitula arose by loss of rays from radiate capitula. However, occasional loss of rays in Senecio glossanthus and in New Zealand species of Bedfordia (Nordenstam 1977) leads to marginal female and filiform florets that do not have lobed corollas (Fig. 3.14G). On the other hand, marginal florets of the discoid Senecio vulgaris observed in this study were frequently found to have four lobes and four anthers - a possible step towards lobed filiform florets (Fig.3.14D). Although I favour the latter sequence of floret evolution in erechthitoid species of Senecio, the sequence does not exclude evolution of erechthitoid capitula from radiate ones. Instead, the sequence suggests that ray florets must first be lost completely (as in some New Zealand

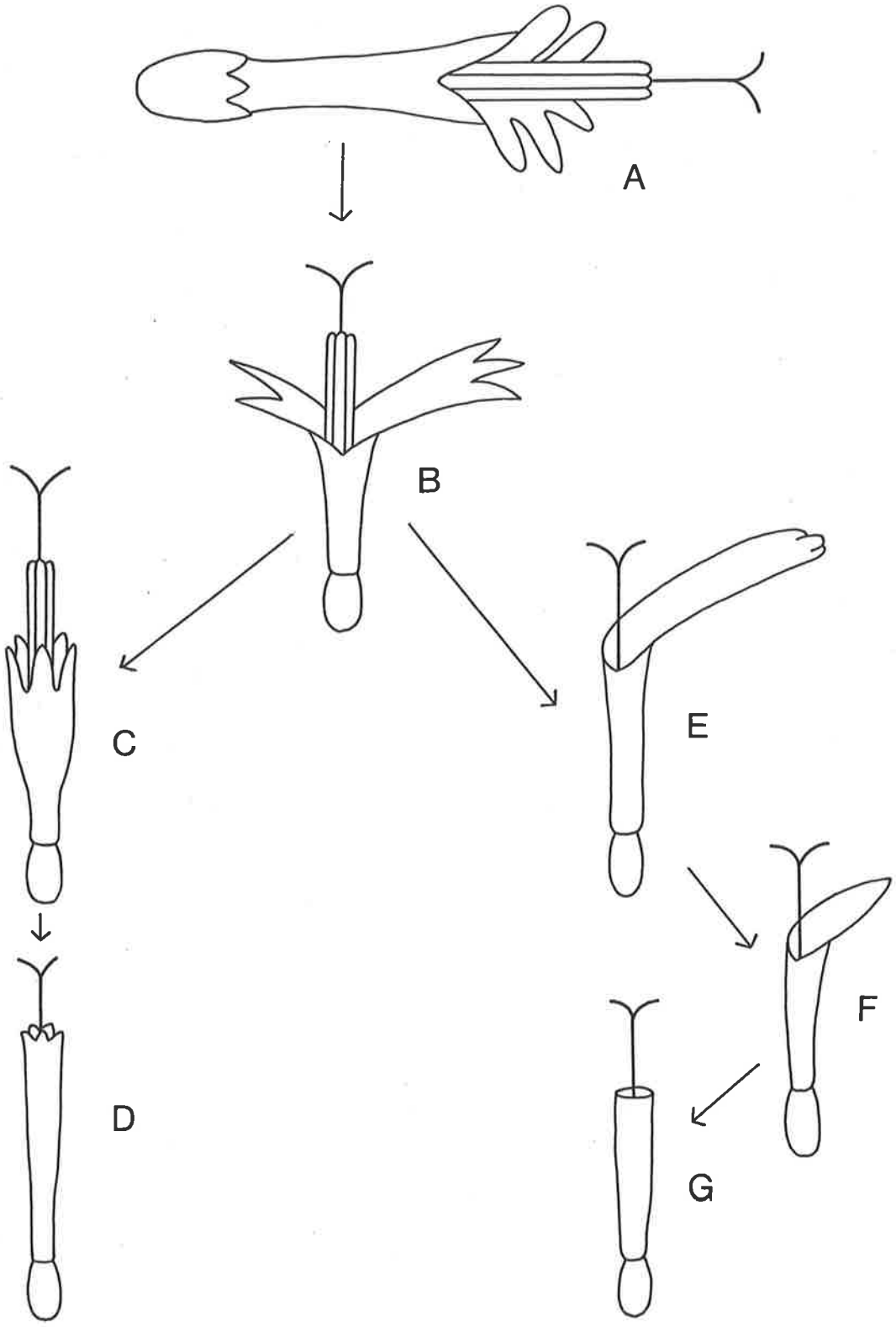

Fig. 3.14 Postulated scheme of evolution of floret types in Compositae (after Jeffrey, 1977). A. Ancestral bilabiate. B. Bilabiate 2+3. C. Bisexual disc. D. Filiform female with lobes. E. Female ray. F. Reduced female ray. G. Filiform female without lobes.

forms of S. lautus subsp. lautus) followed by marginal differentiation of bisexual discoid florets. The question of whether erechthitoid species arose from Australian radiate or discoid taxa will be considered again in view of other morphological evidence.

3.6.2 Groups of Species

To compare degrees of evolutionary advancement it is useful to first group species on a morphological basis. The previously used divisions of "radiate", "discoid" and "erechthitoid" species are based only on floret distributions and need to be re-examined in terms of total morphology. It is then apparent that discoid and erechthitoid species form largely natural groups but radiate species do not.

The most important departure, found in the radiate S. magnificus, S. macranthus, S. vagus and S. pectinatus, is a partially or completely continuous stigmatic surface. A continuous stigmatic surface was one of three characteristics used by Nordenstam (1977, 1978) to separate "senecioid" from "cacalioid" genera within Senecioneae, and is a frequently used characrer in modern treatments of Compositae (see reviews in "The Biology and Chemistry of the Compositae (Heywood, Harbourne and Turner, 1977)). On this basis alone, species of Senecio with a continuous stigmatic surface should be recognized as a distinct subgroup, and might even constitute a separate genus. However, the latter possibility must be considered with respect to variation in all species of Senecio and variation in other genera of Senecioneae.

Generic status for these species is weakened by the occurrence of a superficially continuous stigmatic surface in S. amygdalifolius and S. velleioides. When viewed at 100x magnification

the stigmatic surface of both is seen to be divided by a very narrow line lacking stigmatic papillae. However, S. amygdalifolius and S. velleioides are clearly related to S. magnificus, S. macranthus, S. vagus and S. pectinatus by their comparatively large capitula and florets, a domed rather than truncate style branch apex, a pappus of uniform bristles and glabrous leaves and stems - characteristics that are uncommon or not found in other Australian species of Senecio. S. amygdalifolius and S. velleioides are therefore placed with species having a continuous stigmatic surface. It is difficult to suggest further relationships between species of this group as they are in other respects quite diverse (see Table 3.4).

Two species, S. linearifolius and S. sp. A, have a marginal row of ray florets but areotherwise more closely related to discoid species. S. linearifolius has eight involucral bracts, about twelve bisexual florets, many capitula with short peduncles, short red-brown achenes with flat surface segments and branches often arising at or near ground level. These features are typical of discoid taxa such as S. hypoleucus but are uncommon or unknown among other radiate species. S. sp. A has higher floret and phyllary numbers than S. linearifolius but is otherwise similar. Furthermore, the dense pubescence of S. sp. A does not occur in other radiate species but is found in the discoid S. hypoleucus and S. cunninghamii var. A. S. linearifolius and S. sp. A are accordingly placed as a subgroup of the otherwise discoid species.

The remaining radiate species. S. lautus, S. glossanthus, S. gregorii and S. spathulatus are a diverse assemblage but appear to be more closely related to each other than to species of other groups. The radiate group therefore contains two subgroups - the four above mentioned species, and the six species

TABLE 3.4

Characteristics of *Senecio* species with Continuous or Superficially Continuous Stigmatic Surfaces

Character	*magnificus*	*velleioides*	*macranthus*	*pectinatus*	*vagus*	*amygdalifolius*
Stigmatic surface divided	-	-	-	-	-	+
Filament collar very narrow	-	+	-	-	-	+
Ray corollas hairy	+	+	+	-	-	+
Disc corollas hairy	+	-	+	-	-	-
Veins on ligule >4	+	-	-	-	+	-
Corolla lobes recurved	-	-	-	-	-	+
Florets >60	-	-	+	+	-	-
Female Florets >5	+	+	+	+	+	-
Capitula solitary	-	-	-	+	-	-
Calyculus present	-	-	+	+	+	+
Calyculus radiating	NA	NA	+	-	+	+
Peduncles distally inflated	+	+	-	-	-	-
Leaves glaucous	+	+	-	-	-	-
Stipules or auricles present	+	+	+	-	-	-

with continuous or superficially continuous stigmatic surfaces. It could be argued that the latter comprise a fourth and separate major grouping, or a separate genus, but in view of the intermediate nature of S. amygdalifolius and S. velleioides, the "radiate" category is maintained through Chapters 4 to 8 and is reviewed in Chapter 9 in the light of additional evidence.

A characteristic that does link all radiate species (as circumscribed above) is their general lack of pubescence. Of the ten species, seven are completely glabrous and three are sparsely pubescent as follows:

1. S. vagus subsp. vagus has large glandular hairs on the involucre.

2. S. glossanthus usually has a few long hairs on the youngest shoots.

3. S. lautus subsp. alpinus is occasionally pubescent on the stem (S. lautus subsp. pilosus is very hairy but is known only from the holotype).

Drury (1973a) considered that completely glabrous species are most uncommon in Senecio, however, most of the New Zealand species studied by Drury are now recognised as "cacalioid" (Nordenstam 1978) and have been transferred to Brachyglottis. Of the remaining Australian Senecio species only the erechthitoid S. biserratus and S. sp. B are apparently glabrous. The discoid S. anethifolius, S. cunninghamii var. cunninghamii and S.odoratus var. obtusifolius are glabrate, having a few long hairs on the youngest shoots, but all other discoid and erechthitoid species are variously pubescent.

Erechthitoid species can be separated into two subgroups on the basis of growth form. Other characteristics are generally but not exclusively correlated. Subgroup 1 contains the perennial herbs, S. quadridentatus, S. gunnii, S. aff. apargiaefolius

and S. runcinifolius which have in common a white tomentum on young vegetative shoots, and (with the exception of S. runcinifolius) long slender achenes that are green, red-brown or black in one capitulum. The remaining nine species form a second subgroup, all of which are annual and most of which have short, red-brown achenes and hispid or a mixture of hispid and arachnoid pubescence.

The major groups and subgroups of Australian species of Senecio and their general characteristics are summarized in Table 3.5.

3.6.3 Degree of Evolutionary Advancement

To assess evolutionary advancement eight characters with primitive and advanced states among Australian species were selected. As there are four growth form states (character 8, Table 3.6) each state (form) was assigned a score from 1 (most primitive) to 4 (most advanced). Characters with three states were assigned scores of 1,2.5 and 4 and 2-state characters were assigned scores of 1 and 4. Characters, states and scores are given in Table 3.6, and the scores for species and groups in Table 3.7. All radiate species are listed in Table 3.7 as each has a different total score, but only subgroups of discoid and erechthitoid species were included as species within these subgroups have identical character states. Total scores indicate that S. macranthus has the greatest number of primitive character states and that annual erechthitoid species (Group 3B) have the least. The order of evolutionary advancement among groups is therefore:

TABLE 3.5

Major Groups and Subgroups of
Australian Species of *Senecio*

GROUP 1

Capitula heterogamous radiate, large and few in inflorescence; involucral bracts (8-)11-22; anther bases acute or obtuse; achenes various; stems usually single at ground level; plants glabrous or glabrate; ephemerals, annuals or perennials.

SUBGROUP A	SUBGROUP B
Stigmatic surface continuous or superficially so.	Stigmatic surface of discrete marginal lines
S. magnificus	*S. lautus*
S. velleioides	*S. glossanthus*
S. macranthus	*S. spathulatus*
S. pectinatus	*S. gregorii*
S. vagus	
S. amygdalifolius	

GROUP 2

Capitula usually homogamous discoid, small and many in inflorescence; involucral bracts 8(-14); anther bases often shortly tailed; achenes short and red-brown; multistemmed at ground level; usually white-tomentose at least on young shoots; perennials.

SUBGROUP A	SUBGROUP B
Ray florets absent	Ray florets present
S. hypoleucus	*S. linearifolius*
S. odoratus	*S.* sp. A
S. cunninghamii	
S. anethifolius	
S. gawlerensis	

Table 3.5 - continued

GROUP 3

Capitula heterogamous discoid, small and usually many in inflorescence; involucral bracts usually 8 or 12; anther bases acute or obtuse.

SUBGROUP A	SUBGROUP B
Tomentose at least on young shoots; multistemmed at ground level; achenes long, often green, red-brown and black in one capitulum; perennials	Usually hispid or scabrous; single stemmed at ground level; achenes usually short and red-brown; annuals.
S. quadridentatus	S. biserratus
S. gunnii	S. sp. B
S. aff. apargiaefolius	S. squarrosus
S. runcinifolius	S. bipinnatisectus
	S. minimus
	S. picridioides
	S. glomeratus
	S. hispidulus
	S. sp. C

TABLE 3.6

Primitive and Advanced Character States of Australian Species of *Senecio*

Character	States (scores in parentheses)
1. Stigmatic surface	continuous (1) superficially continuous (2.5) discrete lines (4)
2. Anther base	acute or obtuse (1) tailed (4)
3. Involucral bracts	free (1) fused (4)
4. Calyculus	long bracts (1) short bracts (2.5) absent (4)
5. Capitula	large and few (1) small and many (4)
6. Filiform florets	absent (1) sometimes present (2.5) always present (4)
7. Pappus bristles	uniform (1) dimorphic (4)
8. Growth form	perennial shrub (1) perennial herb (2) annual (3) ephemeral (4)

TABLE 3.7

Scores Indicating Evolutionary Advancement of Species and Groups of *Senecio* native in Australia

Species or Group	Character (see Table 3.6) 1	2	3	4	5	6	7	8	Total Score
S. magnificus	1	1	1	4	1	1	1	1	11
S. velleioides	1	1	1	4	1	1	1	3	13
S. macranthus	1	1	1	1	1	1	1	1	8
S. pectinatus	1	1	1	1	1	1	1	2	9
S. vagus	1	1	1	1	1	1	1	3	10
S. amygdalifolius	2.5	1	1	1	1	1	1	1	9.5
S. lautus	4	1	1	2.5	1	1	4	1	15.5
S. glossanthus	4	1	1	2.5	4	2.5	4	4	23
S. spathulatus	4	1	1	2.5	1	1	1	1	12.5
S. gregorii	4	1	4	4	1	1	1	4	20
Group 2A*	4	4	1	2.5	4	1	4	1	21.5
Group 2B	4	4	1	2.5	4	1	4	1	21.5
Group 3A	4	1	1	2.5	4	4	4	2	22.5
Group 3B	4	1	1	2.5	4	4	4	4	24.5

*Species within groups listed (see Table 3.5) have identical scores.

1. radiate species with continuous stigmatic surfaces (Group 1A);
2. radiate species with discrete stigmatic surfaces (Group 1B);
3. discoid species (Group 2A and 2B);
4. perennial erechthitoid species (Group 3A);
5. annual erechthitoid species (Group 3B).

If primitive states are often associated with one another (Crisci and Stuessy 1980) then one could speculate that, in Senecio, a radiate capitulum and general lack of pubescence are also primitive. However, to be certain of such a trend a much greater proportion of the genus would need to be sampled.

3.6.4 Phylogenetic Speculations

A major problem in constructing a phylogeny for Australian species of Senecio is that it cannot be assumed that they are a monophyletic group. Senecio is a cosmopolitan genus with an apparent center of origin in Africa (Ornduff 1964). It is therefore possible that several ancestral species were independently dispersed to Australia at quite different points on the geological time scale. Only erechthitoid species of Senecio are centered in Australasia (Belcher 1956), and as has been shown above, these are the most advanced of Australian species. Evolutionary pathways of floret differentiation (Fig. 3.14) and discussion) suggest that erechthitoid species evolved either from a radiate ancestor after the loss of ray florets (as in New Zealand populations of S. lautus), or directly from a discoid ancestor. Evidence suggests that the latter may be the case. Achenes of all discoid species (Group 2) and of most annual

erechthitoid species (Group 3B) are indistinguishable from one another and have no parallel among radiate taxa. Achenes of perennial erechthitoid species differ from all other groups and provide no clue to their origins, but the growth form and pubescence of perennial erechthitoid species are similar to those of discoid species. Capitulum form suggests that a discoid species must be ancestral to the two erechthitoid groups, but it is not possible to arrange groups in a logical linear evolutionary sequence. Based on generation length a linear sequence would separate groups with identical achene morphologies, whereas placing groups with similar achenes together implies that perennial erechthitoid species arose from annual ones. A more acceptable thesis is to assume that early and now extinct erechthitoid plants were perennials with short red-brown achenes, and that extant species represent different evolutionary lines conserving either achene morphology or generation length.

The phylogenetic position of S. linearifolius could also be interpreted in a number of ways. The growth form, pubescence, inflorescence structure, capitulum size and achene type of these species are typical of "truly" discoid species such as S. hypoleucus, but both possess ray florets. Alternative possibilities are that S. linearifolius and S. sp. A represent intermediate steps in an evolutionary sequence from radiate to discoid capitula, or instead, that introgression has occurred between the groups. I believe two facts support the latter possibility. Firstly, S. linearifolius is a morphologically variable species with distinct forms occurring in The Grampians of Victoria, alpine areas and wet sclerophyll forests. S. sp. A and other discoid species are not as variable, and in most cases have restricted or relictual distributions. It would seem unlikely that a variable species such as S. linearifolius gave rise to

species with relict distributions outside its present range. Alternatively, if S. sp. A is ancestral on the basis of its relict distribution, then one must explain the sudden appearance of a dense tomentum among the generally glabrous radiate species. Introgression seems therefore to be a more likely explanation. One could even speculate that such an event occurred in the vicinity of the Grampians in Victoria as a disjunct population of the tomentose S. hypoleucus and the only tomentose variety of S. linearifolius occur here within a few kilometers of one another.

In the case of radiate species, I believe one must assume that the two subgroups represent independent migrations to Australia. As the continuous stigmatic surface of subgroup B is more primitive than the divided stigmatic surface of subgroup A (and of other Australian species), a common Australian ancestry for radiate species would imply that the typically "senecioid" stigmatic surface of subgroup B evolved independently in Australia. The question then remains as to whether species with a continuous stigmatic surface belong to Senecio or to another genus. There are other genera of Senecioneae in Australasia with continuous stigmatic surfaces - Bedfordia in Australia, and Brachyglottis, Urostemon, Dolichoglottis and Traversia in New Zealand. However, these genera are all truly "cacalioid" as they also have polarized endothecal tissue and a cylindrical filament collar. Australian species with continuous stigmatic surfaces are otherwise "senecioid" with radial endothecal tissue and swollen filament collars. Furthermore, the stigmatic surface of S. amygdalifolius is only superficially continuous, being separated by a minute longitudinal line lacking papillae. The generic status of these species must therefore await the circumscription of Senecio sensu stricto, and will depend on

whether the latter excludes continuous stigmatic surfaces.

The relationships discussed above are summarized in Figure 3.15 and will be reviewed in later chapters. The following notes pertain to the three species from other genera of Senecioneae included for comparative purposes.

1. Bedfordia salicina. Polarized endothecal tissue and a cylindrical filament collar relate this species to genera such as Brachyglottis rather than to Senecio. A common ancestry might therefore date back to the origins of Senecioneae.

2. Arrhenechtites mixta. Belcher (1956) described this species as having functionally male disc florets but I found that disc florets were bisexual with reduced style branches. A. mixta has shortly ligulate marginal florets, broad but discrete stigmatic lines, mixed polarized and radial endothecal tissue and a slightly swollen filament collar. Furthermore it is endemic in Australia. I do not agree with Belcher's (1956) justifications for transferring Senecio mixtus to Arrhenechtites (see discussion following description). If instead, A. mixta arose from a "senecioid" ancestor in Australia, then the presence of ray florets suggest a radiate ancestry. The broad stigmatic surfaces could be linked with S. amygdalifolius and the unusually pigmented hairs are paralleled in S. vagus as is the dissected foliage. Although highly speculative, A. mixta might therefore be a derivative of Senecio species with continuous stigmatic surfaces.

3. Erechtites valerianaefolia. This species is superficially similar to erechthitoid species of Senecio, but differs in the shape of the style and in belonging to a genus centered in South America. A comment by Carlquist (1976) is particularly relevant in cases of apparent similarity: "An annoying circumstance in

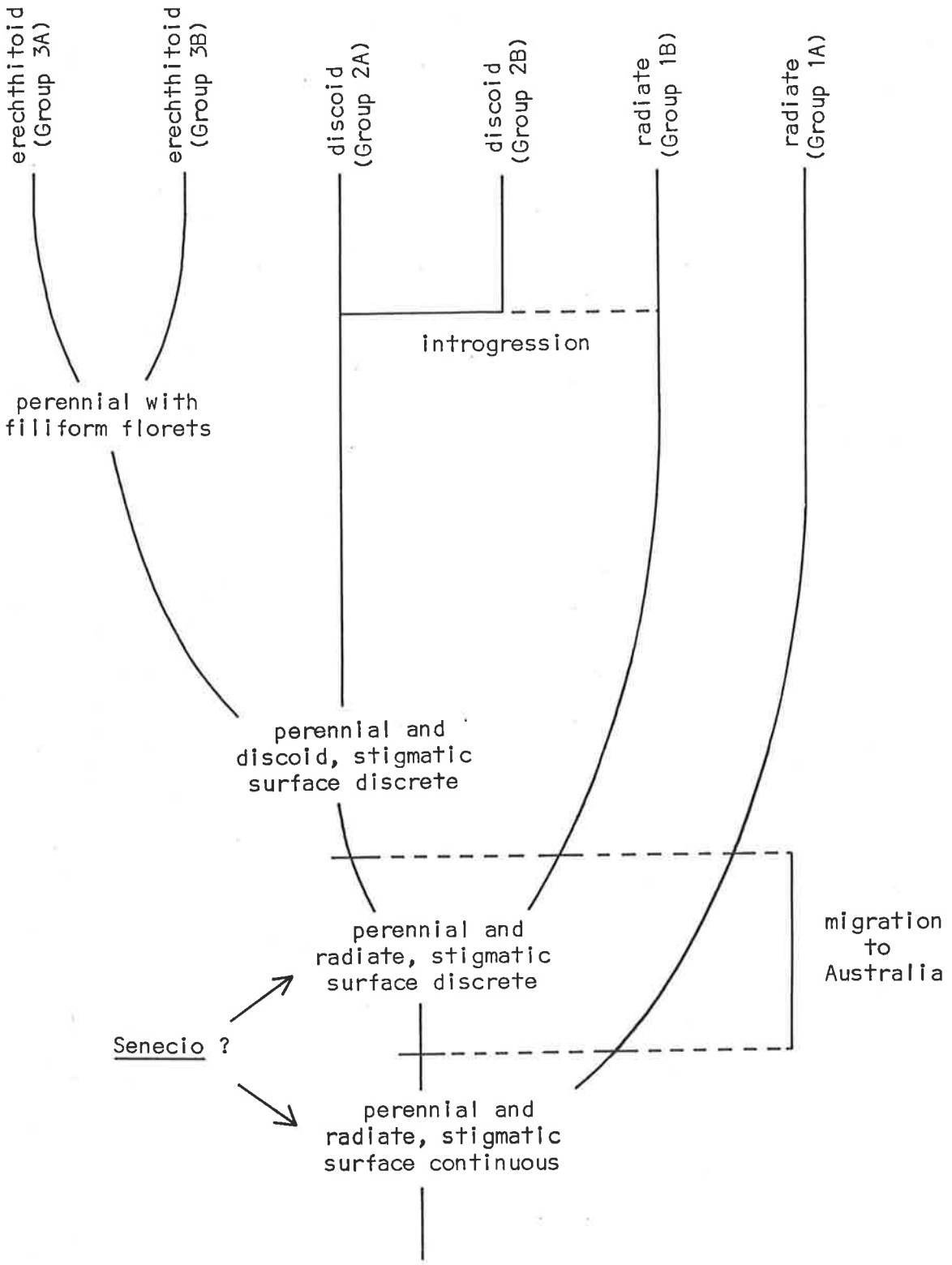

Fig. 3.15 Proposed scheme of evolution of groups and subgroups of Australian species of Senecio based on morphological evidence (see text for explanation).

these instances is the probability that any feature that has evolved in Asteraceae once may well have evolved more than once." Erechtites valerianaefolia and erechthitoid species of Senecio are apparently an example of such an event.

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Australian species of Senecio not included in investigations

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S. gilbertii[1]
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S. laticostatus[3]
S. leptocarpus[2]
S. leucoglossus[1]
S. megaglossus[3]
S. papillosus[2]
S. platylepis
S. primulifolius[2]
S. ramosissimus[1]
S. tuberculatus

* * *

1. endemic in Western Australia
2. endemic in Tasmania
3. very rare, possibly extinct.